TRINIDAD AND TOBAGO: TT-L1055: NATIONAL WATER SECTOR TRANSFORMATION PROGRAM

ENVIRONMENTAL AND SOCIAL ASSESSMENT FOR THE TRINIDAD AND TOBAGO NATIONAL WATER SECTOR TRANSFORMATION PROGRAM

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PROPRIETARY RESTRICTION NOTICE

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Environmental Solutions Limited would like to thank the project team who worked in conducting this assessment. In particular, special thanks to Dr. Theresa Rodriguez-Moodie, Team Leader and Environmental Management Specialist; Mrs. Annmarie Goulbourne, Project Manager and Environmental and Social Specialist; Mr. Ian Gage, Water and Sanitation Engineer; Dr. Fredericka Deare, Social and Gender Specialist; Mrs. Marilyn Crichlow, Water Resources Specialist; and Mr. Richard Coutou, Geologist.

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EXECUTIVE SUMMARY

The purpose of the National Water Sector Transformation Program TT-L1055 in Trinidad and Tobago(T&T) is to improve the efficiency and quality of potable water services and water security in Trinidad and Tobago. The Government of the Republic of Trinidad and Tobago (GoRTT) has sought funding from the Inter-American Development Bank through a Conditional Credit Line for Investment Project (CCLIP) to fund the program. The CCLIP will be implemented in various operations and the first operation which has three components will be carried out in several regions of Trinidad and Tobago. In compliance with the Bank's safeguards policy, the Consultants have been required to prepare the following:

1. Environmental and Social Assessment with framework approach
2. Environment and Social Management Plan (including a Stakeholder Engagement Plan and a Grievance Management Mechanism) with framework approach
3. Programmatic Environmental & Social Evaluation
4. Programmatic Environmental & Social Guidelines

This Environmental and Social Assessment evaluates the most relevant in terms of infrastructure and associated impacts of the following components:

- **Component 1. Water Stabilization and Improvement: (US$44 Million).** This component will finance the development of a comprehensive program to urgently stabilize water supply services to prevent further service decline throughout the country and to ensure access to water, sanitation and hygiene to unserved and underserved households. The activities to be financed include: (i) Construction of new water treatment infrastructure in six locations at Ravine Sable, Sangre Grande, Santa Cruz-Green Meadows, Goldsborough River, Blue Basin and Mayaro, inclusive of intakes; (ii) Refurbishment & upgrading water treatment infrastructure for nine WTPs at Freeport, Caroni, North Oropouche, Guanapo, Maraval, Navet, Hillsborough, Chatham and Courland; (iii) Drilling and equipping of three new wells at Freeport; (iv) Rehabilitation of El Socorro high lift and booster station (v) Drilling and equipping new wells at Penal, Chatham/Palo Seco, and Tucker Valley.

- **Component 2. Support for Water Sector Transformation Plan: (US$2.74 Million).** The Bank's AquaRating International Standard will be used to characterize the performance of WASA and establish a baseline for the restructuring efforts. The results of the assessment will inform the effort to restructure and transform WASA, including addressing issues such as (i) gender equality, diversity and inclusion at the company level; (ii) Resilience to Climate Change, Natural Disasters and Risk management and promulgation throughout WASA; and (iii) Improvement of the Ministry of Public Utilities' (MPU) technical oversight capacity for coordination of water sector transformation and stabilization. In addition, institutional strengthening could be considered to separate the functions of water resources management from WASA and to implement Integrated Water Resources Management (IWRM) supported by a HydroBID based information system.

Component 3. Network Optimization: (US$31 Million). This component will finance priority works to optimize network performance and reduce non-revenue water. These works will be executed through a Co-Management Performance Based Contract with a specialized consulting firm (CF) which would involve WASA and the CF working together as a single Project Team to deliver the targeted results. This would allow for the seamless transfer of know-how and expertise to WASA that is crucial to the long-term sustainability and success of the program. The CF will be required to prepare and implement a Non-Revenue Water Reduction Strategy and Program for the country. The water audit under TT-T1108 will provide production and transmission flows and pressure data as well as hydraulic models to inform the NRW program. Reduction of commercial and physical losses as part of the NRW Reduction program will be implemented. The CF will also provide strategic advice and technical support to the Executive Team of WASA in the transformation of WASA. Under this component, flow and pressure monitoring and water loss reduction will be achieved through (i) the replacement of aged and fragile transmission and distribution network to reduce water loss and high leakages in Petit Valley, La Cuesta, Freeport, Wallerfield and Pt. Fortin; Mt. Lambert, North West; Nelson Street, POS; Laventille; Valsayn South; Freeport Todd and La Cuesta (ii) Installation of two hundred and fifty-six (256) bulk meters and loggers to monitor via telemetry systems production and flows for various facilities (water treatment plants, wells and booster stations) throughout T&T, (iii) selective implementation of DMAs/PMAs, targeted leak detection and repair, smart water infrastructure tools (SWIT), and management information systems; (iv) Implementation of remote monitoring and control SCADA automation for real-time analysis of the most critical areas around T&T; and (v) training and capacity building of WASA personnel in water loss management and SWIT.

Project management and other costs:(US$2.26 Million). This component will finance administrative expenses including, support for project execution (PEU) dedicated staff, audits, monitoring and evaluation, communication, and supervision and implementation of an Environmental and Social Management Plan (ESMP).

The project area extends across several operational zones in Trinidad and Tobago encompassing the following municipalities:

1. Diego Martin
2. San Juan/Laventille
3. Port of Spain
4. Borough of Arima
5. Tunapuna/Piarco
6. Couva/Tabaquite/Talparo
7. Siparia
8. Mayaro/Rio Claro

9. Princes Town

The multi-disciplinary team of experienced scientists and environmental professionals conducted data gathering and analysis together to determine the dominant environmental issues relevant to the proposed project and to identify the potential impacts and mitigation measures. Detailed review of secondary data was used to inform the assessment. Among the key activities were:

- Desktop research
- Analysis of maps and plans
- Review of reports and background documents
- Stakeholder consultations

Other proposed developments and surrounding land use were also reviewed in the context of compatibility with the proposed project including potential positive, negative and cumulative impacts.

The Existing Environment

Physical

The climate of Trinidad and Tobago is tropical, warm and humid with two major seasons: a dry season from January to May and a wet season from June to December. A short dry spell, 'Petite Careme,' typically occurs in the middle of the wet season in September or October. Climate change is expected to affect the island by resulting in reduced rainfall, increased rainfall intensity resulting in higher runoff and flash floods, increased temperatures, sea level rise and more frequent storms.

Trinidad is located along the south-eastern margin of the Caribbean Plate along the southern strike-slip boundary with the South American Plate and several major faults through the island. The region is therefore tectonically active with both shallow and deep earthquakes.

The project area is located along the western section of the Northern Range which has a high susceptibility to landslides. Here, the terrain is mountainous with deep valleys and flatlands mainly to the southern section of the mountain range leading into the flatlands of the Caroni Basin. These valleys and flatland areas have undergone significant development. The watersheds along Trinidad's North Coast are largely pristine and minimally impacted by anthropogenic activity. However, the watersheds that originate in the south slopes of the Northern Range have been heavily impacted by the array of activities that occur within them. The project area is typically affected by natural hazards such as floods, drought, landslides, earthquakes, hurricanes and climate change.

Apart from Port of Spain, the majority of land in the municipalities included in the project area is underdeveloped. More than 70 percent of land in Diego Martin and San Juan/Laventille is considered forest reserve, with agriculture occupying less than 10 percent of land area in either municipality. Similarly, in Blanchisseuse, the most northern community of Tunapuna/Piarco, agriculture, forest reserves and protected areas prevail. Aside from green spaces, residential land use dominated developed areas in both Diego Martin and San Juan/Laventille. In contrast to its neighboring regions, Port of Spain is highly urbanized with no significant agricultural land use, limited environmentally sensitive areas and large tracts of residential and commercial land use.

Ecological

The study area is strongly influenced by human activities and can be characterised as disturbed to highly disturbed. The project area consists of significant areas of residential settlement, commercial and industrial activities. The hilly areas within the project area are a part of the general Northern Range ecosystem that runs along the northern boundary of Trinidad. South of Port of Spain is the Caroni Swamp which is an ecologically sensitive area. The habitats found in the project area have been demarcated in three zones and are discussed as follows: (i) the Northern Range, (ii) the Caroni Swamp and (iii) the developed urban area. The Northern Range and the Caroni Swamp are considered sensitive ecosystems.

Social

The project area for this Consultancy covers all areas of Trinidad and Tobago. However, the first and third component focuses on the North-West, North-East, Central, South regions of Trinidad and operational zones in Tobago which includes the following municipalities:

- Diego Martin (including the islands of (Gaspar Grande, Monos)
- San Juan/Laventille
- Port of Spain
- Tunapuna/Piarco
- Couva/Tabaquite/Talparo
- Siparia
- Mayaro/Rio Claro
- Princess Town
- Borough of Arima

The project is spread over the entire island of Tobago, while Trinidad represents an estimated area of 3,551 km^2, which consists of almost 77% of the island's population (CSO, 2012). The project area covers several municipalities with varying population densities. The project area have some of the highest population densities across Trinidad and Tobago. The majority of the municipalities in Trinidad and parishes in Tobago have experienced growth in population between 2000 and 2011 excluding Port of Span, Diego Martin, San Juan/Laventille and the parish of St. John which experienced a decline in populations.

Impact Assessment and Proposed Mitigation Measures

The project has several potential direct negative impacts, these are mostly short-term and reversible and can be mitigated. Once mitigated, the potentially negative physical and ecological impacts highlighted above are significantly minimised.

The table below summarises the identified impacts in terms of their magnitude, nature of the impact, spatial extent of the project impacts, duration, direction and permanence of the impact.

RISK	MAGNITUDE OF IMPACT	NATURE OF POTENTIAL IMPACT	SPATIAL EXTENT	DURATION	DIRECTION OF IMPACT	PERMANENCE	RESIDUAL IMPACTS POST MITIGATION
Soil erosion	Minor	Loss of topsoil; Sedimentation; soil disruption; negative water quality impact	Areas surrounding construction activities	Medium-long term	Negative	Irreversible	Minor
Soil contamination	Minor	Contamination of water resources	Areas surrounding construction activities	Medium term	Negative	Reversible	Minor
Land pollution	Minor	Poor aesthetics; soil contamination; contamination of water resources	Areas surrounding construction activities	Short term	Negative	Reversible	Minor
Water pollution	Moderate	Contamination of water resources (surface and groundwater)	Areas surrounding construction activities	Medium-long term	Negative	Reversible	Minor
Increased noise	Moderate	Nuisance; Hearing impairment; wildlife disruption	Areas surrounding construction activities	Short term	Negative	Reversible	Minor
Increased dust and emissions	Moderate	Respiratory conditions; possible contribution to climate change	Areas surrounding construction activities	Short term	Negative	Reversible	Minor
Over-extraction of water resources	Moderate	Aquifer mining; saltwater intrusion; aquifer depletion Loss of use of the resources from the aquifers if mined to depletion Excessive extraction from surface water resources can negatively reduce volume water available for downstream users and environmental	Study area	Medium-Long term	Negative	Reversible if mining managed but Irreversible if there is depletion	Minor

RISK	MAGNITUDE OF IMPACT	NATURE OF POTENTIAL IMPACT	SPATIAL EXTENT	DURATION	DIRECTION OF IMPACT	PERMANENCE	RESIDUAL IMPACTS POST MITIGATION
		flows necessary for the sustenance of the river ecosystems.					
Landslides	Major	Soil erosion; sedimentation Damage caused to property and roads	Localised area within study area	Short-medium term	Negative	Irreversible	Minor
Earthquakes	Moderate	Damage to infrastructure, landslides Damage caused to property and roads	Study area and entire island	Short-Long term	Negative	Reversible	Minor
Flooding	Major	Soil erosion; sedimentation; Surface water contamination Damage to property and roads	Flood prone areas within study area	Short-medium term	Negative	Irreversible	Minor
Disruption of biological communities	Moderate	Full or partial habitat loss; impaired habitat functionality; loss of biodiversity	Areas surrounding construction activities	Long term	Negative	Partially irreversible	Minor
Minimisation of non-revenue water	Major	Reduction in losses of non-revenue water Better assessment of demand due to metering customers	Study area and entire island	Long term	Positive	Reversible	Major
Increased reliable water supply to customers	Major	More reliable water for the public and TT can meet the SDG goals.	Study area and entire island	Long term	Positive	Reversible	Major
Improved institutional efficiency of WASA	Major	Sustainability in managing the water resources in the north west region.	Study area and entire island	Long term	Positive	Reversible	Major

RISK	MAGNITUDE OF IMPACT	NATURE OF POTENTIAL IMPACT	SPATIAL EXTENT	DURATION	DIRECTION OF IMPACT	PERMANENCE	RESIDUAL IMPACTS POST MITIGATION
		Better customer relations and customer satisfaction					

On the other hand, the project is expected to result in significant positive social impacts associated with the improvement in the supply of water to customers across the twin-island state. The implementation of the 3 components will result in an improved level of service for the majority of the population. Additionally, significant improvements in the efficiency at which WASA operates and the ability of being able to properly assess demand with metering infrastructure, this will result in improved long-term integrated water resources management, which in the face of climate change will result in the sustainable supply of water to the benefit of all.

1 INTRODUCTION

1.1 PURPOSE

This Environmental and Social Assessment has been prepared in accordance with the Terms of Reference received from the Inter-American Development Bank (IDB) for ***the National Water Sector Transformation Program TT-L1055 in Trinidad and Tobago***. The purpose of the program is to improve the efficiency and quality of potable water and services in Trinidad and Tobago.

Currently, 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). The other customers receive water on a scheduled basis. Most of the domestic customers pay a flat fee per month or per quarter and 100% of industrial customers are metered and pay for water by volume used.

The purpose of the National Water Sector Transformation Program TT-L1055 in Trinidad and Tobago is to improve the efficiency and quality of potable water and services in Trinidad and

There is a high percentage of non-revenue water (NRW) lost through leaks, metering and billing issues. NRW is as high as 40-50% and in some cases estimated at 60% of total water produced. Demand and consumption on the islands are very high compared to the rest of the Caribbean. Water usage/demand is estimated at 364 litres of water per day per capita. Despite this, it is understood that there is no intention to increase water rates due to significant issues with reliability of the water supply (Water and Sanitation Division of the IDB, 2020). Other issues and challenges include:

- Poor governance and implementation arrangements: there has not been a consistent focus on WASA's accountability for the resources allocated and WASA's management structure.
- WASA is dependent on subventions from the Government of the Republic of Trinidad and Tobago (GoRTT) of TT$1.8 billion to TT$2 billion without defined performance targets to account for its use of the resources and in the absence of these subventions
- Water tariffs charged on domestic customers, average US$0.23 per cubic meter, is the lowest in the Caribbean and have not been adjusted since 1993. Revenues are insufficient to meet operating costs.
- There is an inability to take advantage of abundant water resources to meet dry season demand due to WASA's lack of storage capacity.
- The aging infrastructure and bottlenecks in the network that inhibits the transmission of water from water rich areas to water scarce areas.

Considering these issues, the Government of the Republic of Trinidad and Tobago (GoRTT) has targeted construction of new water treatment plants, rehabilitation of WTPs, drilling of wells and a reduction in non-revenue water in order to increase the reliability and resilience of water supply to customers. These infrastructure works are expected to work synergistically with WASA's transformation and re-organization to achieve a more efficient, lean, technology driven, financially sustainable and customer centric

organization. The GoRTT has sought funding from the Inter-American Development Bank through a Conditional Credit Line for Investment Project (CCLIP). This overall CCLIP is for US$315 million credit line to address water supply issues across the entire country.

1.2 PROJECT DESCRIPTION

In August 2022, the Government of Trinidad and Tobago (GoRTT) announced that it will carry out its mandate to transform the water sector. Significant investments will be required to achieve wider water sector transformation and undertake long-term infrastructural improvements to improve water supply, increase water security, protect watersheds, and water resources, strengthen sector institutions, and support the sector in its planning capacity and execution. The Bank is therefore proposing to provide financing for water sector support through the CCLIP instrument. The CCLIP will allow the GoRTT to access financing through several phased loan operations that are smaller tranches of commitment and provide greater flexibility to define the individual loan operations. In addition, the CCLIP will allow the Bank to support the development of water and sanitation services in the medium and long-term.

The CCLIP is proposed with Bank financing for an amount up to US$315 million from Ordinary Capital resources to be implemented through three individual loan operations over a ten-year period. The first operation is designed as a specific investment loan for a total amount of US$80 million with disbursement period of 4 years to allow sufficient time to procure and implement a 3-year co-management contract. To support the preparation of the project, a non-reimbursable Technical Cooperation in the amount of US$800,000 has been approved (ATN/OC-18337-TT), which will finance field work to conduct a water audit.

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Table 1-1 below shows the proposed cost estimates of the Infrastructure Rehabilitation and Institutional components of the First Loan Operation. Planning and costing of subsequent loan operations will be done at an agreed time between the GoRTT and the Bank.

Table 1-1: Programme Components and Budget - First Loan Operation

Preliminary Budget for IDB Proposed Action Plan 2020-2024	Estimated Cost (US$ million)
Component 1: Water Stabilization and Improvement: for the development of a comprehensive program to urgently stabilize water supply services to prevent further service decline throughout the country and to ensure access to water, sanitation, and hygiene to unserved and underserved households.	44
Component 2. Support for Water Sector Transformation Plan.	2.74
Component 3. Network Optimization. This component will finance priority works to optimize network performance and reduce non-revenue water.	31
Project management and other costs. This component will finance administrative expenses including, support for project execution (PEU) dedicated staff, audits, monitoring and evaluation, communication, and supervision and implementation of an Environmental and Social Management Plan (ESMP).	2.26
TOTAL	80

The CCLIP will be implemented in various operations throughout Trinidad and Tobago. The first operation has three components which are outlined below as extracted from the Terms of Reference.

- Component 1. Water Stabilization and Improvement: (US$44 Million). This component will finance the development of a comprehensive program to urgently stabilize water supply services to prevent further service decline throughout the country and to ensure access to water, sanitation and hygiene to unserved and underserved households. The activities to be financed include: (i) Construction of new water treatment infrastructure in six locations at Ravine Sable, Sangre Grande, Santa Cruz-Green Meadows, Goldsborough River, Blue Basin and Mayaro, inclusive of intakes; (ii) Refurbishment & upgrading water treatment infrastructure for nine WTPs at Freeport, Caroni, North Oropouche, Guanapo, Maraval, Navet, Hillsborough, Chatham and Courland; (iii) Drilling and equipping of three new wells at Freeport; (iv) Rehabilitation of El Socorro high lift and booster station (v) Drilling and equipping new wells at Penal, Chatham/Palo Seco, and Tucker Valley.

- Component 2. Support for Water Sector Transformation Plan: (US$2.74 Million). The Bank's AquaRating International Standard will be used to characterize the performance of WASA and establish a baseline for the restructuring efforts. The results of the assessment will inform the effort to restructure and transform WASA, including addressing issues such as (i) gender equality, diversity and inclusion at the company level; (ii) Resilience to Climate Change, Natural Disasters and Risk management and promulgation throughout WASA; and (iii) Improvement of the Ministry

of Public Utilities' (MPU) technical oversight capacity for coordination of water sector transformation and stabilization. In addition, institutional strengthening could be considered to separate the functions of water resources management from WASA and to implement Integrated Water Resources Management (IWRM) supported by a HydroBID based information system.

- Component 3. Network Optimization: (US$31 Million). This component will finance priority works to optimize network performance and reduce non-revenue water. These works will be executed through a Co-Management Performance Based Contract with a specialized consulting firm (CF) which would involve WASA and the CF working together as a single Project Team to deliver the targeted results. This would allow for the seamless transfer of know-how and expertise to WASA that is crucial to the long-term sustainability and success of the program. The CF will be required to prepare and implement a Non-Revenue Water Reduction Strategy and Program for the country. The water audit under TT-T1108 will provide production and transmission flows and pressure data as well as hydraulic models to inform the NRW program. Reduction of commercial and physical losses as part of the NRW Reduction program will be implemented The CF will also provide strategic advice and technical support to the Executive Team of WASA in the transformation of WASA. Under this component, flow and pressure monitoring and water loss reduction will be achieved through (i) the replacement of aged and fragile transmission and distribution network to reduce water loss and high leakages in Petit Valley, La Cuesta, Freeport, Wallerfield and Pt. Fortin; Mt. Lambert, North West; Nelson Street, POS; Laventille; Valsayn South; Freeport Todd and La Cuesta (ii) Installation of two hundred and fifty-six (256) bulk meters and loggers to monitor via telemetry systems production and flows for various facilities (water treatment plants, wells and booster stations) throughout T&T, (iii) selective implementation of DMAs/PMAs, targeted leak detection and repair, smart water infrastructure tools (SWIT), and management information systems; (iv) Implementation of remote monitoring and control SCADA automation for real-time analysis of the most critical areas around T&T; and (v) training and capacity building of WASA personnel in water loss management and SWIT.

- Project management and other costs:(US$2.26 Million). This component will finance administrative expenses including, support for project execution (PEU) dedicated staff, audits, monitoring and evaluation, communication, and supervision and implementation of an Environmental and Social Management Plan (ESMP).

1.3 THE CONSULTANT'S MANDATE

The Consultants have been mandated to review and examine the project activities under *the National Water Sector Transformation Program TT-L1055 in Trinidad and Tobago* for the first Operation of the CCLIP as well as the overall CCLIP. In compliance with the Bank's safeguards policy, the Consultants have been required to prepare the following:

1. Environmental and Social Assessment with framework approach

2. Environment and Social Management Plan (including a Stakeholder Engagement Plan and a Grievance Management Mechanism) with framework approach
3. Programmatic Environmental & Social Evaluation
4. Programmatic Environmental & Social Guidelines.

The purpose of the Environmental and Social Assessment (ESA) is to identify the nature and significance of the potential impacts of the components in the first operation of the CCLIP. Additionally, a compliant Environmental and Social Management Plan (ESMP) is also required to manage all the impacts identified in the ESA. These risks and impacts were assessed using a framework approach, given their geographic dispersion and the fact that most sub-project do not have a final design yet. As such, their proposed mitigation measures will follow the alike principles.

The TOR requires that a Programmatic Environmental & Social Evaluation be conducted of the overall CCLIP, assessing the possible impacts of the future phases of the program, and a Programmatic Environmental & Social Guidelines be developed. The Programmatic Environmental & Social Evaluation and Guidelines are separate documents and have been developed in accordance with the requirements established in the IDB Environment and Safeguards Compliance Policy and Guidelines[1]. The documents focus on issues of potentially significant impact including:

- **Social impacts**: i) possible temporary loss of livelihoods; ii) potential negative impacts linked to gender; iii) risk of social exclusion; iv) risk of indirectly inducing poverty (for payment of services for instance); v) governance or social conflicts that might affect project implementation. Sub-projects with physical displacement and permanent economic displacement will not be eligible under this operation.
- **Environmental impacts**: during construction and operation: in the general environment in the project's area of influence and to the biodiversity in particular. Additionally, natural disaster risks, cultural heritage impacts and any potential negative impacts to the long-term sustainability of the area should be identified. Also, current environmental liabilities at the site and existing infrastructure to be repaired/substituted should be identified.

The focus of this document is the ESA to be accompanied by the ESMP. More specifically, the **Environmental and Social Assessment** (ESA) has been conducted for the following activities:

- An information review of all the available documentation including ESAs of previous program, if any;
- Site reconnaissance the project site in selected locations in Trinidad, including visual observation of the relevant areas directly and indirectly affected by the operation; describe the reasoning drivers behind selected sites.

[1] IDB Safeguard Policies and Guidelines are available at www.iadb.org/sustainability

- Collect information to build the Environmental and Social baseline data and necessary for assessing possible impacts associated with each project/intervention. This diagnosis comprised:

    a. Environment conditions: i) main environmental conditions (geomorphology, geology; ii) weather and natural conditions; iii) identification of water resources and its conditions and potential contamination and previous liabilities; iv) air quality and possible sources of contamination; v) natural conditions and biodiversity (protected areas, natural habitats etc.; v) soil use and general conditions and potential project's impacts; vi) zoning and regulations; vii) existing environment liabilities and/or conflicting interest regarding the projects; viii) public services linked to environment conditions (sewage, solid waste, drainage, etc.); ix) cultural sites within the project's areas of influence; x) traffic and associated impacts.

    b. Natural hazard conditions that might be enhanced by the project of the first operation;

    c. Social situation: i) socioeconomic characterization of population in the area of influence; ii) housing conditions and services; iii) main sources of income of population involved in the projects; iv) identification of vulnerable groups; v) identification of local organizations and their potential role in the projects; vi) identification of participation and civic engagement projects in the project's area of influence, (vii) identification of governance aspects or social conflicts that might affect project implementation

    d. Health and safety, and labour impacts and risks associated with the operation during all its phases (construction and operation);

    e. Evaluate the legal and regulatory framework applicable to the projects/interventions including IDB policies and requirements.

The **Environmental and Social Management Plan (ESMP)** is a document that supports and is prepared based on the results of the ESA elaborated above, it involved the following activities:

- Assessment of possible impacts and risks associated with the project of the first operation during construction and operation including: resettlement (OP 710), environmental matters (as defined in OP 703); gender equality issues (OP 761); health and safety during construction and operation; community relationships plans); natural disasters risks;

- Development of mitigation, management and monitoring plans require to avoid, minimize, and or compensate for adverse environmental and social impacts; In the specific cases in which executive plans need to be developed by the contractor at a later stage, provide both a justification and guidelines with reasonable and justifiable levels of detail which could serve as parameters for the development of said executive plans.

- If applicable, development of a livelihood restoration plan;

The **Stakeholder Engagement Plan and Grievance Management Mechanism** was developed and includes:

- A consultation methodology, list of stakeholders to be consulted and the method of consultation. A summary of the main findings of the consultation activities are included in the ESA;
- Meaningful consultation with affected stakeholders following the completion of the draft documents. The Program, the site selection process, the main impacts and risks will be presented. The purpose of the consultation is to seek feedback from the public on the draft ESA, the Program and the proposed ESMP.
- The final reporting of the consultations in the final ESAs to demonstrate and document the meaningfulness of the consultation, and especially how the suggestions and concerns of stakeholders have been considered/answered/incorporated into the project and ESAs/ESMPs, RPs if the preparation of these was necessary.

1.4 THE STUDY AREA

The project area for this Consultancy covers all areas of Trinidad and Tobago (Figure 1-1). However, the first and third component focuses on the North-West, North-East, Central, South regions of Trinidad and operational zones in Tobago which includes the following municipalities:

- Diego Martin
- San Juan/Laventille
- Port of Spain
- Borough of Arima
- Tunapuna/Piarco
- Couva/Tabaquite/Talparo
- Siparia
- Mayaro/Rio Claro
- Princes Town

The project covers the entire island of Tobago, while Trinidad represents an estimated area of 3,551 km^2, which consists of almost 77% of the island's population (CSO, 2012). The project area covers several municipalities with varying population densities. Figure 1-2 shows that sections of the project area have some of the highest population densities across Trinidad and Tobago. The majority of the municipalities in Trinidad and parishes in Tobago have experienced growth in population between 2000 and 2011 excluding Port of Span, Diego Martin, San Juan/Laventille and the parish of St. John which experienced a decline in populations (Table 1-2) (CSO, 2012).

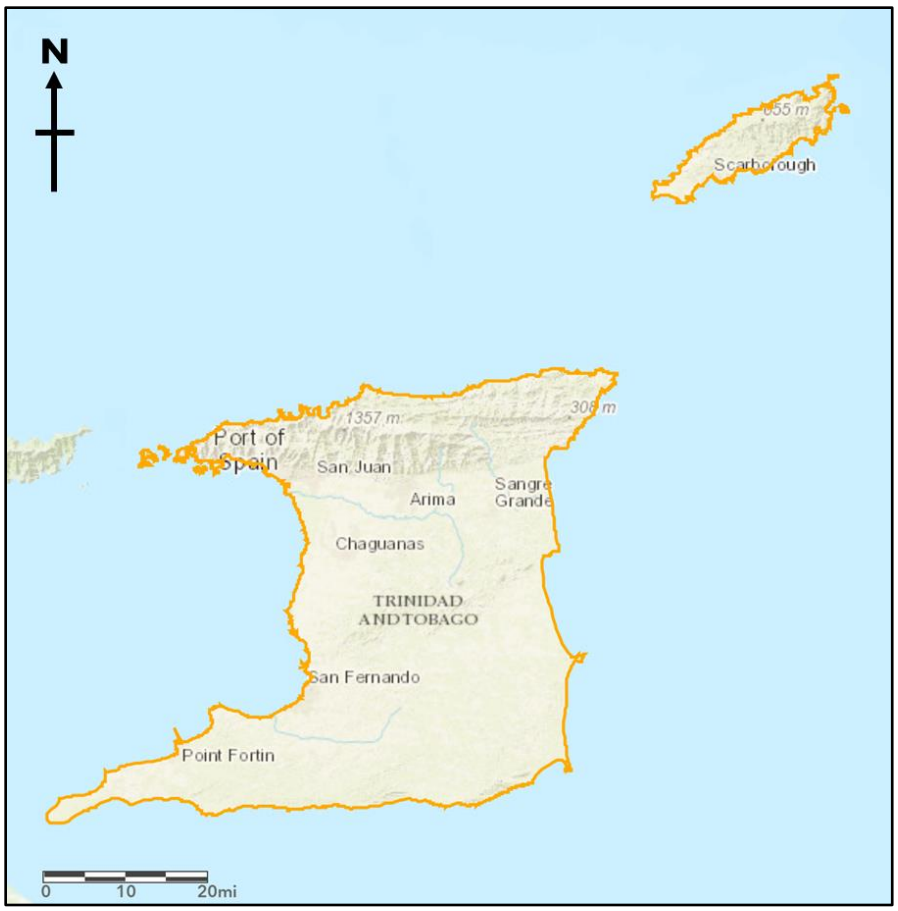


Figure 1-1: The Study Area -Trinidad and Tobago (Data Source: ESRI Living Atlas)

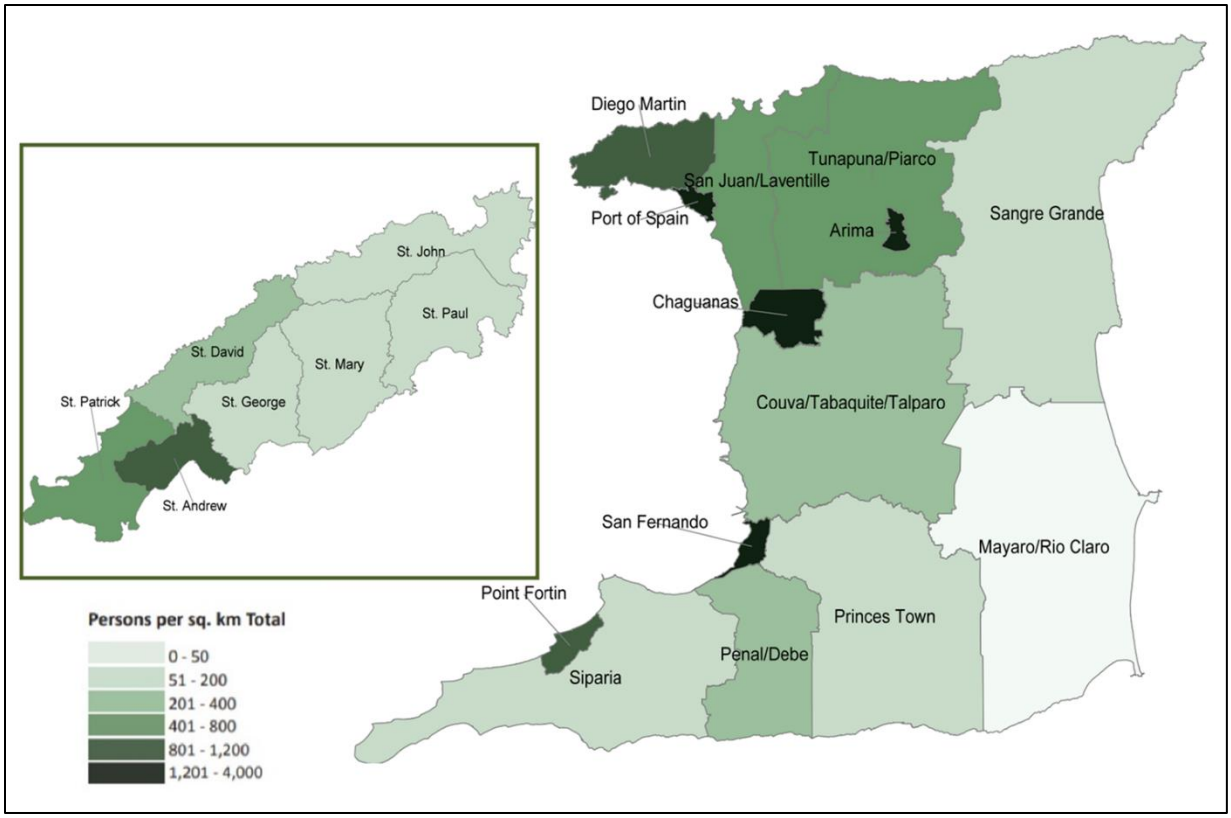


Figure 1-2: The project area and population densities across Trinidad and Tobago (modified from Trinidad and Tobago 2011 population and Housing Census Demographic Report) (CSO, 2012).

Table 1-2: Population change from 2000 – 2011 of the municipalities and parishes in the project area (modified from Trinidad and Tobago 2011 population and Housing Census Demographic Report) (CSO, 2012).

Island	Municipality/Parish	% Population Change from 2000 - 2011
Trinidad	Borough of Arima	0.4
	City of San Fernando	-1.1
	Couva/Tabaquite/Talparo	0.9
	Port of Spain	24.3
	Diego Martin	-0.2
	Penal/Debe	0.6
	Point Fortin	0.6
	Princes Town	1.0
	Sangre Grande	1.4
	Siparia	0.6
	San/Juan-Laventille	-1.0
	Tunapuna/Piarco	0.5
Tobago	St. Andrew	1.0
	St. David	1.4%
	St. George	2.3%

Island	Municipality/Parish	% Population Change from 2000 - 2011
	St. John	-0.6%
	St. Mary	1.0%
	St. Patrick	1.0%
	St.Mary	1.0%

The area of influence is defined by the immediate and wider project area. The immediate project area includes Trinidad's northwest, northeast, central and southern zones. The population that will benefit from project interventions reside in the 10 municipalities of Couva/Tabaquite/Talparo, Diego Martin, Penal/Debe, Princes Town, Sangre Grande, Siparia, and Tunapuna/Piarco, and the boroughs of Arima and Point Fortin. One of the communities in the project area also falls within the city of San Fernando. The immediate project area is among the most populous in Trinidad and Tobago. According to the latest Population and Housing Census Report for Trinidad and Tobago, the population of this area stood at 247,034 persons in 2011, accounting for almost one-fifth of the national population.

1.5 ANALYSIS OF ALTERNATIVES

1.5.1 The No Project/ No Action Alternative

If the project is not implemented the issues related to disruptions and scheduling of water supply, large percentage of NRW will continue to plague the project areas and country, and the corresponding issues of unreliable 24/7 water supply will also continue. The projected impacts of climate change are expected to result in overall lower rainfall amounts and increased temperatures (increased evaporation) and thus reduced aquifer recharge. If this is coupled with continued over-pumping it can result in deleterious effects on the country's water resource in the long run.

1.5.2 Alternative Project

An alternative could be to increase the amount of water being pumped from the aquifers currently since it is estimated that Trinidad and Tobago has more than enough water resources available at this time to be accessed.

While this approach would address the immediate need to deliver an adequate supply of water to currently underserved households it must be balanced with the need to avoid over-exploitation of water resources. There is great risk in losing environmental balance which is critical to assess before taking any decisions on increased pumping. Additionally, without addressing the various inefficiencies of the system, this will only result in more wastage.

It would be best to implement the project wholistically as was designed based on the challenges that were identified in the supply and management of water sources. Leaving out components would yield only short-term solutions and reduce the resilience of the sector, which is not sustainable considering the climate change risk faced by the island. Further, the benefit to be received from a better demand analyses and control and accountability for water supply due to metering, as well as address major losses due to non-revenue water inclusive of aged infrastructure would not be accrued.

1.6 LIMITATIONS

It is important that the following limitations are noted and understood prior to the review of the report:

- The timeframe for carrying out the assignment was very short and so this limited the ability for extensive field verification activities. As such a heavy reliance was placed on the use of secondary data that is already available for the study area, referenced documentation, review of satellite imagery and maps, and the conduct of key informant interviews.
- The project took place during the Corona Virus (COVID-19) pandemic. The Covid-19 pandemic has led to Trinidad and Tobago, like other nations worldwide, imposing a range of protocols and strategies to stymie the spread of the disease. Measures such as physical distancing, the closure of schools as well as stay-at-home orders for non-essential activities, have restricted the movement of the population with many citizens having to work from home. Trinidad and Tobago has recently started reopening the economy, however the Central Statistical Office and other Ministry Offices where some data is available remain close at the time this Assessment is being conducted. However, access to statistical data from the last Population and Housing Census can be obtained online. It should be noted that the Census is dated, having been conducted in 2011.
- COVID-19 also affected the availability of key stakeholders as well as the nature of the consultations. There was heavy reliance on virtual meetings and consultations. Although, this may be skewed to persons having internet access or access to telephone, this mechanism is still believed to have the potential to capture a wide audience especially since the project area is so large. The nature of the public consultation to be held to present the findings of the reports are likely to be affected. The approach will be agreed upon following further discussions with the IDB and the GoRTT prior to the completion and submission of the Final ESA and ESMP.

1.7 ORGANIZATION OF THE REPORT

The report is organized into seven main sections:

- Section 1- Presents an overview of the project and the main activities being executed under this Consultancy
- Section 2- Presents the policy, legal and regulatory framework
- Section 3- Presents the institutional framework
- Section 4- Presents the approach and methodology
- Section 5- Presents the assessment of the existing environment
- Section 6- Presents the impact assessment and mitigation measures including cumulative impacts
- Section 7- Presents the conclusion.

2 POLICY, LEGAL AND REGULATORY FRAMEWORK

In Trinidad and Tobago, there are several statutes that have direct or indirect jurisdiction over matters of the environment. These range from public health to physical planning and land use. The statutes are rationalised by the Environmental Management Act of 1995, which later became the Environmental Management Act Chapter 35:05 (EM Act 35:05), which is the legal underpinning for environmental management in Trinidad and Tobago.

The preamble of the Act recognizes the diversity of governmental entities involved in the environmental sector. The Act establishes the Environmental Management Authority (EMA) to co-ordinate, facilitate and oversee the execution of the national environmental strategy and programmes, to promote public awareness of environmental concerns and to establish an effective regulatory regime which can conserve and enhance the environment.

The following legislation, policies and plans were deemed most relevant to the water supply improvement project, which includes not just those governing the environment but also those governing the Water and Sewerage Authority. The aim of the project is to improve the country-wide efficiency and quality of potable water and services and is well aligned with the goals and outcomes set forth in the National Development Strategy of Trinidad and Tobago – Vision 2030.

2.1 REVIEW OF RELEVANT LEGISLATION, REGULATION AND POLICY

2.1.1 Policy and Plans

Table 2-1 presents several policies and plans relevant to the Water Supply Improvement Project.

Table 2-1: Relevant Policies and Plans

POLICY/PLAN	RELEVANCE TO THE PROJECT
National Development Strategy of Trinidad and Tobago – Vision 2030	This long-term National Development Strategy aims to put the country in a position to achieve developed country status by 2030. Under Theme III - Improving Productivity through Quality Infrastructure and Transportation, Goal 2 states: "Our public utility system will be better managed with improved access for all Public Utility Systems play a strategic role for human civilization, essential in economic and social development, whether they relate to water supply, sewerage treatment, electricity and public lighting systems, or telecommunication services. In order to achieve our National Vision, Trinidad and Tobago needs efficient, cost-effective and reliable water and wastewater services, electricity, and telecommunication services as these are key enablers which determine the quality of life." This is aligned with Goal 6 of the Sustainable Development Goals: Ensure availability and Sustainable management of water and sanitation for all.

POLICY/PLAN	RELEVANCE TO THE PROJECT
National Integrated Water Resources Management Policy 2005	The national goal for the water sector is to support the socio-economic development of Trinidad and Tobago through the integrated management of the water resources and the water environment (land, air, flora and fauna), satisfying and managing the growing demands for all water users in a sustainable, efficient and effective manner, while maintaining and/or enhancing the quality of the environment and the integrity of ecosystems, and minimizing losses to life and damage to property due to water related disasters. One of the principles upon which this policy operates is "*Potable water of such quality and quantity as to sustain life should be available to all citizens, irrespective of the citizen's ability to pay. This minimum service is a requirement for reasons of public health and environmental condition*." This is integral to the project being assessed.
National Environmental Policy, 2006	Environmental Management Policy, 2006, was prepared by the Environmental Management Authority in accordance with the requirements of the Environmental Management Act, 2000. The goal of the policy is to facilitate and encourage environmentally sustainable development so that there is a balance between economic and environmentally sound practices to enhance the quality of life and meet the needs of the present and future generations. The roll out of the project activities would therefore need to take place so as not to result in pollution of the environment, result in ecological losses and not negatively impact the health and the well-being of humans.
National Climate Change Policy (NCCP) 2011	The goal of the National Climate Change Policy (NCCP) is "… *to provide policy guidance for the development of an appropriate administrative and legislative framework… for the pursuance of a low-carbon development path for Trinidad and Tobago*". Trinidad and Tobago is particularly vulnerable to the adverse impacts of climate change such as those related to temperature increases, changes in precipitation and sea level rise", all of which will impact the water resources sector and as such climate change considerations are crucial to the activities planned under the Water Supply Improvement Project.
Draft National Policy on Gender and Development 2009	The National Policy on Gender and Development provides a framework for including gender perspectives in all activities of government and civil society, thereby promoting the full and equal participation of men and women in the development process. Therefore, the activities of WASA as the project is rolled out should be gender sensitive, accounting fully for and integrating the needs and interests of women and men into project activities.
National Protected Areas Policy, 2011	This objective of the National Protected Areas Policy is to provide guidelines for the selection, designation and management of all Protected Areas (PAs) established for the conservation of natural heritage in Trinidad and Tobago.

POLICY/PLAN	RELEVANCE TO THE PROJECT
	The administrative framework for the management of PAs is complex. Several agencies and multi-sectoral committees have some responsibility for PAs management. The Caroni Swamp Forest Reserve, which falls within the project area and is protected by this policy and legislation elaborated in Section 2.1.2. The Northern Range is a sensitive ecosystem which also falls within the project areas.
National Wildlife Policy, 2013	Conservation and management of Wildlife in protected areas are elaborated in this policy. These strategies have been employed in the Caroni Bird Sanctuary which occurs within the demarcated project areas.
National Forest Policy, 2011	The objective of this policy is to conserve, manage and develop its forests and forest resources. This is pursued through three mutually reinforcing objectives: 1. To optimise the contribution of forest resources to livelihoods; cultural and spiritual/religious use, while ensuring sustainable use of forests, including extraction of timber and wildlife 2. To protect native genetic, species and ecosystem diversity 3. 3. To maintain and enhance the natural productivity of forest ecosystems and ecological processes (watershed functions, etc.) to provide important ecosystem services The management and protection of the Caroni Swamp Forest Reserve and its assets which is located within the study area is also governed by this policy.

Legislation and Regulations

Table 2-2 outlines several legislations and regulations relevant to the Water Supply Improvement Project.

Table 2-2: Relevant legislation and regulations

LEGISLATION/REGULATIONS	RELEVANCE TO THE PROJECT
Water and Sewerage Authority Act of 1965	Under section 3(2) of the Statutory Authorities Act (Chapter 24:01), the Water and Sewerage Authority has been declared a statutory authority subject to the provisions of that Act. "*The Act provides for the development and control of water supply and sewerage facilities in Trinidad and Tobago and matters of sanitation incidental thereto; the promotion of the conservation and proper use of water resources; and for the*

LEGISLATION/REGULATIONS	RELEVANCE TO THE PROJECT
	establishment of an Authority to administer the several purposes aforesaid and matters connected therewith."
The Environmental Management Act, 2000	This Act establishes an Environmental Management Authority (EMA) to execute the objectives of the Act. Functions of the EMA related to the project related to this project are to develop and establish national environmental standards and criteria, monitor compliance with the standards criteria and programmes relating to the environment and take all appropriate action for the prevention and control of pollution and conservation of the environment. The EMA has put in place a National Environmental Policy, 2001 and the Certification of Environmental Clearance Rules, 2001 to facilitate enforcement and compliance. The Act speaks to the requirement that persons must comply with the procedures and standards with respect to permits or licences required for any person to install or operate any process or source from which pollutants will be or may continue to be released into the environment.
Certificate of Environmental Clearance Rules, 2001	The Certificate of Environmental Clearance Rules, 2001 state that an application must be submitted to TCPD in respect of a designated activity constituting a development requiring express grant of permission under the Town and Country Planning Act.
Noise Pollution Rules 2001	The Noise Pollution Rules, 2001 indicate that subject to any variation, no person shall emit or cause to be emitted any sound that causes the sound pressure levels to be greater than the prescribed standards. Construction activity when conducted on a construction site between the hours of 8.00 a.m. and 8.00 p.m. of the same day are exempt from the prescribed standards.
Environmentally Sensitive Species Rules, 2001	Environmentally Sensitive Species Rules, 2001 speak to the following objectives: a) *"maintenance of species abundance and diversity* b) *preservation of the integrity of species' populations to ensure genetic viability and to sustain their intangible and direct material benefits* c) *maintenance of its importance of significance to the ecosystem (s) of the immediate locality or to wider areas* d) *regulation of species which are or may pose a health or ecological liability*

LEGISLATION/REGULATIONS	RELEVANCE TO THE PROJECT
	e) provision of valuable educational and non-destructive scientific research opportunities *f) demonstration of the benefits of wise use and the pitfalls of indiscriminate use of particular species"* The Consultants will make a note of any endangered/sensitive species identified within the study areas.
Environmentally Sensitive Areas Rules, 2001	The Environmentally Sensitive Areas Rules, 2001, outlines in its objectives the protection, preservation, management or rehabilitation of an area that is fragile, threatened or degraded and the regulation of the use of the natural resources contained within the area. The north west region study area includes the northern portion of the Caroni Swamp, which is considered a sensitive area. This area has been declared a Forest Reserve and a Bird Sanctuary.
Forest Act #42 of 1915 Chapter 66:01 amended 1955, 1999	The Caroni Swamp Forest Reserve (4,000 ha.) is protected under the Forests Act (Legal Notice # 141 of 1987). The northern section of which occurs within the one of the components in this project.
Occupational Safety and Health Act of Trinidad and Tobago, 2004	This act speaks to the responsibility of the employer to ensure, so far as is reasonably practicable, the safety, health and welfare of its workers.
Air Pollution Rules 2014 and associated Regulations	This document provides monitoring standards for ambient air quality that should be adhered to during development activities.
Water Pollution Rules 2019	This document provides monitoring standards for ambient water quality that should be adhered to during development activities.

2.1.2 International Treaties and Protocols

- **Convention on Biological Diversity** – The Convention on Biological Diversity (CBD), adopted in 1992, is the foremost international convention obliging its contracting parties to take action on invasive alien species.
- **The 2030 Agenda** – The 2030 Agenda is a Global Pact unanimously agreed to by the 193 Member States of the United Nations to take bold and transformative steps to shift the world on to a sustainable and resilient path, while leaving no one behind. The 17 Sustainable Development Goals (SDGs) and 169 targets of this Agenda, which is the successor to the Millennium Development Goals (MDGs), build on existing global agreements.
- **United Nations Framework Convention on Climate Change (UNFCCC) Gender Action Plan -**The integration of gender into environmental initiatives has become a development priority globally and in the Caribbean. Subsidiary Body for the Implementation (SBI) of the Framework Convention on Climate Change (FCCC) at the 24th Conference of the Parties to the UNFCCC (COP 24)

recommended that countries should begin review of the areas of progress, areas for improvement and further work to be undertaken under the Lima work programme on gender and its gender action plan. COP 24 called upon countries, constituted bodies and observers to intensify consultations in 2019, with the support of the secretariat, in order to advance the gender action plan. The National Determined Contributions (NDC) Partnership seeks to support its members in sharing and applying successful models for integrating gender equity into NDC planning and implementation. Member countries are already developing valuable approaches that provide useful learning opportunities for others. State Parties need gender expertise and resources that can be drawn upon through the SBI to support countries as they apply and scale-up gender-responsive climate policy and practices and develop nationally specific Gender Action Plans.

2.2 RELEVANT IDB ENVIRONMENTAL AND SOCIAL SAFEGUARDS

The IDB has several social and environmental safeguards that are applicable to all Bank-Financed Projects. They serve as a guide for the identification of potential social and environmental impacts of Bank-Financed Projects and how consultation should take place.

The principal Relevant Operational Policies are outlined in the table below. A brief description is provided along with it is relationship of each policy to the project.

Table 2-3: IDB Operational Policies

NAME	CONTENT	RELATIONSHIP TO THE PROJECT
OP-102: Access to Information Policy (April 2010)	This policy sets out the principles which guide disclosure of information and the transparent use of public funds in order to enhance the Bank's accountability and development effectiveness.	The report will be required to be made available to the public and Project teams must comply with the Information Disclosure Policy.
OP-703: Operational Policy on Environment and Safeguards Compliance (January 2006) and Guidelines (May 2007)	This policy guides the environmental quality of the Bank's operations and its support to environmental projects in the Latin American and Caribbean region. Contained within are the policy directives related to both environmental mainstreaming and safeguards. The environmental safeguards establish procedures and standards to ensure quality and the environmental sustainability of both public and private sector operations.	The Bank requires that Category A and B operations be subject to Environmental Assessments (EA). This project is a Category B project which has required the need for an Environmental and Social Assessment and an Environmental and Social Management Plan (ESMP). A Strategic Environmental and Social Assessment (SESA) and an Environmental and Social Management Framework (ESMF) is also required.

NAME	CONTENT	RELATIONSHIP TO THE PROJECT
OP-704: Operational Policy on Natural Disaster Risk Management (February 2007) and Guidelines (March 2008)	The purpose of the Bank's disaster risk management policy is to guide its efforts to assist borrowers in reducing risks emanating from natural hazards and in managing disasters, in order to support the attainment of their social and economic development goals. The Bank will not finance projects that, according to its analysis, would increase the threat of loss of human life, significant human injuries, severe economic disruption or significant property damage related to natural hazards.	This project is required to consider the necessary measures to reduce disaster risk to acceptable levels as determined by the Bank on the basis of generally accepted standards and practices. A Strategic Disaster Risk Assessment is being prepared as part of this project.
OP-708: Public Utilities Policy (November 2013)	This Policy's objective is to guide the Bank's actions to promote universal access to and increase the efficiency and quality of public utilities service delivery under conditions that are affordable and environmentally and socially sustainable, so they contribute to the process of socially inclusive economic development. This Policy covers the following public utilities: water and sanitation, electricity, natural gas, solid waste, and telecommunications services.	This project is a public utilities project (water and sanitation) and aligns with the general Policy Principles of access, good governance, efficiency, innovation and environmental sustainability
OP-710: Operational Policy on Involuntary Resettlement (July 1998) and Guidelines (November 1999)	The objective of the policy is to minimize the disruption of the livelihood of people living in a project's area of influence, by avoiding or minimizing the need for physical displacement, ensuring that when people must be displaced they are treated equitably and, where feasible, can share in the benefits of the project that requires their resettlement.	This project will not require physical displacement. A grievance mechanism/ management plan will be prepared as part of the project, as well as a LRP if needed.
OP-761: Operational Policy on Gender Equality in Development (November 2010) and Guidelines (September 2013)	This policy seeks to ensure that gender issues are addressed in the design of projects supporting infrastructure, economic opportunities and competitiveness, and institutional capacity of the State; and that gender	This project actively promotes gender equality and the empowerment of women and introduces safeguards to prevent or mitigate adverse impacts on women or men. A Stakeholder Engagement Plan

NAME	CONTENT	RELATIONSHIP TO THE PROJECT
	elements are included in the execution and evaluation of projects	will also be prepared. The ESMP will also consider any of these issues.
OP-765: Operational Policy on Indigenous Peoples (July 2006) and Guidelines (October 2006)	This policy directs the Bank to use its best efforts prevent or minimize exclusion and adverse impacts that Bank operations might generate with respect to indigenous peoples and their rights.	This project is not expected to impact any Indigenous groups in Trinidad.

3 INSTITUTIONAL FRAMEWORK

The Trinidad and Tobago water sector comprises the following entities:

a. The Water and Sewerage Authority (WASA) – the service provider
b. The Ministry of Public Utilities (MPU) - the ministry responsible for policy direction
c. The Regulated Industries Commission (RIC) - the economic regulator; and
d. The Environmental Management Authority (EMA) - responsible for environmental regulation
e. The Water Resources Agency – the resource regulator is an agency within WASA

These main agencies above and some other supporting agencies are summarised in Sections 3.1 to 3.7 below as they are all integral to the undertaking of the Water Supply Improvement Project.

3.1 Water and Sewerage Authority

The Water and Sewerage Authority (WASA) is a state-owned utility mandated by the Water and Sewerage Authority Act of 1965 to manage the water and sewerage sector of Trinidad and Tobago. The Act had brought together several agencies, which were formally charged with the responsibility of providing water and sewerage facilities to Trinidad and Tobago. WASA is responsible for the development and control of water supply and sewerage facilities in Trinidad and Tobago and promoting the conservation and proper use of water resources.

The mandate of WASA is to secure water for every sector, deliver it and sustain it (WASA, 2008). The mission of the organisation is:

- To be a leading provider of water and wastewater services.
- To deliver customer service along the highest internationally recognised and accepted standards.
- To continuously develop best business practices utilizing advanced technology and a well-developed and motivated workforce.
- To leverage on industry expertise to offer global water and wastewater services
- To sustain a commercialised business while remaining sensitive to our stakeholders and our environment.

WASA operates upon 4 major developmental pillars, these include: human capital development, customer care cost optimisation and revenue enhancement. The organisational structure for WASA is illustrated below.

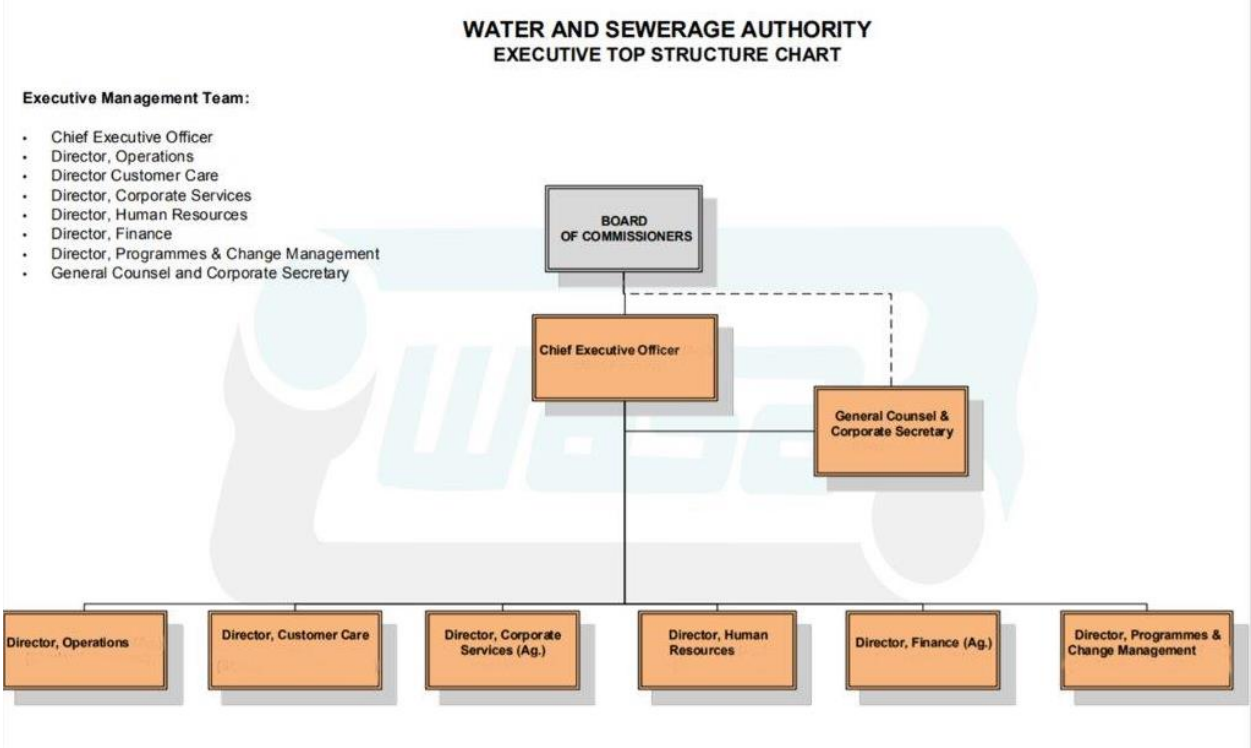


Figure 3-1: Organisational Structure for the Water and Sewerage Authority

3.1.1 Challenges

Water and Sanitation Division of the IDB, 2020 indicated in their Guidance Brief on the scope and implementation of an Action Plan for WASA that a well-performing water utility is characterized by servicing a high proportion of the population with water and wastewater services that are reliable, continuous and responsive while operating in a cost-efficient manner. To be a well-performing utility, whether public or private, the utility needs to function within robust and transparent governance, legal/regulatory and institutional framework that provides the enabling environment for it to efficiently provide affordable quality water supply and wastewater services. At the same time, the utility should also be subjected to an accountability framework between the Board, Management, the parent and resource providing Ministries, customers and other key stakeholders.

The Guidance Brief spoke to the institutional weaknesses of WASA. Figure 3-2 below indicates that WASA is currently in a "Spiral of Decline", that began with low tariffs and low collections ultimately resulting in WASA's current position of degraded assets. It is recommended that to begin the turnaround of WASA will require improved governance at three levels – across the sector, at the Board level and at the organisational level. This will involve:

(i) creating an effective enabling environment (legislation and regulation) to allow WASA to successfully function;
(ii) ensuring the Board has the appropriate skills and targets as set by the Cabinet for WASA to transform; and
(iii) equip the Executive team with a robust performance management system to invoke change in WASA's operations.

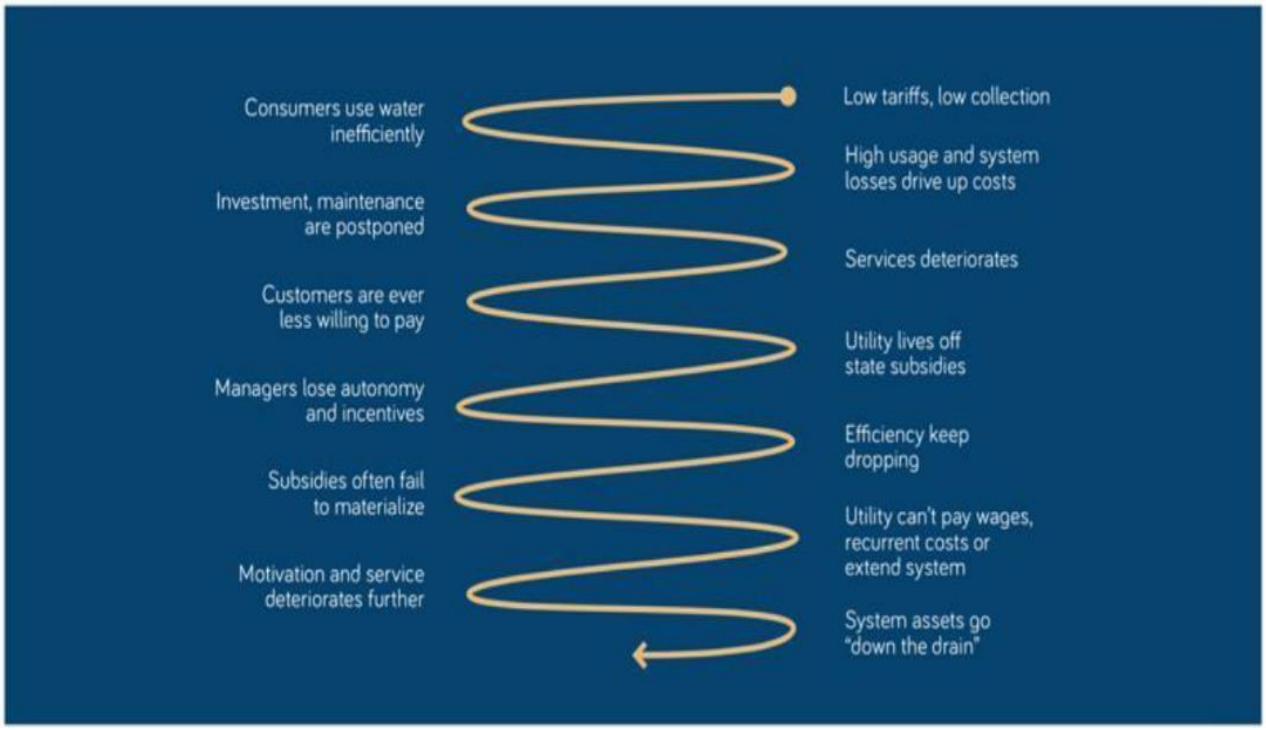


Figure 3-2: Spiral of Decline

In Trinidad and Tobago, the foundation for improved governance is there to be built upon as institutions such as the Regulated Industries Commission (RIC), Environmental Management Authority (EMA), and the Water Resources Agency (WRA), Office of the Procurement Regulator and the Occupational Safety and Health Authority already exist (SAFEGE, 2017 in Water and Sanitation Division of the IDB, 2020). The Government, therefore, needs to strengthen the legislative and regulatory tools of these regulators to provide proper oversight of WASA's performance.

Of major concern is that there is very limited measurement of the water moving within and around WASA's network which makes it difficult to estimate the volumes of water that is received by customers and that WASA receives no revenue for. In addition, data and information management is considerably lacking in WASA, inhibiting proper planning and performance monitoring to inform decision-making. Democratizing access to water data using social media and other platforms would be useful to get information into the hands of civil society and bring about accountability (Water and Sanitation Division of the IDB, 2020).

WASA has also been plagued by a range of operational inefficiencies, weak governance structures, poor management, public mistrust and a culture of underperformance. Of particular concern to WASA is its significant financial obligations under the DESALCOTT agreement which cannot be renegotiated at this time as well as the accumulated debt from previous years that continues to negatively affect its efforts toward achieving the desired financial viability.

3.2 Water Resources Agency (WRA)

The Water Resources Agency (WRA) is a subsidiary agency of WASA for which its mission statement is to effectively manage the country's water resources and promote conservation, development and protection of these resources, for sustainable use, in a cost-effective and integrated manner to support socio-economic growth (WASA, 2008). The primary roles and responsibilities of the WRA are as follows:

- Water Resources Assessment
- Water Resources Policy, Strategy Development and Implementation
- Development and Maintenance of a Water Resources Database and Information System
- Establishing and maintaining a hydrological and hydrogeological monitoring network to facilitate reliable and effective data collection
- Implementation of Integrated Water Resources Management including facilitating the participation and involvement of stakeholders in the process
- Master Planning and Water Resource Allocation
- Regulation of water abstraction from the national water resource
- Management of the permit and licensing system to regulate:
  - Drilling and construction of private water wells
  - Abstraction of water from the surface water and groundwater sources
- Water Demand Analysis

3.3 Ministry of Public Utilities

The mission of the Ministry of Public Utilities is to facilitate the effective delivery of efficient, affordable and quality public utilities services through a committed, resourceful team of professionals in close collaboration with all stakeholders. It does this through:

- The provision of effective and efficient leadership and governance to the Utilities Sector;
- Ensuring that Trinidad and Tobago's utility sector (electricity, post and telecommunications) is modern, customer-oriented and technologically enabled to provide effective, cost-efficient quality services to all citizens;
- The provision of a framework within the Ministry for promoting employee well-being and ensuring that all employees are treated with dignity, fairness and respect
- Collaboration with the agencies to ensure that they practice prudent financial management with a view to becoming financially viable;

Water is one of the basic necessities to sustain human life. It is also a vital component in the operation of an industrialised society. As such, Government is faced with the challenge of satisfying the needs of its citizenry on one hand while catering for the increasingly sophisticated demands of a dynamic and expanding economy on the other.

The Ministry of Public Utilities is mandated to manage the nation's resources in such a manner as to satisfy its diverse customer base while respecting the constraints and carrying capacity of the environment. The

state enterprise responsible for the delivery of water and wastewater services to the population of Trinidad and Tobago is the Water and Sewerage Authority (WASA) (Ministry of Public Utilities, 2013).

3.4 Regulated Industries Commission

The Regulated Industries Commission (RIC) is an independent, statutory body established to ensure the promotion of the highest quality of utility services at fair and reasonable rates while building a credible regulatory regime that responds adequately to stakeholders concerns and also to ensure fairness, transparency and equity in the provision of utility services throughout the country. The RIC regulates the delivery of services by the Water and Sewerage Authority and the Trinidad and Tobago Electricity Commission.

Services provided by the RIC include:

- Making recommendations on the award of licences
- Monitoring and enforcing compliance with licence conditions
- Establishing the principles upon which tariffs will be based and monitoring rates charged to ensure compliance
- Prescribing standards for services and monitoring compliance with those standards
- Carrying out studies of efficiency and economy of operation and performance
- Facilitating competition between service providers where competition is possible and desirable
- Investigating complaints by consumers, of their failure to obtain redress from service providers
- Imposing and collecting fees for licences
- Ensuring that service providers earn sufficient return to finance necessary investment (Ministry of Public Utilities, 2013)

3.5 Environmental Management Authority

The Environmental Management Authority (EMA) is established by the Environmental Management Act, 2000 to carry out the objectives of the Act. The Environmental Management Authority has a Strategic Plan for the period 2010 to 2014. The EMA's strategic goals for this period are summarised as follows:

- To protect and improve air quality, inland and coastal water quality.
- To prevent negative health consequences from chemicals spills and the unsafe handling and disposal of solid and hazardous wastes.
- To protect, conserve, and/or restore selected ecosystems and species
- To develop an innovative programme to balance environmental protection and economic development and facilitate the expeditious processing of CEC applications.
- To protect human health and the natural environment from the effects of noise while allowing for reasonable social, cultural and economic activity.
- To mitigate and adapt to climate change.
- To protect human health and the natural environment through the timely enforcement of statutes, ensuring compliance with permit and license conditions and the promotion of environmental stewardship

WASA would need to make an application for a CEC for any activity that will likely result in significant environmental pollution.

3.6 Office of the Procurement Regulator

The Office of Procurement Regulation is a body corporate established pursuant to an Act of Parliament, namely the Public Procurement and Disposal of Public Property Act, 2015. The Act aims to provide for public procurement, and for the retention and disposal of public property in accordance with the principles of good governance, namely accountability, integrity, transparency, and value for money and to promote local industry development, sustainable procurement and sustainable development (Office of Procurement Regulation, 2020).

Though the Act was assented to on January 14, 2015, it comes into operation on a date to be fixed by the President by proclamation. However, to allow for the establishment of the Office of the Procurement Regulation (OPR), the appointment of the Members of the Board, the performance of certain key functions of the OPR, and the drafting of Regulations, the Act was partially proclaimed by way of Legal Notice 150 of 2015 (Office of Procurement Regulation, 2020).

3.7 Occupational Safety and Health Authority and Agency

The Occupational Safety and Health (OSH) Authority and Agency was established under the Occupational Safety and Health Act (OSH Act) (2006). It is a multi-stakeholder advisory body to the Ministry of Labour and Small Enterprise Development (MOLSED). The Authority comprises 17 members and is led by a Chairman. The core task of the Authority is to encourage the enforcement of the OSH Act, to promote training and research, provide information and to develop Regulations and Approved Codes of Practice (A.C.O.P.). The OSH Agency is the enforcement arm of the OSH Authority. The Agency is led by an Executive Director.

There are operational units within the Inspectorate comprised of Safety and Health Inspector Is, Safety and Health Inspectors IIs, Senior Inspectors and the Chief Inspector who is the head of the Inspectorate. Inspectors are empowered under the OSH Act to access all industrial establishments, acquire any information needed to carry out investigations and use their legal powers.

As an enforcement body, the main objective of the OSH Agency is to ensure compliance with the OSH Act. Its enforcement policy promotes voluntary compliance in the first instance. Therefore, public awareness, the involvement and sensitization of tripartite partners and other stakeholders are considered critical in promoting a preventative safety and health culture in Trinidad and Tobago. Close co-operation with other ministries and institutions, as well as supporting OSH training structures and the provision of accessible OSH information are also essential to OSHA's mandate. However, OSHA is also actively pursuing prosecution of safety and health infractions as another arm of enforcement under the OSH Act (Occupational Safety and Health Authority and Agency, 2020).

4 APPROACH AND METHODOLOGY

4.1 GENERAL APPROACH

The multi-disciplinary team of experienced scientists and environmental professionals conducted data gathering and analysis together to determine the dominant environmental issues relevant to the proposed project and to identify the potential impacts and mitigation measures. A detailed review of secondary data was used to inform the assessment. Among the key activities were:

- Desktop research
- Analysis of maps and plans
- Review of reports and background documents
- Stakeholder consultations

Other proposed developments and surrounding land use were also reviewed in the context of compatibility with the proposed project including potential positive, negative and cumulative impacts.

The following subsections describe the approach for assessing the physical, biological and socio-economic environment.

4.2 PHYSICAL ASSESSMENT

This section describes the methods associated with conducting the topographical, climate, hydrological, natural hazard assessments of Trinidad and Tobago.

4.2.1 Topography, Geology and Soils

Assessing the topography, geology and soils of the site included a literature review and analysis of 1:50,000 topographic maps and Google Earth images. The soil analysis was completed using available secondary data.

4.2.2 Climate

The climate of the area was determined through a review of data from the Trinidad and Tobago Meteorological Services and other published literature. Climate change projections from the Draft State of the Caribbean Climate, 2020 prepared by the Climate Studies Group at UWI were also reviewed and referenced.

4.2.3 Natural Hazards

Desktop review of past events was used to inform the section on natural hazards. This included literature on droughts, flooding, landslides, earthquakes, hurricanes and climate change.

4.2.4 Hydrology

Hydrology and drainage were assessed via the review of literature, data and maps from the Water and Sewerage Authority Resources Authority (WASA), the Environmental Management Authority, and the Ministry of Planning. Available water quality data received from WASA were also analysed within the context of the project.

4.2.5 Air and Noise

This project did not involve the collection of air and noise samples. It is based on available ambient air quality data and noise baseline data received from the Environmental Management Authority (EMA) via published literature were also analysed within the context of the project.

Particulate matter was primarily examined since its effects from exposure of PM_{10} on human health include but are not limited to: deleterious effects on the respiratory systems, damage to lung tissue, cancer, and premature death; the age, gender and health of the individual will determine the extent of these effects. This was considered a significant concern based on the proposed activities.

4.3 ECOLOGICAL ASSESSMENT

The Ecological Assessment is based primarily on the review of secondary data available from the Trinidad and Tobago State of the Environment Report and the Environmental Management Authority. The review of this information along with the review of satellite imagery over time and general knowledge of the landscape of the twin island state was heavily relied on to inform the identification of locations of likely ecological significance and to evaluate the potential impacts of the project activities.

4.4 SOCIOECONOMIC ASSESSMENT

The proposed project will likely affect the surrounding community and vice versa. As such, the main purpose of the socioeconomic analysis was to place the proposed project within the context of the local human environment to understand the existing socioeconomic setting and determine the potential impacts discerning negative and positive influences.

The methodological approach to this assessment was in keeping with the databases available and needed to support proper analysis and useful findings and included the following main methods.

- Desk Research
- Field Investigations
- Stakeholder Mapping and Analysis
- Stakeholder Consultations via Key Informants Interviews.

Desk Research:

Desktop research and review of earlier environmental studies associated with the specific site or closely related areas helped to put the development project into its local context. Demographic and housing data from the Central Statistical Office (CSO) were also acquired largely via their online published data as the offices were not open during the study period as a result of the COVID-19 closure of non-essential services. The following are secondary documentation that were reviewed:

- IDB Environment and Safeguards Compliance Policy (OP 703) and Environment and Safeguards Compliance Policy (OP 761), IFC Standards on Environmental and Social Sustainability (2012) and relevant local legislation like the Environmental Management Act of 2000; the CEC Rules (2001)
- National policies, plans and programmes that are relevant to the socio-economic development of the affected areas include Vision 2030 National Strategic Plan; the National Spatial Development Strategy – A Planning Framework for the Metropolitan area which includes, the Municipalities within the study area

- Secondary information relating to the Municipalities and affected communities – these include the baseline reports to Municipal Local Area Economic Profiles.
- Mapped data from the Ministries of Works and Transport, Agriculture, Land and Fisheries, Education, Health, Community Development, Rural Development and Local Government, National Security, and Office of Disaster Preparedness and Management (ODPM).
- CSOs 2011 population statistics for the affected communities, the sub-regions and municipalities within which the communities are located including statistics on:
    a. Population and demography - total population by sex, age group, ethnic composition, religion and disability;
    b. Household composition – number of households and sex of head of household;
    c. Housing conditions and services – water sources, sanitation facilities, lightning assets, and environmental problems experienced.
    d. Using the information collected (secondary and primary data), compile profiles of the affected municipalities and communities – identify the socio-economic characteristics of the communities.
    e. Income levels and sources; poverty rates and vulnerable groups.

- Cultural heritage sites within the project's areas of influence

Field Investigations:

The consultant conducted rapid appraisal field surveys of affected areas to verify secondary information reviewed and to determine changes that have taken place in recent times, to understand the socioeconomic and cultural context of the different settlements, and to identify and describe their problems and opportunities through the active interaction with local communities. These surveys included windscreen surveys.

Stakeholder Mapping and Analysis:

Stakeholder engagement is the basis for building strong, constructive, and responsive relationships that are essential for the successful management of a project's environmental and social impacts. It is an ongoing process that involves the following elements: stakeholder analysis and planning, disclosure and dissemination of information, consultation and participation, and ongoing reporting to Affected Communities. The nature, frequency, and level of effort of stakeholder engagement is commensurate with the project's risks and adverse impacts, and the project's phase of development.

This Stakeholder Analysis is a requirement of the IDB's mandated Environmental and Safeguards Policy and is being conducted from the early stages of the project. With the assistance of the key implementing agency, WASA, the team identified key institutions, government agencies, private sector entities, community groups, non-governmental organizations and community groups to consult with as the various components of the overall Water Supply Improvement Program is rolled out.

For the development of the Stakeholder Engagement Plan, stakeholders were grouped according to who may be impacted, have special interest in, or may influence the proposed project (Figure 4-1). Several of the stakeholders included, but are not limited to the following:

1. Water and Sewerage Authority
2. Environmental Management Authority
3. Ministry of Planning and Development
4. Central Statistical Office
5. Ministry of Public Utilities
6. Member of Parliament, Local Government Councils and Councilors
7. The Population
8. Community Groups
9. Local and Regional Corporations
10. Ministry of Works
11. TTECH
12. TSTT
13. National Gas
14. Cable Company

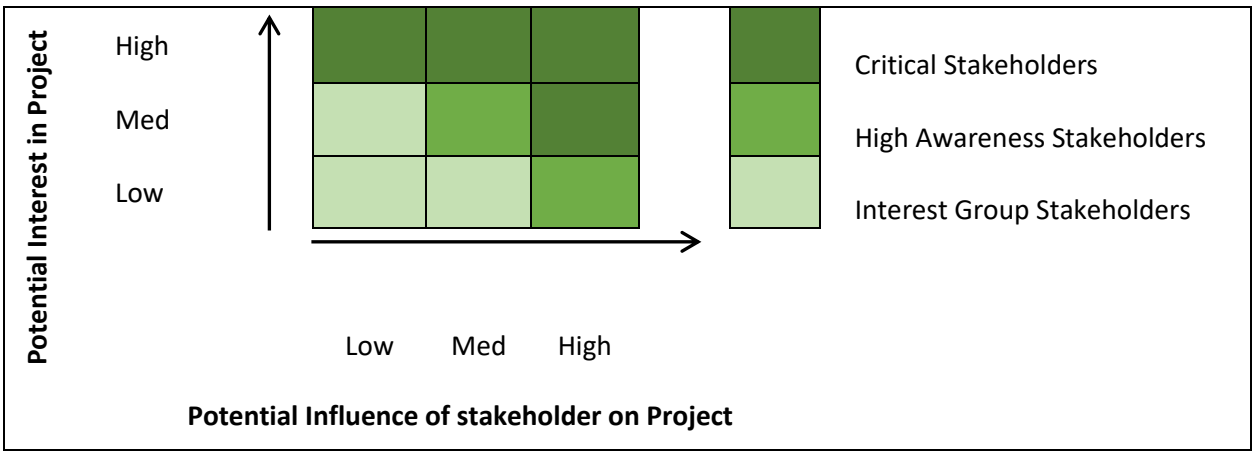


Figure 4-1: Stakeholder Mapping

Medium Interest Stakeholders:

Their roles are based on a specific administrative mandate and capability/capacity which is a standard engagement for them.

Stakeholders with Important Interests:

These stakeholders have important information or specific action-based deliverables that project implementation must rely on. The Stakeholder Consultation process will not qualify as robust if these entities are not consulted.

Critical Stakeholders:

These stakeholders are critical engines of project development both in relation to conceptual planning and actual resource deployment. They must be consulted.

Stakeholders were also separated in relation to:

- Stakeholders that are involved in the Project's development and planned implementation to include those technical Stakeholders who have a specific interest or implementation responsibility for aspects of the project.
- Affected Stakeholders: Those that may be affected by the different components and phases of the project. The stakeholders contacted will be those assumed to be affected, directly or indirectly, by aspects and effects of Project implementation.
- Stakeholders being able to influence Project implementation

Stakeholder Consultations: The method of engagement is outlined for the various stakeholder groups, in order to meet the varying needs identified. Table 4-1 below shows the various levels of engagement.

Table 4-1: Stakeholder level of Engagement and Approaches

LEVEL	ROLE OR RESPONSIBILITY	COMMUNICATION	NATURE OF RELATIONSHIP	ENGAGEMENT APPROACHES
Monitor	Monitor stakeholders' views.	One-way; stakeholder to company	Long term	Media and internet tracking. Second-hand reports from other stakeholders possibly via targeted interviews or virtual meetings.
Inform	Inform or educate stakeholders.	One-way; company to stakeholder, no invitation to reply.	Short or long-term relationship with stakeholders.	Bulletins, letters, brochures, reports, and websites. Speeches, conference and public presentations. Open house and facility tours. Road shows and public displays. Press releases, press conferences, media advertising, lobbying.
Transact	Work together in a contractual relationship where one partner directs the objectives and provides funding.	Limited two-way; setting and monitoring performance according to terms of contract.	Relationship terms set by contractual agreement.	Public Private Partnerships and Private Finance Initiatives, Grant-making, cause related marketing.
Consult	Gain information and feedback from stakeholders to inform decisions made internally.	Limited two-way; company asks questions and the stakeholders answer.	Short or long-term involvement.	Surveys, focus groups, workplace assessments, one-to-one meetings. Public meetings and workshops. Standing

LEVEL	ROLE OR RESPONSIBILITY	COMMUNICATION	NATURE OF RELATIONSHIP	ENGAGEMENT APPROACHES
				stakeholder advisory forums. On-line feedback and discussion.
Involve	Work directly with stakeholders to ensure that their concerns are fully understood and considered in decision making.	Two-way, or multi-way between company and stakeholders. Learning takes place on both sides. Stakeholders and company take action individually.	May be one-off or longer-term engagement.	Multi-stakeholder forums. Advisory panels. Consensus building processes. Participatory decision-making processes.
Collaborate	Partner with or convene a network of stakeholders to develop mutually agreed solutions and joint plan of action.	Two-way, or multi-way between company and stakeholders. Learning, negotiations, and decision making on both sides. Stakeholders work together to take action.	Long-term.	Joint projects, voluntary two-party or multi-stakeholder. Initiatives, partnerships.
Empower	Delegate decision-making on a particular issue to stakeholders.	New organizational forms of accountability; stakeholders have formal role in governance of an organization or decisions delegated out to stakeholders.	Long-term.	Integration of stakeholders into governance structure (e.g. as members, shareholders or on particular committees etc.)

It is important to note that this Consultancy took place during the COVID-19 pandemic which impacted how stakeholder engagement, including public consultations, were able to be carried out. However, the Consultation Plan also presents the mechanism that can also be utilized when things normalize. As a result of the pandemic the following approach was taken:

- Community Key Informant interviews electronically or via the telephone were utilized in place of conducting in person household surveys. This would mean that the number of responses were less, but the Consultants believe that the community Key Informants consulted were knowledgeable representatives from key communities.

- Considerations will need to be given to conducting a virtual public consultation. Although this may be skewed to persons having internet access or telephone access, this mechanism is still believed to have the potential to capture a wide audience especially since the project area is so large. The assistance of the Government of Trinidad and Tobago will be sought to determine if there are any virtual platforms available to facilitate this process. Considerations are also being made to have this streamed via a local radio station to increase the reach. This approach will be confirmed through discussions with the IDB.

The Consultant will support the executing agency conducting consultation activities during this consultancy and will capture records during the process (e.g. attendance sheets, recordings etc.). ESL will also prepare a consultation report including a summary of the main findings of the consultation activities that will inform the ESA, ESMP, SESA and ESMF.

4.5 IMPACT ASSESSMENT AND MITIGATION MEASURES

Following the assessments of the existing environment, the team identified various environmental and social aspects and possible impacts associated with the various project components. The construction and operation phases of the proposed activities were also analysed. These impacts were assessed with respect to their direction, duration, magnitude and type.

- Direction defines whether the impact is positive or negative
- Duration defines whether an impact is a short-term, long term, intermittent or continuous
- Magnitude defines an impact as minor, moderate, major or significant
- Type defines an impact as reversible or irreversible

Impacts were identified based on the factors in Table 4-2.

Table 4-2 Impact Assessment Criteria

IMPACT ASSESSMENT CHARACTERISTIC	
Direction of impact	
Rank	**Definition**
Positive	• Impacts of the project on the environment and vice versa are likely to be good
Negative	• Impacts of the project on the environment and vice versa are likely to be bad
Magnitude of impact	
Rank	**Definition –** one/the combination of
Low	• Little or negligible action and/or control are useful, but not required in the short term, review in the future is useful • Exceeding of threshold value in case of operating problems (abnormal conditions) and low effect and low probability of occurrence and/or high probability of detection. • Minimal effect • Limited probability of occurrence • "Aspect" controlled under normal conditions • High knowledge of "Aspect"
Moderate	• Action and/or control are required in the near future

IMPACT ASSESSMENT CHARACTERISTIC	
	• Exceeding of threshold values in case of operating problems (abnormal conditions) and above • Average high probability of occurrence and/or low probability of detection. • Financial threat • Effect likely to increase under planned activities • Rising concern of shareholders • Emergency situation would cause a large environmental impact • Complaint likely to be received • "Aspect" not fully controlled under normal conditions
High	• Immediate Action and/or control is mandatory • Aspect" is currently not controlled under normal operations. • Could break legal or policy documents. • In breach of legislation • Sensitive environment (groundwater proximity, conservation area, residential area) • Repeated complaints
Impact Duration	
Short term	Occurring infrequently or during one project phase
Medium term	Occurring frequently during a few project phases
Long term	Occurring frequently during most or all project phases
Types of Impacts	
Reversible	Effects that are reversible and diminish when activities cease or over time.
Irreversible	Effects that are not reversible and do not diminish even if the activity ceases to occur, and do not diminish with time.
Cumulative	Effects of an action are added to or interact with other effects in a particular place and within a particular time
Probability of Impacts	
Low	An impact which is unlikely to occur
Moderate	An impact which may occur
High	An impact which is very likely to occur

Appropriate mitigation measures were then recommended to address all the negative impacts. These results were used to develop management actions to deal with the negative impacts identified. These management plans have been developed as one ESMP document. The ESMP includes a Stakeholder Engagement Plan and a Grievance Mechanism.

5 THE EXISTING ENVIRONMENT

This section describes the existing physical, ecological and socio-economic environmental setting for Trinidad and Tobago).

5.1 PHYSICAL ENVIRONMENT

5.1.1 Topography

The topography across Trinidad is characterized by three distinct east-west trending mountain ranges, The Northern Range, The Central Range and the Southern Range, separated gently rolling flatlands (Figure 5-1). The Northern Range is the highest set of mountains on the island with a peak reaching 940m above sea level (EL Cerro Dele Aripo). The Northern Range is said to be a continuation of the mountains of the Paria Peninsular in Venezuela. The Central range reaches a maximum height of 300m and the hills of the Southern Range are much lower. Tobago has hilly terrain with steep slopes associated with the Main Ridge with elevations up to 640 m surrounded by low lying areas.

The project area extends across Trinidad and Tobago (Figure 5-1). Here, the terrain is mountainous with deep valleys and flatlands mainly to the southern section of the mountain range leading into the flatlands of the Caroni Basin. These valleys and flatland areas have undergone significant development.

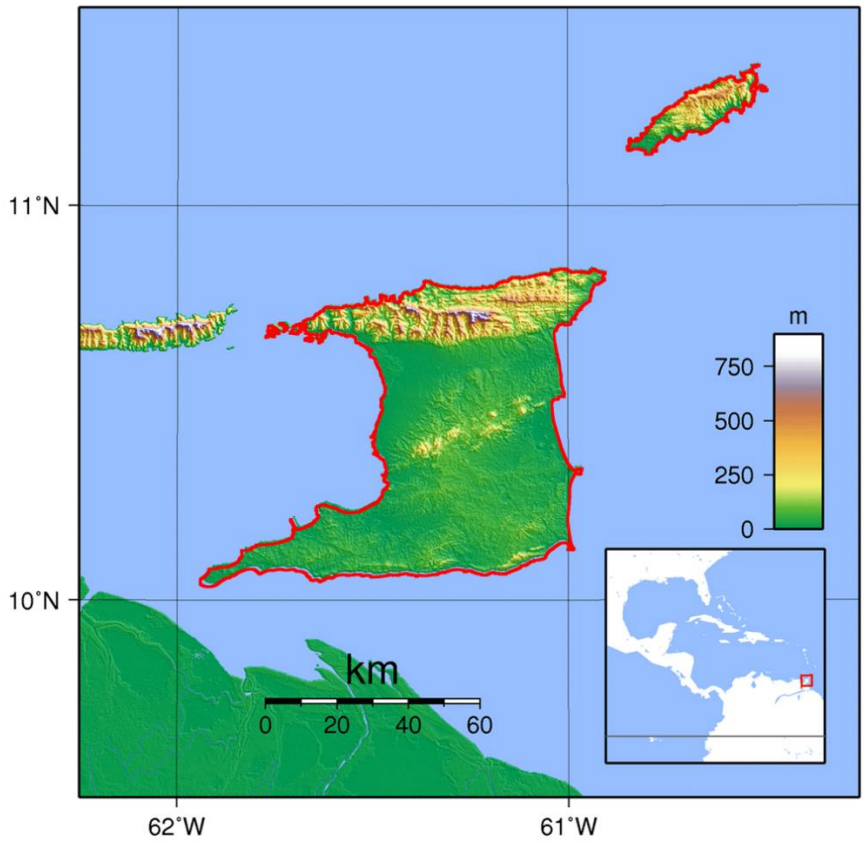


Figure 5-1: Digital elevation model of Trinidad and Tobago (modified from Mapsland, 2020)

5.1.2 Geology

Trinidad and Tobago is located on the southeastern edge of the Caribbean Plate and the South American Plate margins (Weber, 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 (Figure 5-3). While in Tobago, the Central Fault System consists of normal faults with crosscutting north-northwest striking, oblique-slip faults (Snoke and Wadge, 2001). The South Fault system in Tobago does not show any surface expression however movement is captured in offshore seismic reflection profiles. These islands, therefore, sit within an active earthquake zone (See Section 5.1.7.3.1).

The geology of Trinidad can be described as three areas of uplifted ranges separated by a flat-lying basin filled areas which were produced by the erosion of uplifted ranges (Figure 5-4) (Garcia-Caro, Mann & Escalona, 2011). The three uplifted ranges are known as the Northern Range, Central Range, and the Southern Range. The Northern Range has some of the oldest rocks (Late Jurassic – Cretaceous) in Trinidad (Figure 5-4). These consist of clastic sedimentary rocks, recrystallized limestones, and low-grade metamorphic rock facies including serictic phyllits, sericiticquartzites and massive-ortho-quartzites, which sometimes show relic structures (GSTT,2020). The Central Range consists of Pre-Middle Miocene clastic and carbonate sedimentary rocks that underwent deformation and displacement. The right lateral shearing of these rocks along the Central Range fault zone creates an angular unconformity (Garciacaro, et al., 2011). The Southern Range contains clastic sedimentary rocks ranging in age from Late Cretaceous to Pleistocene. This area represents the uplifted and eroded section of the Southern Basin (Garciacaro, et al., 2011).

Surrounding the uplifted ranges, are low lying areas known as the Northern Basin/GOP Pull Apart Basin/Caroni Plains and the Southern Basin. The Northern Basin is infilled with consists of young alluvial fan deposit. These sediments were derived from the erosion of the rocks from the Northern range, transported and deposited by major rivers on the southern flanks of the mountains. The phyllitic rocks of the Northern Range make it very are suspectable to mass movements (landslides) (See Section 5.1.7.3.2). The Southern Basin is characterized as an intensely deformed basin consisting of Oligocene to Pliocene clastic rocks. This basin has been the main site of petroleum exploration with abstraction from the clastic deep water and paralic formations.

Tobago's geology is subdivided into four main groups: the North Coast Schist, the Plutonic Suite, the Tobago Volcanic Group and Pleistocene coralline limestone rocks (Figure 5-5). The North Coast Schists are Cretaceous low grade metamorphosed volcanic rocks. The plutonic suite consists of Albian age (Cretaceous) deformed volcanic plutonic complexes, ultramafic rocks, gabbro-diorite, and biotite ± hornblende tonalite (Snoke, et al., 2013). Parts of the plutonic suite intruded and contact metamorphosed the Tobago Volcanic Group (Snoke, et al., 2013). This group is predominantly Albian lithic-clast volcaniclastic breccias (Snoke, et al., 2013). The youngest rocks are located in the southern section of Tobago. These sedimentary rocks are predominately coralline limestones.

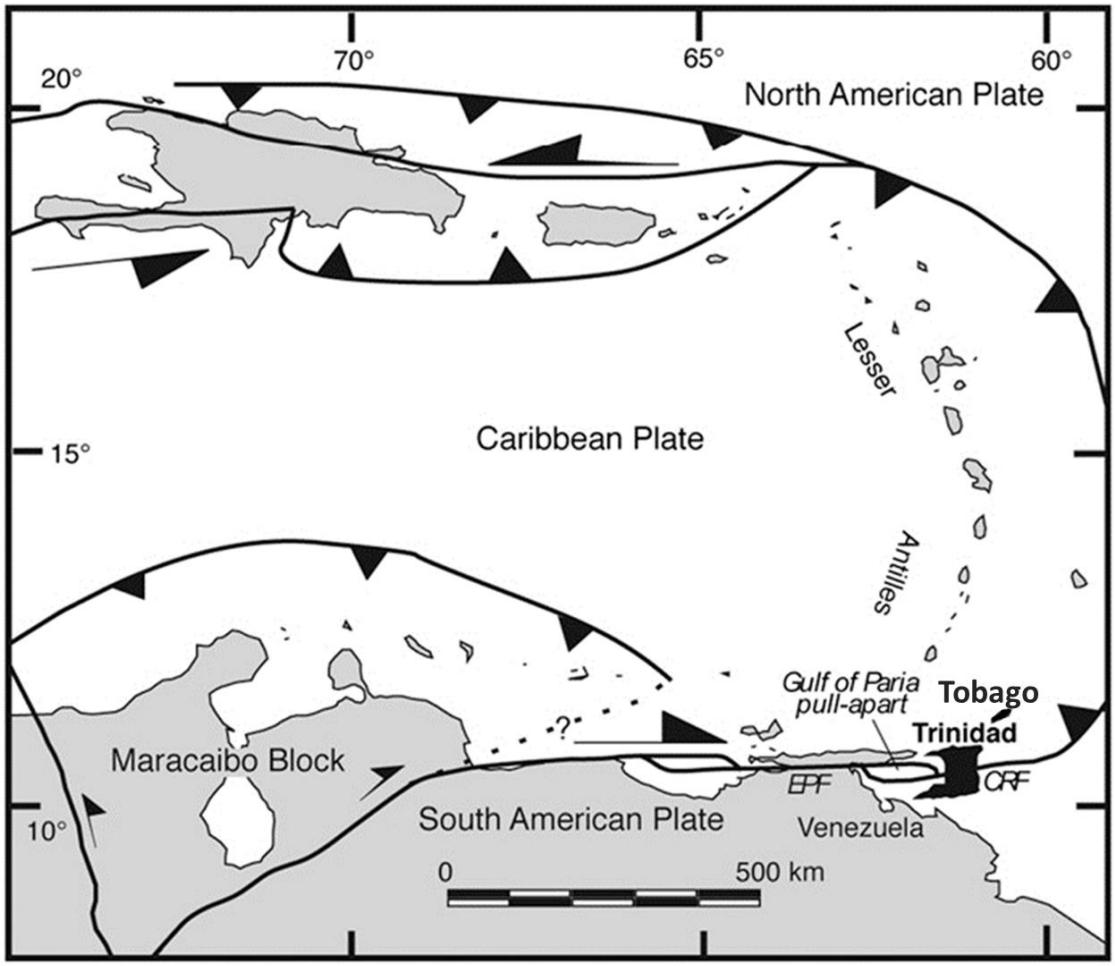


Figure 5-2: Location of Trinidad and Tobago on the south-eastern margin of the Caribbean Plate Margin (Weber, et al., 2011)

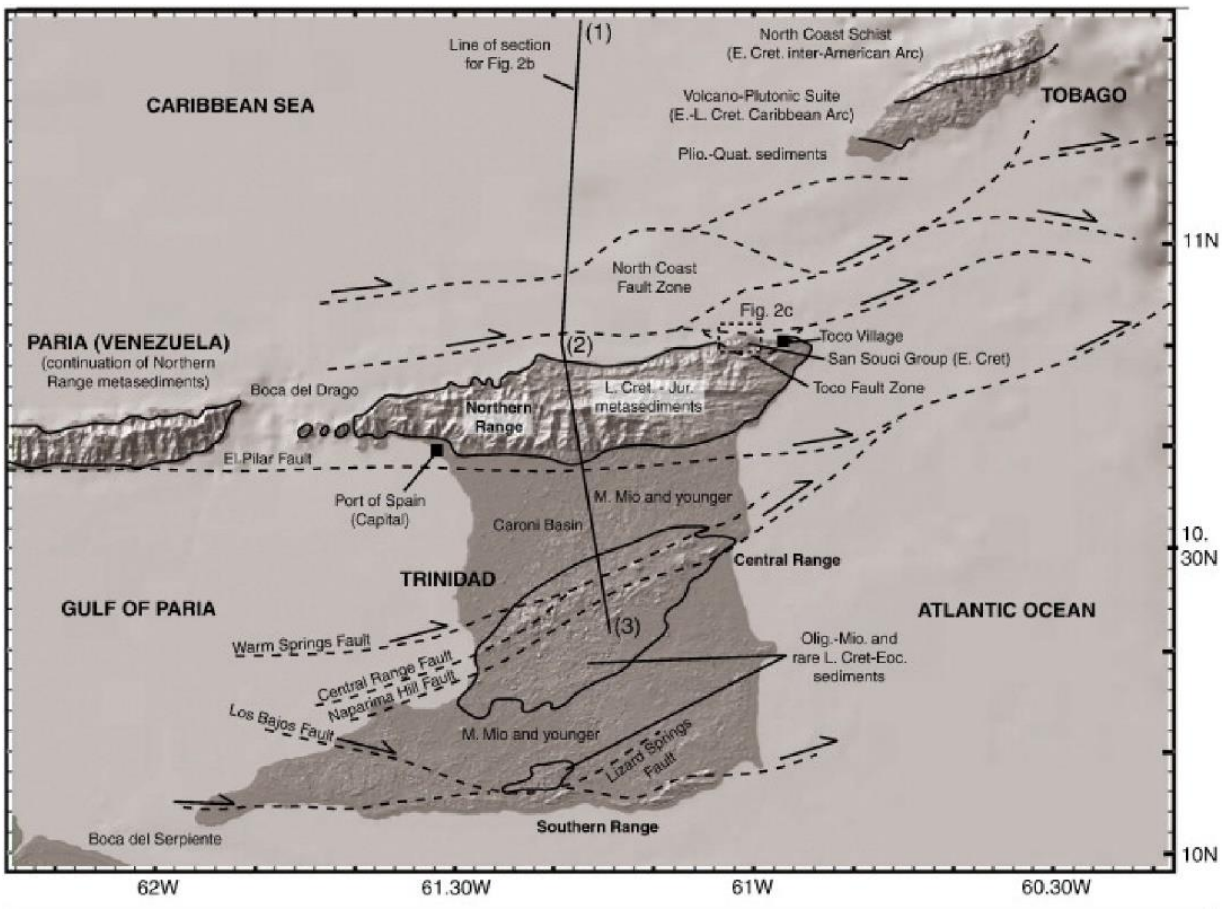


Figure 5-3: Major east-west trending faults which cut across Trinidad Roberson (Roberson & Burke, 1989)

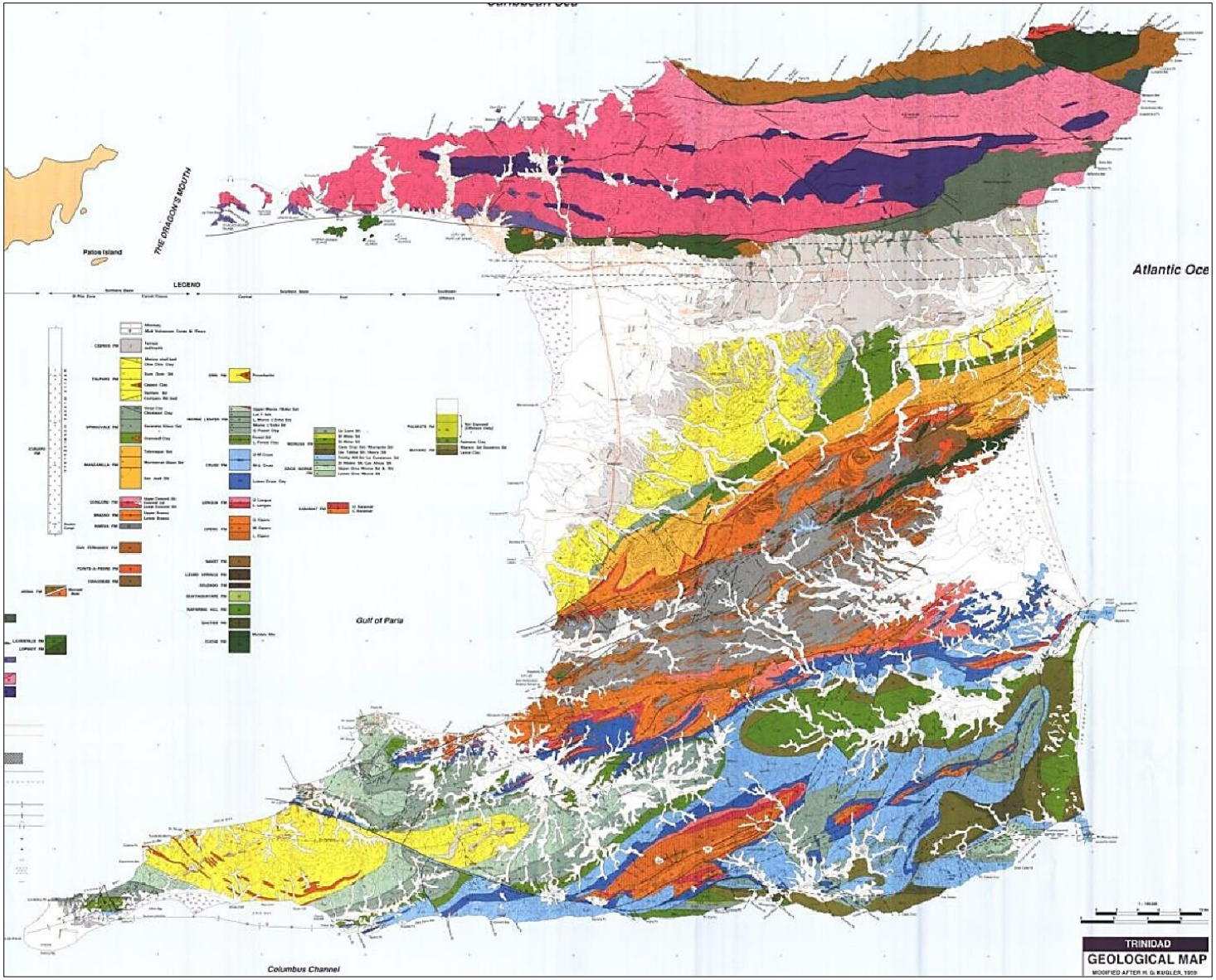


Figure 5-4: Geology map of Trinidad (Saunders, 1998)

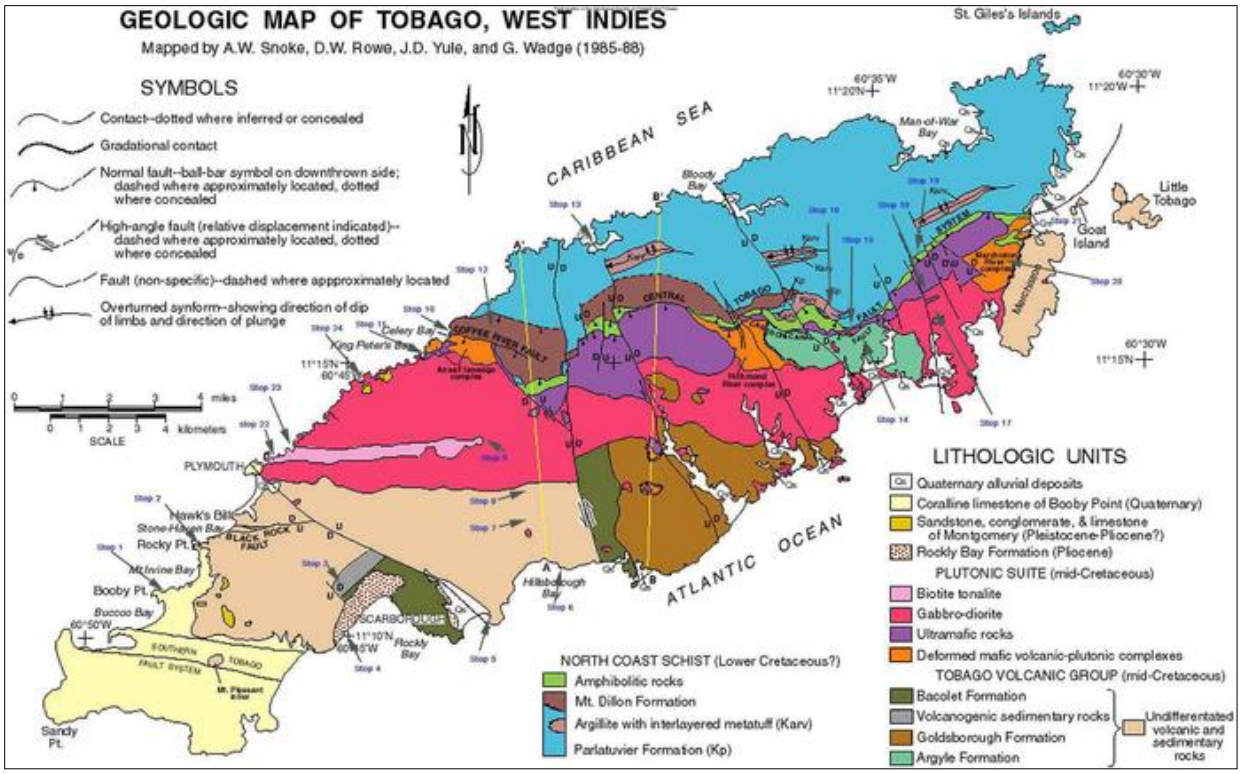


Figure 5-5: Geology map of Tobago (Snoke, Yule and Wadge, 1988)

5.1.3 Land Use and Water Resources

The information for this component of the report was obtained from the comparative analysis of the 2007 Landuse map for selected watersheds in Trinidad and Tobago (Figure 5-6 and Figure 5-7) and the 2020 satellite imagery for each watershed.

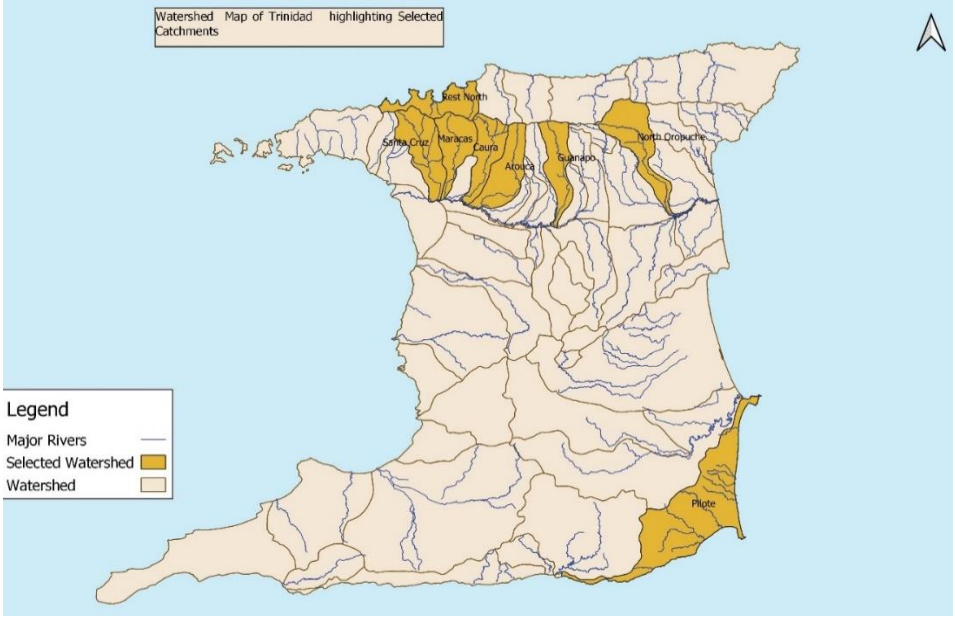


Figure 5-6: Watershed Map of Trinidad highlighting Selected Watersheds/Catchments

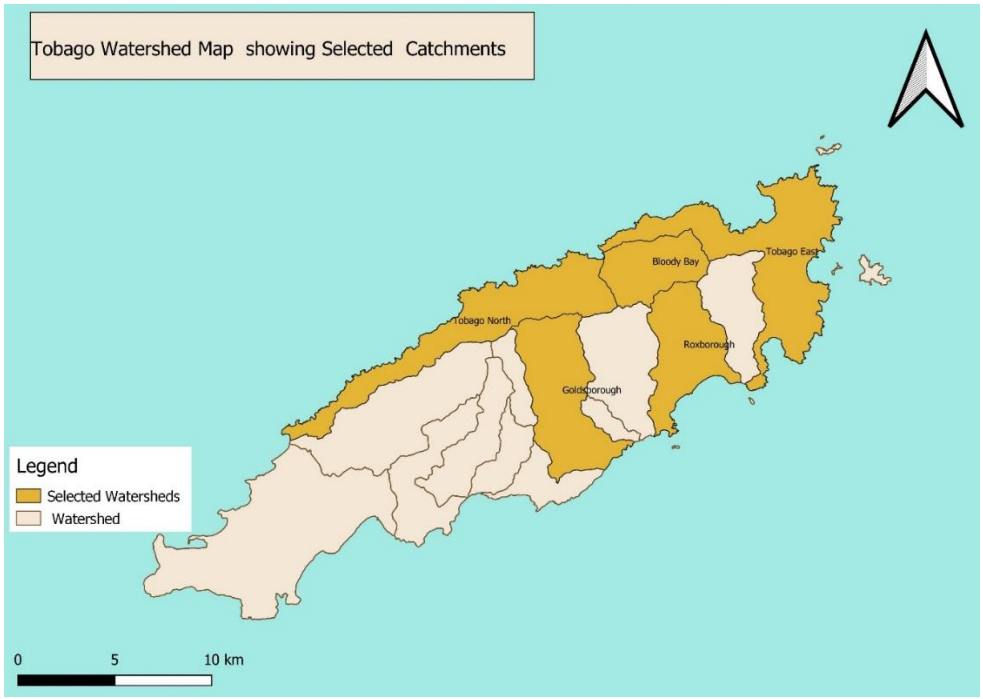


Figure 5-7: Watershed Map of Tobago highlighting Selected Watersheds/Catchments

5.1.3.1 Trinidad Watersheds

5.1.3.1.1 The North Oropouche Watershed

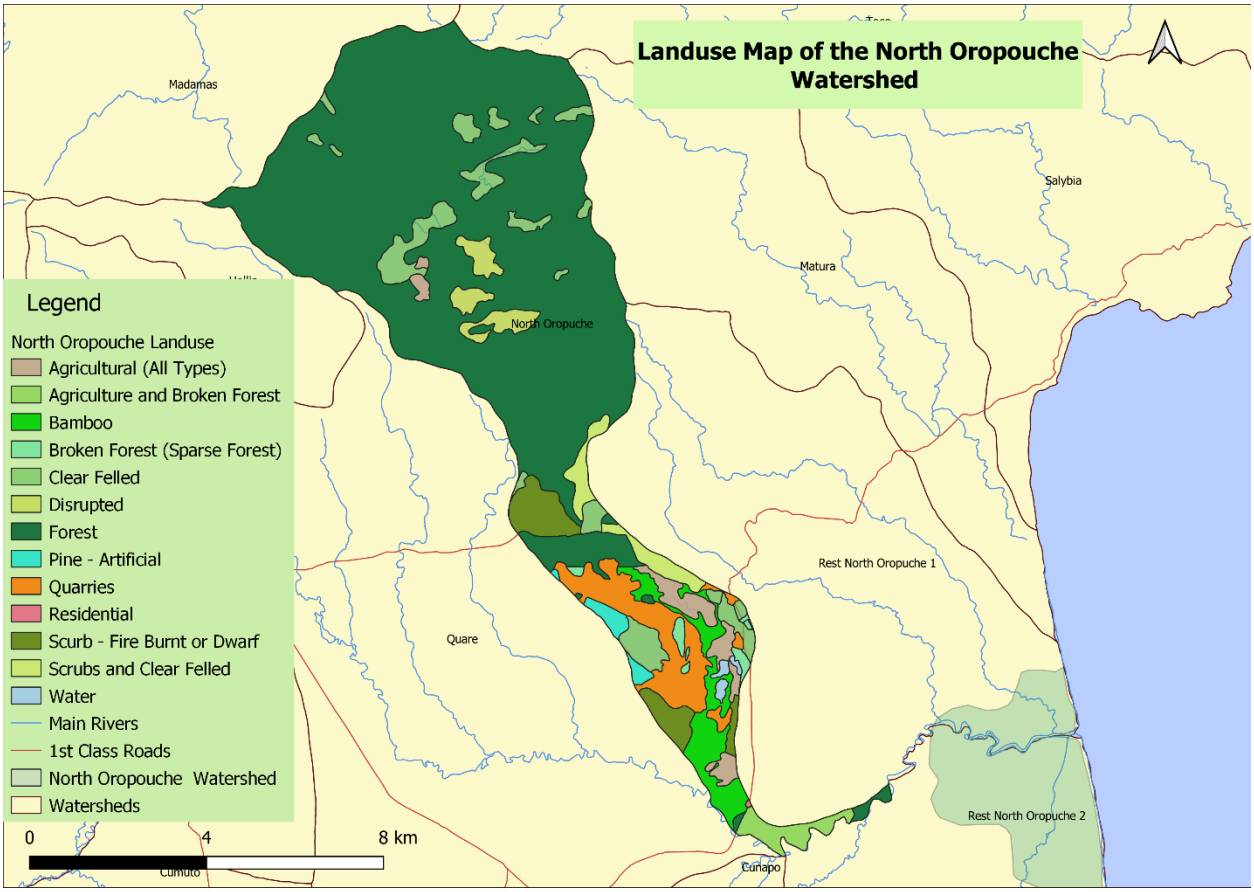


Figure 5-8: Landuse Map of the North Oropouche Watershed

The upper half of the catchment consists primarily of forest, with pockets of agriculture, clear-felled and distributed areas(Figure 5-8). Within this watershed is the community of Cumaca (which is not included in this map) that is considered a very low-density community where residences are miles away from their nearest neighbour. The lower half of the watershed consists mainly of a linear pattern of housing along the main arteries and large-scale quarrying operations.

The main water uses of the North Oropouche River are:

- Irrigation
- Local water supply – the North Oropouche Water Treatment Plant for surrounding communities
- Recreation (in the upper half of the catchment)
- Washing of gravel and other mineral extraction activities

The major impact of anthropogenic activity on water resources include:

- Sediments from the mining operation causing sedimentation of the watercourse.
- Run off from agricultural plots causing the pollution of nearby watercourses. This runoff contains pesticides, fertilizers and animal waste

- The encroachment of squatters along access routes cleared for mining operations can contaminate both underlying groundwater sources and nearby surface water sources due to poor water, waste and sanitation facilities.

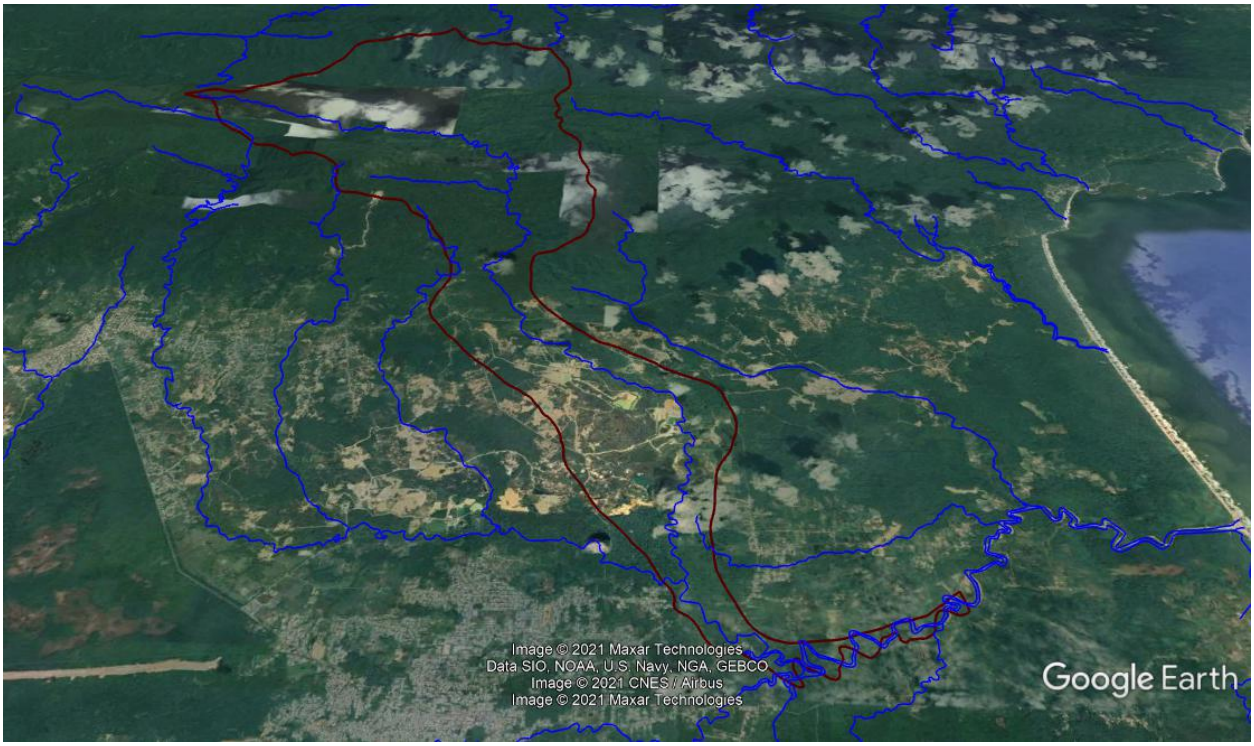


Figure 5-9: Satellite Imagery of the North Oropouche Watershed (Source: Google Earth Pro). The maroon line is the outline of the watershed.

5.1.3.1.2 Guanapo Watershed

The major land uses within the Guanapo watershed consist of a mix of forest, agriculture, residential and mining activities (Figure 5-10). The upper reaches of the watershed consist mainly of forest and one quarry. The middle reaches of the catchment comprise residential activity, agriculture and the Guanapo Landfill. The Guanapo Landfill is situated in the middle of the watershed on the west of the Guanapo River and 1.5 km north of the Eastern Main Road. There is a combination of settlement types within the watershed which consist of both spontaneous settlement and planned development. The spontaneous settlement occurs in, pockets, a nucleated pattern on the outskirts of the landfill and a linear pattern along the arteries leading to and from the landfill. It should be noted that many of the inhabitants of these communities depend on the landfill as the source of their livelihoods. The planned development occurs as both high-density housing schemes and low-density dispersed settlements. The high-density housing schemes occur in the western boundary of the watershed in the vicinity of the Crossings and Demerara Road. The low-density disperse residences typically occur in association with 2 to 5 acres agricultural plots.

Agricultural activity is the main land use type within the middle and lower reaches of the Guanapo catchment. This activity consists of both the cultivation of a variety of crops and animal husbandry.

In the lower reaches of the catchment, there are also pockets of industrial activity, housing and mining operations.

The main uses of the Guanapo River are:

- Irrigation
- Local and national water supply (the Guanapo Water Treatment Plant and Guanapo River flows into the Caroni River upstream of the Caroni Water Treatment Plant)
- Recreation (in the upper reaches)
- Washing of gravel and other mineral extraction activities
- Conduit for grey water from domestic activities

The major impacts of anthropogenic activity on water resources include:

- Grey water runoff from houses
- Run off from agricultural plots. This runoff contains pesticides, fertilizers and animal waste
- Runoff from the quarries within the watershed particularly the quarry in the upper reaches of the watershed. The Guanapo Water Treatment plant is impacted by heavy sedimentation after heavy rainfall events.
- The expansion of the pockets of squatting communities affects the ability to adequately plan and meet the water demand, as expansions of these settlements are typically not included in water supply projections. These communities typically tend to balloon in vulnerable areas namely on the banks of rivers and on very steep slopes.

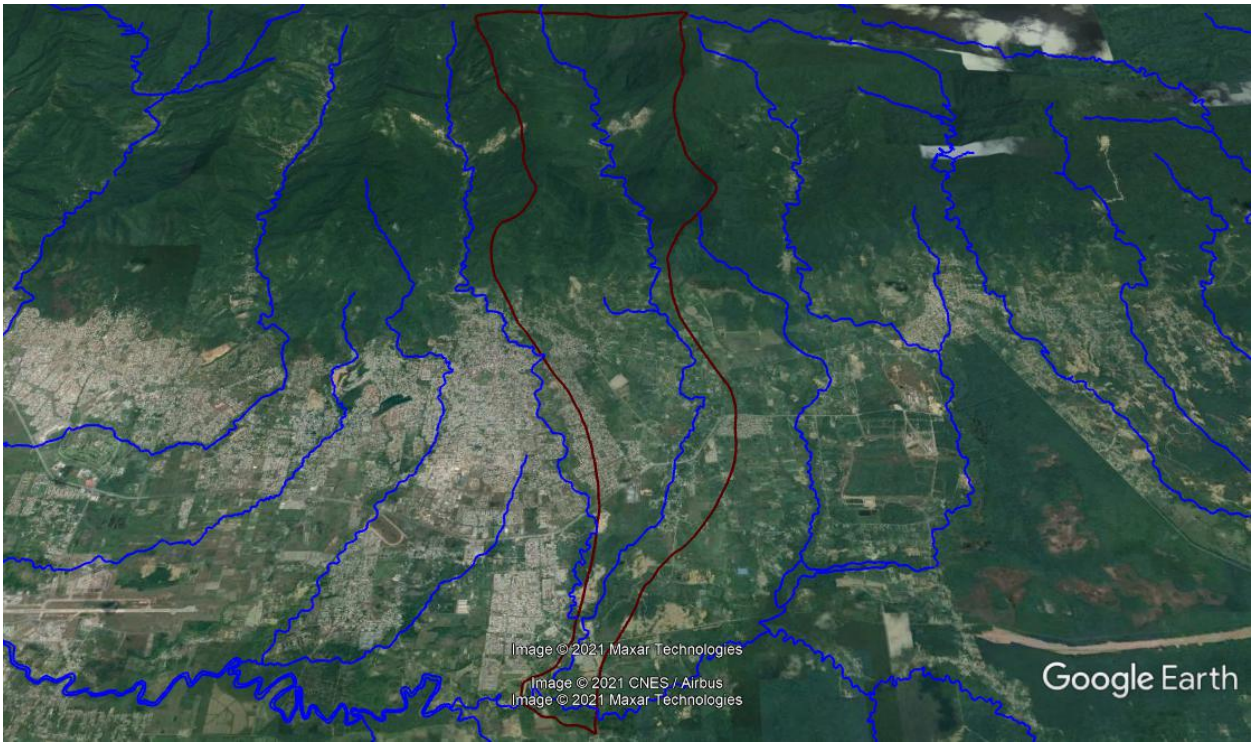


Figure 5-10: Satellite Imagery of the Guanapo Watershed (Source: Google Earth Pro). The maroon line is the outline of the watershed.

5.1.3.1.3 Lopinot Watershed

The Lopinot Watershed consists of a variety of land uses such as agriculture, housing, forest, commerce and industry (Figure 5-11). The upper half of the catchment consists mainly of forest and plantation type

agriculture with pockets of short-term crops, clear-felled areas and housing. There is also a number of hotels, tourism and recreational facilities. Medium to low-density housing also occurs in a linear pattern along the major arteries.

The lower half of the watershed consists mainly of housing, commerce and agriculture. Most of the housing occurs along a 2.7 km wide band adjacent to the east-west corridor north of the Churchill Roosevelt (CR) Highway. Residences south of the CR Highway are concentrated on the southeastern area of the watershed. The Oropune Gardens is an example of a housing development south of the CR Highway. There is also squatting in the vicinity of Windy Hill and Victory Heights.

Commercial activity is concentrated along the Eastern Main Road, the CR Highway and the other main arteries. Agriculture is the most dominant activity south of the highway. This consists mainly of short-term crops.

The main water uses of the Lopinot River are:

- Irrigation
- Local water supply (water is abstracted from the Lopinot River and other tributaries for domestic purposes.)
- Recreation (in the upper reaches)
- Washing of gravel and other mineral extraction activities
- Conduit for grey water from domestic activities

The major impact of anthropogenic activity on water resources include:

- Grey water runoff from houses
- Poorly functioning sewerage treatment plants and other wastewater applications
- Illegal water abstraction in the upper reaches of the catchment.
- Run off from agricultural plots. This runoff contains pesticides, fertilizers and animal waste
- The expansion of the pockets of squatting communities affects the ability to adequately plan and meet the water demand, as expansions of these settlements are typically not included in water supply projections. These communities usually tend to balloon in vulnerable areas namely on the banks of rivers and very steep slopes.

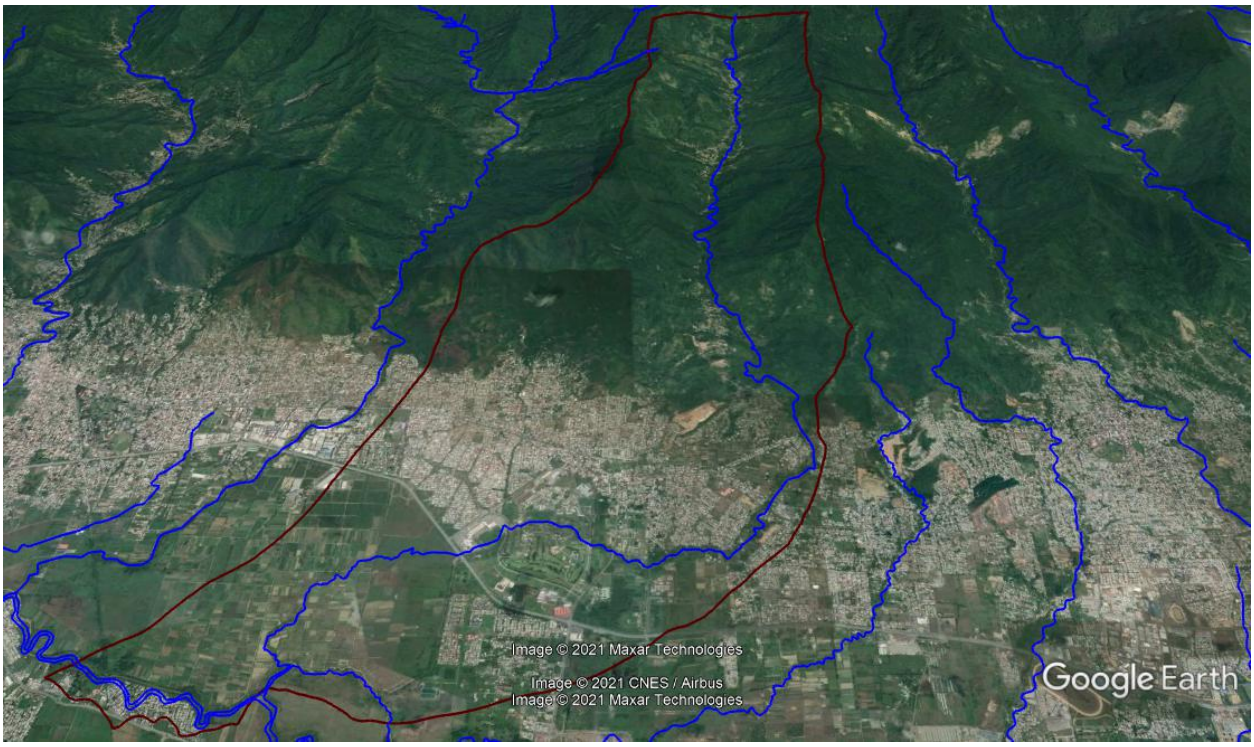


Figure 5-11: Satellite Imagery of the Lopinot/ Arouca Watershed. (Source: Google Earth Pro). The maroon line is the outline of the watershed.

5.1.3.1.4 Caura Watershed

The Caura Watershed consists of a mix of land use types (Figure 5-12). These include forest, agriculture, residential housing, commerce and industry.

The upper half of the watershed consists mainly of forest, pockets of agriculture and a low-density linear pattern of housing. The agricultural activity consists of a combination of short, medium and long-term crops. The lower half of the catchment consists of commercial and industrial activity, residential activity and agriculture. Residential activity occurs as a 1km band along the east-west corridor north of the main road. The commercial activity occurs along the major roadways. Two industrial estates within the lower half of the catchment between the CR Highway and the Bus Route are the Macoya Industrial Estate and the Trinicity Industrial Estate. The Caura River separates these estates. These estates consist of both industrial and commercial enterprises. There are also housing and recreational /sporting grounds on the outskirts of these Estates.

South of the CR Highway agriculture is the main land use. There is also a wholesale farmers market and low-density housing within this zone.

The main water uses of the Caura River are:

- Irrigation
- Local water supply (The Caura Water Treatment Plant and several rural intakes that utilize water from tributaries to supply households)
- Recreation (in the upper reaches)
- Conduit for grey water from domestic activities

The major impacts of anthropogenic activity on water resources include:

- Grey water runoff from houses
- Poorly functioning sewage treatment plants and other wastewater applications
- Illegal water abstraction in the upper reaches of the catchment.
- Run off from agricultural plots. This runoff contains pesticides, fertilizers and animal waste

Figure 5-12: Satellite Imagery of the Caura Watershed. (Source: Google Earth Pro). The maroon line is the outline of the watershed.

5.1.3.1.5 Maracas /St. Joseph Watershed

The Maracas Watershed consists of a mix of land uses (Figure 5-13). These include housing, forest agriculture and commerce. The upper half of the watershed consists mainly of forest, agriculture and housing. Agriculture consists of a mix of both short-term cultivation and plantation type enterprises. Housing/residential activity occurs in a linear pattern along the major arteries and is nucleated in some areas. There is also a mix of both planned housing schemes and spontaneous developments. Mineral extraction/mining operation is a major activity within the upper reaches of the Maracas/St. Joseph watershed. The lower half of the Maracas watershed consists mainly of housing, with pockets of agriculture and commercial activity concentrated along the main arteries. The Head Office of the Water and Sewerage Authority and the Mount Hope Hospital are located within the Maracas/ St. Joseph watershed.

The main water uses of the Maracas St. Joseph River include:

- Irrigation

- Local water supply (The Acono Water Treatment Plant and several rural intakes that utilize water from tributaries to supply households)
- Recreation (in the upper reaches)
- Conduit for grey water from domestic activities

The major impact of anthropogenic activity on water resources include:

- Mining operation causes siltation of the river in the vicinity of the Acono water treatment plant
- Grey water runoff from houses
- Poorly functioning sewage treatment plants and other wastewater applications
- Illegal water abstraction in the upper reaches of the catchment.
- Run off from agricultural plots. This runoff contains pesticides, fertilizers and animal waste
- The presence of a squatter settlement over a major aquifer system. This can result in groundwater contamination.
- The expansion of the pockets of squatting communities affects the ability to adequately plan and meet the water demand, as expansions of these settlements are typically not included in water supply projections. These communities usually tend to balloon in vulnerable areas namely on the banks of rivers and very steep slopes.

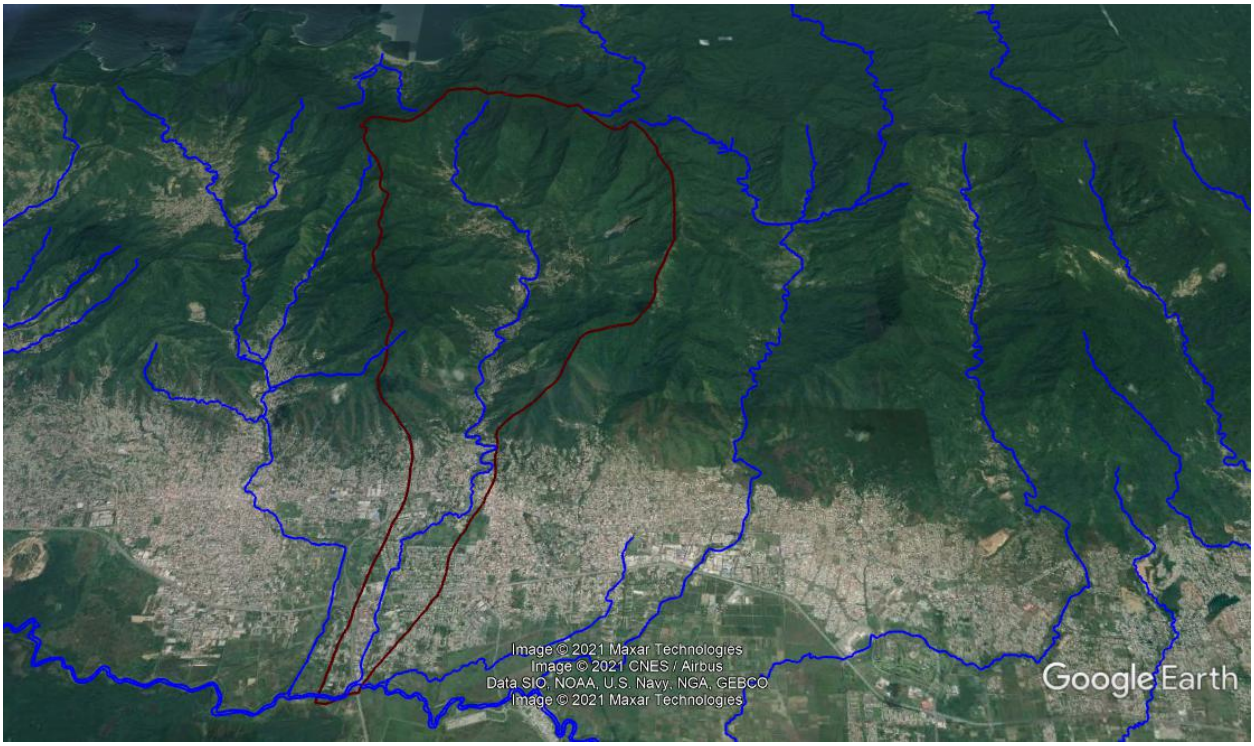


Figure 5-13: Satellite Imagery of the Maracas Watershed. (Source: Google Earth Pro). The maroon line is the outline of the watershed.

5.1.3.1.6 San Juan Watershed

The San Juan Watershed consists mainly of forests, agriculture, housing, commerce and mining operations (Figure 5-14). The Upper half of the watershed consists mainly of forests with pockets of agriculture and mining operations. Housing occurs along the major arteries and is nucleated in several areas. The lower

half of the watershed consists of housing, agriculture and commerce. Most of the agriculture occurs south of the Priority Bus Route on the eastern half of the watershed. Commercial activity occurs along the major roadways and in pockets. Commercial activity has started to encroach on the other activities in the lower watershed. Land use changes in the rest of the watershed are geared toward expansion in the housing market.

The main water uses of the San Juan River include:

- Irrigation
- Local water supply - many rural intakes utilize water from tributaries to supply households
- Recreation (in the upper reaches)
- Conduit for grey water from domestic activities
- The major impacts of anthropogenic activity on water resources include:
- Mining operation which can cause siltation of water courses
- Fire has destroyed hillside vegetation leading to several impacts on the hydrological cycle.
- Grey water runoff from houses causing the reduction in the quality of water in waterways
- Poorly functioning sewage treatment plants and other wastewater applications
- Illegal water abstraction in the upper reaches of the catchment.
- Run off from agricultural plots. This runoff contains pesticides, fertilizers and animal waste
- The conversion of prime agricultural land to housing and commercial enterprises. This increases impervious surfaces thus reducing infiltration and can exacerbate flooding within this watershed
- The conversion of forest and plantation type agriculture to housing can compromise a number of hydrological processes namely, interception of precipitation, infiltration, groundwater recharge, base flow and surface runoff. This can further exacerbate flooding within the watershed particularly as most of these conversions are on the catchment slopes.

Figure 5-14: Satellite Imagery of the San Juan Watershed (Source: Google Earth Pro). The maroon line is the outline of the watershed.

5.1.3.1.7 Rincon (Rest North) Watershed

The Rincon watershed consists mainly of forest with pockets of agriculture and housing (Figure 5-15). Housing occurs at very low densities along the roadways and in small clusters along Trinidad's Northern Coast. There is a mix of short to medium cultivation and long-term plantation-style agriculture.

The main water uses of the Rincon river include:

- Irrigation
- Local water supply-there are a number of rural intakes that utilize water from tributaries to supply households
- Recreation

The major impacts of anthropogenic activity on water resources include:

- Run off from agricultural plots which can impair the quality of water in waterways. To date, these releases are minimal, but they need to be adequately monitored.
- A lot of pressure to develop these lands for housing and tourism-based ventures.

Figure 5-15: Satellite Imagery of Rest North Watershed (Source: Google Earth Pro). The maroon line is the outline of the watershed.

5.1.3.1.8 Pilote Watershed

This watershed consists primarily of forest with agriculture and housing along the coastline (Figure 5-16). There is one industrial development along the southeastern tip of Trinidad.

The main water use of the Pilote River is Irrigation. Water supply in the Pilote watershed is obtained from the Guayaguayare Water Treatment plant, Petrotrin Water Treatment Plant, Tournebridge Water Treatment Plant and the Maloney Water Treatment Plant.

The major impact of anthropogenic activity on water resources in the Pilote watershed is runoff from agricultural plots.

Figure 5-16: Satellite Imagery of the Pilote Watershed

5.1.3.2 Tobago Watersheds

The Landuse for the underlying watersheds was derived from observing Satellite Imagery from Google Earth.

5.1.3.2.1 Goldsborough Watershed

The Goldsborough Watershed consists of a mix of land uses (Figure 5-17). They include forest, agriculture and housing and administrative buildings. The majority of the watershed consists of forests, particularly at the higher elevations. The valley floor consists mainly of agriculture and low-density housing. There is also a linear pattern of housing along Windward Road and St. James Road. There are also schools, a church, businesses and sporting and community facilities close to the coastline.

Figure 5-17: Image of the lower riches of the Goldsborough watershed showing the agriculture and low density housing along the valley floor(Source: Google Earth Pro). The maroon line is the outline of the watershed.

The main water uses of the Goldsborough River include:

- Irrigation
- Recreation (in the upper reaches)

The major impact of anthropogenic activity on water resources includes runoff from agricultural plots that can negatively affect the quality of the receiving watercourse.

5.1.3.2.2 Argyle Watershed

The Argyle River is located within the Roxborough watershed (Figure 5-18). This watershed consists of forests in the upper and middle reaches of the watershed. The lower reaches of the watershed consist of agriculture, housing and other forms of built development. The lands near the lower reaches of the Argyle river consists mainly of housing.

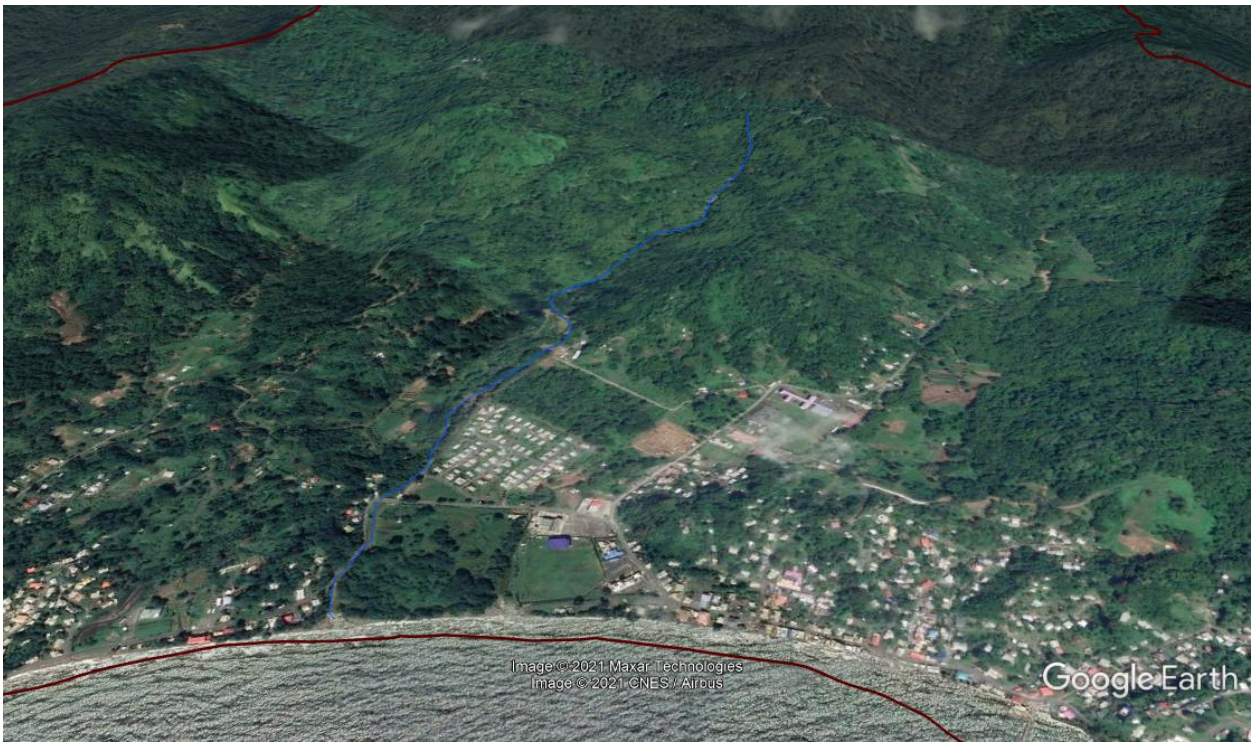


Figure 5-18: Image of Landuse close to the Argyle River(Source: Google Earth Pro). The maroon line is the outline of the watershed.

The main water uses of the Argyle River include:

- Recreation
- Ecotourism

No impacts from anthropogenic activities were detected

5.1.3.2.3 Invarine Watershed

The Invarine River is located within the Roxborough watershed (Figure 5 19 and Figure 5 20). This watershed consists of forests in the upper and middle reaches of the watershed. The lower reaches of the watershed consist of agriculture, housing and other forms of built development. The lands near the lower reaches of the Invarine River consist mainly of agriculture and built development.

Figure 5-19: Image of Landuse close to the Invarine River(Source: Google Earth Pro). The maroon line is the outline of the watershed.

The main water uses of the Invarine River include:

- Recreation
- Ecotourism

The major impact of anthropogenic activity on water resources includes runoff from agricultural plots that can negatively affect the quality of the receiving watercourse.

Figure 5-20: Roxborough watershed showing land use in the Vicinity of Invarine and Argyle River (Source: Google Earth Pro).The maroon line is the outline of the watershed.

5.1.3.2.4 Bloody Bay Watershed

The Bloody Bay River is the main watercourse in the Blood Bay Watershed (Figure 5 21). The land use within this watershed consists mainly of forests with pockets of cleared lands. The built-up areas of the watershed occur on the north eastern ridge of the watershed along the Charlotteville/ L' Anse Fourmi Road. This settlement is linear in nature.

Figure 5-20: Image of the Landuse near the Bloody Bay River(Source: Google Earth Pro).The maroon line is the outline of the watershed.

The uses of the Blood Bay River include:

- Recreation
- Ecotourism

No impacts from anthropogenic activities were detected

5.1.3.2.5 Little Englishman Watershed (Tobago North)

Little Englishman River is in the Tobago North Watershed (Figure 5-22). This Watershed is mainly forested with pockets of agriculture and clusters of built-up areas close to the coastline.

Figure 5-22: Image of the Landuse near the Little Englishman River (Source: Google Earth Pro).The maroon line is the outline of the watershed.

The uses of the Englishman River include

- Recreation
- Ecotourism

No impacts of anthropogenic activities were detected.

5.1.3.2.6 Parlatuvier East Watershed

The Parlatuvier East River is in the Tobago North Watershed (Figure 5 23 and Figure 5 24). This Watershed is mainly forested with pockets of agriculture and clusters of built-up areas close to the coastline. The land near the Parlatuvier East River is mainly forested.

The uses of the Parlatuvier East River include:

- Recreation
- Ecotourism

No impacts of anthropogenic activities were detected.

Figure 5-21: Landuse in the vicinity of the Parlatuvier River (Source: Google Earth Pro). The maroon line is the outline of the watershed.

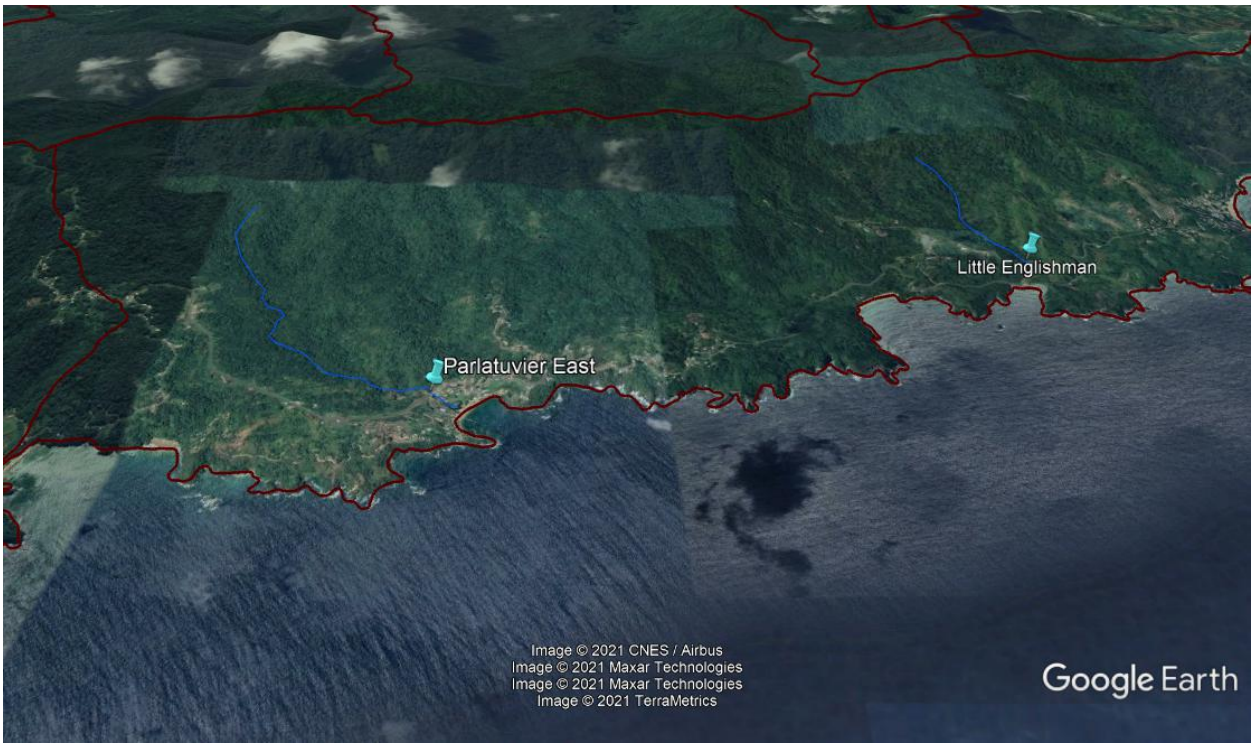


Figure 5-22: Tobago North Watershed showing land use in the Vicinity of Little Englishman and Parlatuvier East (Source: Google Earth Pro).The maroon line is the outline of the watershed.

5.1.3.2.7 Hermitage Watershed

The Hermitage River is located in the Tobago East Watershed (Figure 5-25). The Watershed consists mainly of forest and pockets of built-up areas near the coast. The lands in the vicinity of the Hermitage River are mainly forested with a very minor clearing observed (marker on map).

Uses of the Hermitage River include:

- Recreation
- Ecotourism

No impacts of anthropogenic activities were detected.

Figure 5-25: Image of the land use in the vicinity of the Hermitage River (Source: Google Earth Pro) The maroon line is the outline of the watershed.

5.1.4 Hydrology

Projects to be implemented to improve the water supply in Trinidad and Tobago span throughout the country and include the following:

Trinidad

- Drilling new wells in North West, North East, Central, South East and South West namely in the areas of Tucker Valley, Aripo, Arima, Arouca, Cumuto, Las Lomas, Freeport, Talparo, Ravine Sable, Guaracara, Guayaguayare, Granville, Chatham, Palo Seco, Cap de Ville, Coora, Barrackpore, Penal and Palo Seco
- Constructing or upgrading intakes in North West, North East and South East namely on the rivers of Santa Cruz, Naranjo- St. Joseph, Caura WTP, Guanapo, North Oropouche and Pilote.

Tobago

- Drilling a new well in Louis D'Or
- Rehabilitating a well in Roxborough and
- Constructing new intakes on rivers of the Goldsborough, Argyle, Invarine, Bloody Bay, Little Englishman, Parlatuvier east, Hermitage and Top river in Charlotteville.

5.1.4.1.1 Hydrology Overview

The surface water availability of Trinidad is estimated at 3,600 MCM/year while for Tobago it is 136 MCM/year. Expressed per capita the water availability in Trinidad and Tobago is more than 2,000 cubic metres per year. According to the World Bank's criterion (i.e. 1000 cubic metres/year), Trinidad and Tobago is not a water-scarce country. However, the surface availability is strongly influenced by seasonal and regional variation (DHV Consultants, 1999).

The island of Trinidad is the most southerly of the Caribbean islands and forms the north-eastern extension of the South-American continent. West of the island is the Gulf of Paria, north is the Caribbean Sea, east is the Atlantic Ocean and south is the Columbus Channel. The island is subdivided by three mountain ranges which are separated by undulating land, plains and swamps and has five physiographic regions namely the Northern Range, the Northern Basin, the Central Range, the Southern basin and the Southern Range.

The Northern Range with a maximum elevation is 940 metres above mean sea level consists of low-grade, metamorphosed sedimentary rocks and limestone lenses with igneous rocks present as volcanics in a small area on the north eastern coast around Sans Souci. The northern slope of the Range is steeper than the southern slope. The Caroni River drains the western part of the southern slope of the Northern Range and the Oropuche river drains the eastern part of the southern slope. Many of the larger rivers in Trinidad have their sources on the southern slopes of the Northern Range, for example, San Juan River, St. Joseph river, Tacarigua river, Arouca river, Oropuna river, Guanapo river, El Mamo river and Aripo river. The rivers on the western part of the Northern Range have U-shaped valleys and drain directly into the Gulf of Paria.

The Northern Basin extends from the foothills of the Northern range to those of the Caroni and North Oropuche River Systems, northern terraces and the Las Lomas peneplain. There are also two swamp areas in the Northern Basin: the Caroni-Laventille and the North-Oropuche Swamps.

The Central Range extends across the island and consists of hill ridges that are separated by ravines with streams fed by springs. During the dry season, these streams dry up. The northern slope of the Central Range is steeper than the southern slope. The Caroni river drains the Central Range to the west and the Oropuche river to the east. The Guaracara and Navet rivers drain the Central Range to the southwest whereas the Poole river drains it to the southeast. The Nariva Swamp, a shallow inland fresh water lagoon, is located east of the Central Range.

The Southern Basin and the Naparima Peneplain, foothills of the Central Range, form a gently rolling area consisting mainly of sands, silts, clays and gravels. The peneplain is dissected by numerous small streams with high runoff rates. In the southwestern part of Trinidad, lignite and bituminous oil residues are present

in some shales. The Erin Formation and the Pitch Lake in La Brea are also located in the southwestern part. Swamps in the Southern Basin are the South Oropuche Swamp, the Los Blanquizales Swamp and the Rousillac Swamp.

The Southern Range is a row of hills, aligned in a southwest to northeast direction. West of Moruga, the Range splits into two sections. The highest elevation is found at the Trinity Hills, 303 metres above mean sea level. The Southern range consists largely of sands, silts, clays and gravels. The South Oropuche River drains the Southern Range and Naparima area to the west whereas the Ortoire River drains these areas to the east. The Moruga River drains the Southern Range to the south.

The major aquifers of Trinidad are the Northwest Peninsula Gravels, the Northern gravels, the Central Sands and the Southern Sands with the first three aquifers being the major producing aquifers of Trinidad. There are some minor aquifers like the Mayaro Sandstone and the Guayaguayare in the east of Trinidad.

The main aquifers in the Northwest Peninsula Gravels and Limestones are the Tucker Valley gravels, Diego Martin Valley gravels, the Maraval-Port of Spain Gravels which include the Cascade, St. Anns and Savannah. There are also some water-bearing limestone areas such as St. Anns, Dorrington Gardens and Paramin.

The Northwest Peninsula Gravels are unconfined and recharged through direct infiltration by rainfall into the pervious valley soils and streambed infiltration. The aquifers consist of interbedded sands, gravels, boulders and clay, derived from erosion of the Northern Range rocks. The upper section of the Northwest Peninsula Gravels and Northern Gravel aquifers, within the valleys, are likely to be perennially recharged by surface flows.

The Northern Gravels derived from erosion of the Northern Range rocks extend from Port of Spain to approximately 3 km east of Arima. It is unconfined gravel and consist of stratified beds of sand, gravel, silt and clay. The major source of recharge is through direct infiltration of rainfall into the soils overlying the gravel fans, streambed infiltration from the rivers crossing the gravel fans, and subsurface flow from the Northern Range.

In the area of focus, the river which emerges from the south of the Northern Range is the San Juan River and its related aquifer is the El Soccoro Gravels. The rivers recharge the gravel fan aquifer as they flow over them into the Caroni River.

For the coastal aquifers between Chaguaramas and El Soccoro, the abstraction rates must not exceed the balanced yields, to keep a hydrodynamic balance and prevent seawater intrusion.

The aquifers of the Central Sands consist of blanket sands and are divided into the Sum Sum Sand (unseparated, Upper and Lower), the Mahaica Sand and the Durham Sand. They are located on the southern limb of the Caroni syncline. The aquifers are confined and consist of fine to very fine marine sands. The major source of recharge is direct infiltration of rainfall into the pervious valley soils and streambed infiltration. Water from the Sum Sum, Mahaica and Durham wellfields have high iron content. The Las Lomas wells usually exhibit this high iron content.

The Southern Sands are multiple-sand aquifers, which can be divided into the Erin Formation, which are sands of the Pleistocene Age and the Morne L'Enfer Formation which are sandstones of the Pliocene-Pleistocene Age. The area is heavily faulted dividing the Formations into discontinuous basins.

Both aquifers of the Erin Formation and the Morne L'Enfer Formation are confined aquifers. The Erin Sand aquifer consists of fine and very fine sands whereas the Morne L'Enfer aquifer consists of sands with thin layers of silt and silty clay with lignite and is divided by the Lot Seven Silts into an upper and a lower part.

The water quality from the Southern aquifers generally is of good quality but may have high iron content. Hydrogen Sulphide has been found in the water from deep wells in the Cap-de-Ville well field.

Other aquifers in Trinidad with limited groundwater potential are the Mayaro Sandstone in the Mayaro Formation in south-east Trinidad that dips in the south-eastern direction under the sea. It is susceptible to salt water intrusion. Also, the Guayaguayare Sandstone of the Mayaro Formation is in the east of Trinidad.

The island of Tobago is located 32 km to the northeast of Trinidad, has an oval shape and is 300 km^2 in area. The climate is comparable to that of Trinidad. The average rainfall for Tobago varies from 1,400 to 2,800 mm per year (mean annual rainfall over 30 years) and there are five main catchment/hydrometric areas in Tobago.

Tobago is largely composed of igneous and metamorphic rocks and could be subdivided into two physiographic regions, the Main Ridge and the Coastal Plain. The Main Ridge is an upland composed of metamorphic and volcanic rocks that occupies a third of the island in the north. It is approximately 18 km long and 5 km wide with a peak elevation of about 550 m. The north-facing slopes are generally steeper than the southern slopes.

Some aquifers in Tobago are the Government Farm, Richmond, Bloody Bay and the Coral Limestone. The Richmond aquifer consists of alluvial deposits and is unconfined. The Government Farm aquifer consists of clastics, (volcanic and sedimentary material) and is unconfined. The Coral Limestone aquifer consists of limestone/clay and marl and is unconfined. The Bloody Bay aquifer consists of alluvial deposits and is unconfined. Generally, yields from wells in Tobago are much less than those in Trinidad.

5.1.5 Water Demand and Deficit

The water demand for Trinidad and Tobago is estimated at 135 IMG/day or 83 gals/capita/day (gpcd) while the production is 232 IMGD. Despite production being 72% greater than demand only 53% of the population receives a 24/7 water supply in the wet season and 42% in the dry season. Water scheduling is 'normal' for the country.

The requisite information to produce the projected water demand and deficit for the additional areas studied was not readily available for all the watersheds across Trinidad and Tobago. There are no flow meters to monitor the additional watershed in the same manner as those in the north western sections. As such the calculation which follows is only for the north western section as detailed information on the watersheds were available.

In the north western area, the population is estimated as three hundred and two thousand and ninety persons (302,090) based on projected statistics from the Central Statistical Office (CSO).

According to the Water and Sewerage Authority the following are the estimates on potable Water Demand and Supply. Based on a per capita consumption of 373 l/c/d in the wet season and 428.95 l/c/d in the dry season, the Domestic Demand is estimated as 112.90 MLD and 117.36 MLD respectively.

The Commercial and Industrial Demands are estimated as the same in both the wet and dry seasons and are 25.47 MLD and 10.10 MLD respectively. Non-Revenue Water is estimated at 50% in both the wet and dry seasons. This equates to 140.15 MLD and 144.61 MLD in the wet and dry seasons respectively.

As a result of the estimated Demands and Non-Revenue Water, the estimated Total Demand for the wet and dry seasons in the north west of Trinidad are 288.63 MLD and 297.54 MLD respectively. The Potable Water Supply for the wet and dry seasons are 284 MLD and 256 MLD respectively resulting in the deficit between water supply and demand to be 4.61 MLD and 41.92 MLD respectively.

5.1.6 Climate

The climate of Trinidad and Tobago is tropical, warm and humid with two major seasons: a dry season from January to May and a wet season from June to December. A short dry spell, 'Petite Careme,' typically occurs in the middle of the wet season in September or October. The average annual temperature is approximately 26° C with minor diurnal variations. The average annual rainfall is approximately 2,200 mm with over 78% of the mean annual rainfall occurring during the wet season (DHV Consultants, 1999).

In general, the eastern half of the island receives more rainfall than the western half. Maximum amounts of precipitation occur in the northeast of Trinidad where orographic effects dominate. The mean annual rainfall for Trinidad varies with maximum values as high as 3,800 mm on the eastern peaks of the Northern Range, slightly north-east of the Caroni basin, in response to the orographic effects of the North-East Trade winds; and minimum values of 1,200 mm in the north-western Peninsula and southwest of the island.

Evapotranspiration is significant and averages over the island from 34% of the total precipitation in the wet season to 70% in the dry season (DHV Consultants, 1999). Evapotranspiration also varies considerably with physiography and with rainfall event quantities.

Relative humidity ranges from 65-70% at the end of the dry season to 80- 85% in the wet season. In coastal areas, the range is less with relative humidity between 70% and 80% (DHV Consultants, 1999).

5.1.7 Natural Hazards

The project area is typically affected by natural hazards such as floods, drought, landslides, earthquakes, hurricanes and climate change. Each of these are further elaborated below.

5.1.7.1 Hydrometeorological Hazards

5.1.7.1.1 Dry Spells/Drought

Trinidad and Tobago's climate is divided into two yearly seasons, the dry and wet seasons. The dry season typically occurs between the months of January and May, and the wet season from June to December. During the dry season it is common to have 14 to 20 consecutive days with below average rainfall and this is considered a feature of the local dry season (TTWC, 2020). These are considered dry spells or short-period droughts. During the dry season, the average temperature ranges from 20°C to 33°C with monthly precipitation ranging between 30 mm to 110 mm.

Impacts during the dry season include: -

- High temperatures with frequent hot days (temperature >34°C) occurring in Trinidad. These can sometimes persist for several consecutive days. This raises the risk of heat-stress on persons and livestock.

- Increased number of bush fires due to the lack of moisture and the drying of weeds, grass, bushes and plants.
- Reduce air quality due to dry periods causing increased dust and fumes from bush fires.
- Increased water scarcity due to the lack of rainfall and high rates of evapotranspiration.
- Increase losses or agriculture and livestock due to dry conditions and heat stress.

WASA prepares a Water Supply Management Plan for the Dry Season. This plan presents a schedule with shorter durations of piped water and truck borne water. The Operational Implementation Plan tends to focus on the critical areas for water supply in the dry season (called Hot Spots). Crichlow, M. (2007) elaborates on actions such as:

- Water scheduling and water trucking
- Redistribution of water
- Provision of additional storage
- Diversification of water supply
- Purchase of additional water from Desalcott
- Minimization of Plant Disruption
- Optimization of production levels from Caroni Arena Treatment Plant
- Enhance ground water production to safe yield and possibly more, and
- Aggressive pipeline repair or replacement
- Implementation of a Water Conservation Public Education Programme
- Promotion of the installation of water efficient fixtures and repair of internal leaks by customers
- Promotion of water use efficiency for industries and agriculture

5.1.7.1.2 Heavy Rains, Tropical Storms and Hurricanes

The hurricane season in the Caribbean occurs between the months of June through November. Trinidad and Tobago is situated in the southern Caribbean and therefore has a lower risk of being exposed to tropical storms and hurricanes compared to the rest of the Caribbean (Figure 5-23) (RMS, 2020). However, in the past the country has been impacted by several hurricanes and tropical storms which have deviated from the normal route or have passed close to the islands (Table 5-8).

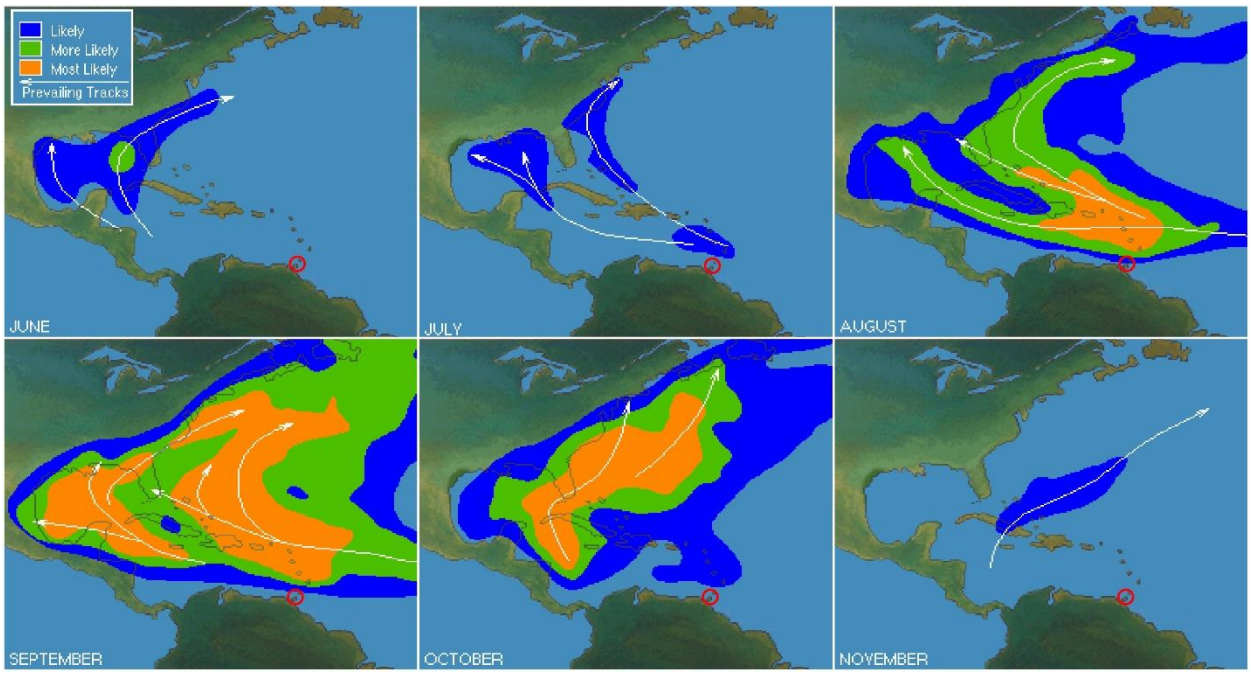


Figure 5-23: Location of Trinidad and Tobago (red circle) and the typical hurricane tracks and likely hood of experiencing a hurricane by month (NOAA, n.d.).

The country, however, is largely impacted by rains associated with the Inter-tropical Convergence Zone (ITCZ) and tropical waves moving across the Atlantic Ocean into the Caribbean Sea. These lead to periods of heavy rainfall, particularly during the wet season (June to December). These systems impact the island frequently and have caused increased risk of flooding, heavy winds and increased lightening.

Table 5-1: Tropical Storms and Hurricanes which have impacts Trinidad and Tobago (ODPM, n.d.)

Hurricanes and Tropical Storms that have made landfall in Trinidad and Tobago		
Hurricane Flora	30 September 1963	Category 3 Hurricane making landfall causing the deaths of 20 persons across the two islands, destroying 50% of cash crops. Overall estimated damage was TT$30 million.
Tropical Storm Alma	14 August 1974	Made landfall causing the deaths of two persons.
Tropical Storm Arthur	25 July 1990	Made landfall over Tobago.
Tropical Storm Fran	14 August 1990	Made landfall over south Trinidad.
Tropical Storm Bret	7 September 1993	Made landfall causing severe flooding and high winds causing trees to fall.
Tropical Storm Joyce	1 October 2000	Made landfall and caused significant wind damage in Tobago.
Hurricanes and Tropical Storms that have not made landfall in Trinidad and Tobago but has affected the islands.		
Hurricane Felix	31 August 2007	Caused flooding in Central and South Trinidad
Hurricane Emily	13 July 2005	Induced landslides in the Northern Range of Trinidad and widespread flooding across the island with 1 home being washed away.
Hurrican**e Ivan**	6 September 2004	Category 4 Hurricane not making landfall but causing severe flooding in Tobago and high winds caused over 45 houses to lose roofs. Over 305 of the island was left without electricity and the estimated damage was US$4.9 million.

5.1.7.1.3 Flooding

Floods are caused by nature or by man-made (anthropogenic) actions and can cause huge losses to life and property. Climatological factors when combined with global warming can result in flooding being more severe. Two of the main man-made causes of floods that result in disastrous effects are deforestation and global warming.

The main types of floods are:

- River (or fluvial) Floods which are overbank flooding that occur when water rises and overflows the edges of a river or stream. They are usually caused by excessive precipitation and are climatologically driven.
- Flash Floods which are intense, high velocity torrents of water that occur in a river channel. In addition to excessive rainfall and/or intense rainfall over a short duration, they are usually caused by Urbanization and poor land use practices in the watershed. These issues create more impervious surface areas resulting in reduced infiltration and more runoff.
- Coastal Floods which occur in areas on the coast and are typically the result of extreme tidal conditions caused by severe weather.

Overall floods are caused by prolonged rainfall, Intense/heavy rainfall, urbanization, deforestation, poor land use practices, topography, improper waste disposal and quarrying.

In addition, development in the flood plain or cutting off of the river from the flood plain, which is a natural area for retaining flood water, results in a loss of natural storage for the flood waters and flooding.

Flood management is undertaken by the Water Resources Agency (WRA), the following are key measures currently being employed:

- WRA has installed a number of crest gauges placed in specific locations in the flood-prone basins throughout Trinidad. These gauges are flood level monitoring stations.
- WRA is in the process of upgrading its hydrological network including the flood monitoring network. At present, the WRA has partnered with the Ministry of Local Government and Rural Development, and the Trinidad and Tobago Red Cross to undertake a Community Flood Early Warning System. This system includes the installation/modernization of real-time gauges (streamflow) in every Regional Corporation and a mechanism to allow for monitoring of flood levels, notification of flood risk to specific affected communities, flood response and collection of flood data.
- The system also includes flood mapping and preparation of flood inundation maps using updated Digital Elevation Models by organized teams.

The Drainage Division of the Ministry of Works has responsibility for rivers, maintenance of the channels and providing approvals for the use of rivers (this is not allocation of water). However, some attention must be paid to the paving of river channels which is currently being done. These areas serve as points for recharge to the aquifers and this practice can eventually have a serious negative impact on the recharge to aquifers.

5.1.7.2 Climate Change

With respect to climate change, predicted impacts and the effects include:

- reduced rainfall in the dry season and increased rainfall which has the effect of reduced available water, a decline in surface runoff, reduced groundwater and increased risk of droughts.
- increased rainfall intensity which has the effect of increased surface water runoff and increased risk of flooding and flash floods. Flooding could contribute to higher turbidity and sediment load in rivers.
- increased temperature would have the effect on the availability of water resources as evaporation rates would increase and water consumption per capita would increase. Warmer temperatures would also cause sea level rise and increased salinity in coastal aquifers and streams which will reduce fresh water supplies.
- sea level rise and more frequent storms which will have the effect of increased risk on coastal areas. Sea level rise will also decelerate wetland renewal and change the salinity distribution and productivity of mangroves.

(Crichlow, 2008 and Asian Development Bank, 2016)

5.1.7.3 Geological Hazards

5.1.7.3.1 Earthquakes

Trinidad and Tobago is located along the south-eastern margin of the Caribbean Plate along the southern strike-slip boundary with the South American Plate (Figure 5-2) and several major faults through the islands (Figure 5-3). The region is therefore tectonically active with both shallow and deep earthquakes (Figure 5-24). Locally in Trinidad, earthquakes mainly occur in five main zones with the North Paria Peninsular being the most significant source of earthquakes and several significant earthquakes with magnitudes greater than 5 on the Richter Scale have been recording around Trinidad between 1955 and 2008 (Figure 5-25). While, in Tobago the south western section of the island mostly shallow earthquakes. Trinidad and Tobago has also experienced local earthquake swarms with magnitudes up to 5.8and depths ranging from 0-70 km.

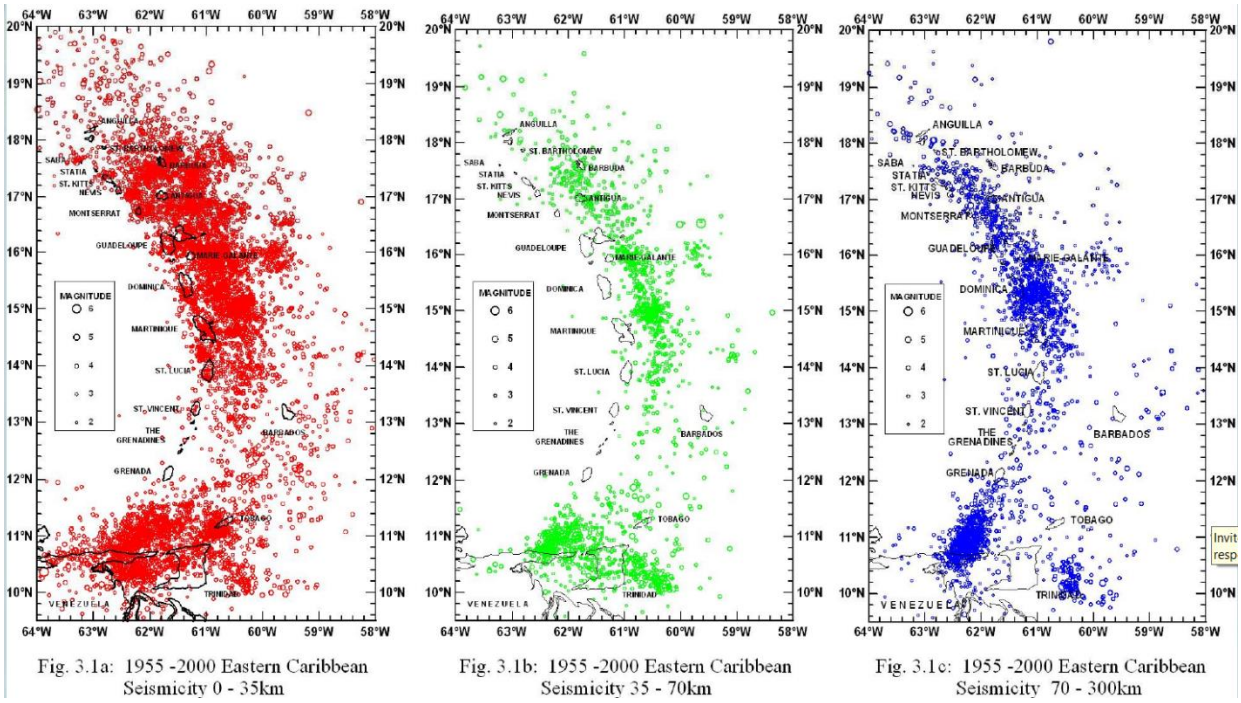


Fig. 3.1a: 1955 -2000 Eastern Caribbean Seismicity 0 - 35km

Fig. 3.1b: 1955 -2000 Eastern Caribbean Seismicity 35 - 70km

Fig. 3.1c: 1955 -2000 Eastern Caribbean Seismicity 70 - 300km

Figure 5-24: Earthquake Caribbean Seismicity showing Trinidad and Tobago at the bottom of the map (UWI SRC, 2010)

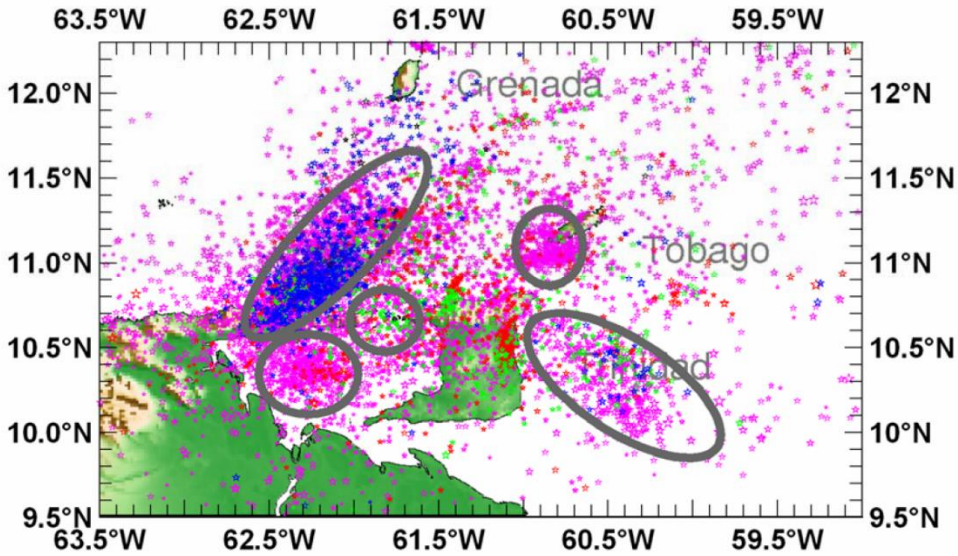


Figure 5-25: Earthquake zones around Trinidad and Tobago (UWI SRC, 2010)

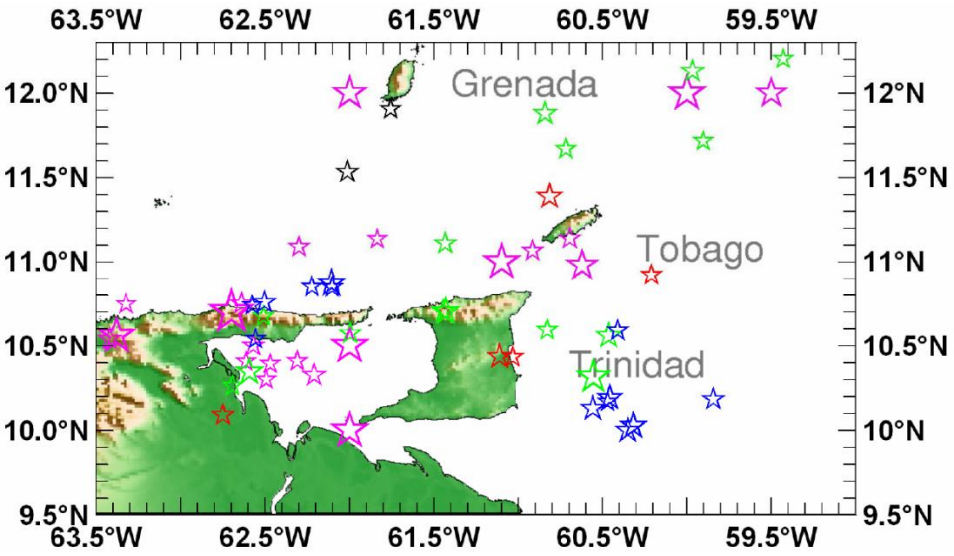


Figure 5-26: Earthquakes with magnitude greater than 5 occurring around Trinidad and Tobago between 1955 – 2008 (UWI SRC, 2010)

5.1.7.3.2 Landslides

Landslides in Trinidad and Tobago are largely controlled by the islands topography and geology and have been categorized within two distinct groups (Kanithi & Kanhai, 2006):

1. Landslides associated with metamorphic rocks within the Northern Range (Figure 5-27)and
2. Landslides associated with unconsolidated sedimentary rocks which occur mostly within the Central and Southern Ranges.
3. Landslides associated with metamorphic and igneous rocks within the Mian Ridge Area

Within the Northern Range, most of the landslides occur where there are layers of weathered debris on steep slopes, usually after rainfall events. The occasional translational or rotational landslide may occur in areas where the rocks dip towards the roads. These have a high potential to damage or block access roads to communities, affect utilities and water supply and distribution infrastructure.

In the Central and Southern Ranges, landslides occur in unconsolidated sands, soils, and muds/clays. These slides occur when clays become over saturated, swell, and begin to slip on gentle slopes (sometimes with gradients less than 5 degrees). Slips have been known to occur from over saturation or have been triggered by heavy vehicular traffic and earthquakes.

Figure 5-27: Landslide occurred on September 13, 2017 along the North Coast Road in the Northern Range, Trinidad (Photo From: Trinidad and Tobago Weather Center) (TTWC, 2020).

5.2 ECOLOGICAL ENVIRONMENT

Trinidad and Tobago has a rich biodiversity which plays important role in many of the ecosystem services that support human well-being. However, many flora and fauna species have been under threat due to human development. The terrestrial ecosystems provide habitats for over 420 species of birds, 600 species of butterflies, 95 different mammals, 85 reptiles, 30 amphibians and 54 species of freshwater fishes (GoTT, 2021). The marine system of the country is similarly diverse with fringing coral reef, sea-grass beds, oceanic islands and pelagic (or open sea) ecosystems, supporting over 354 species of marine fish. However, human activities have negatively impacted the country's biodiversity creating areas that are strongly influenced by residential settlement, commercial and industrial activities, characterised as disturbed to highly disturbed.

Within Trinidad and Tobago there are several areas considered sensitive ecosystems (Environmentally Sensitive Areas (ESA)) based on the Environmentally Sensitive Areas Rules, 2001 and there are several policies and regulations that govern their use which have already been elaborated in Section 2.1 above. These areas include:

1. The Northern Range
2. Matura National Park
3. Aripo Savannas
4. The Caroni Swamp
5. Nariva Swamp
6. Main Ridge Forest Reserve

The operational zones identified for Component 1 and 3 does not infringe on the boundaries of the ESAs. Therefore, no major ecological impacts are expected in these sensitive areas based on the proposed construction or maintenance works that may take place during this project.

5.2.1 The Northern Range

The Northern Range Protected Area is 36,570 ha in size and runs along the northern edge of Trinidad (Figure 5-28) (BirdLife International, 2020). The Northern Range is dissected by thirteen major valleys to the south, each with access roads and settlements, with the valley and foothills to the west in the project area being mainly residential. The rivers are regularly used for recreation and a network of foot paths cross the forested areas which provide access to hunters. Due to the topography, the eastern end of the northern range experiences the highest rainfall in Trinidad, in excess of 3800mm per annum, and has some of the least disturbed and most luxuriant forest (BirdLife International, 2020).

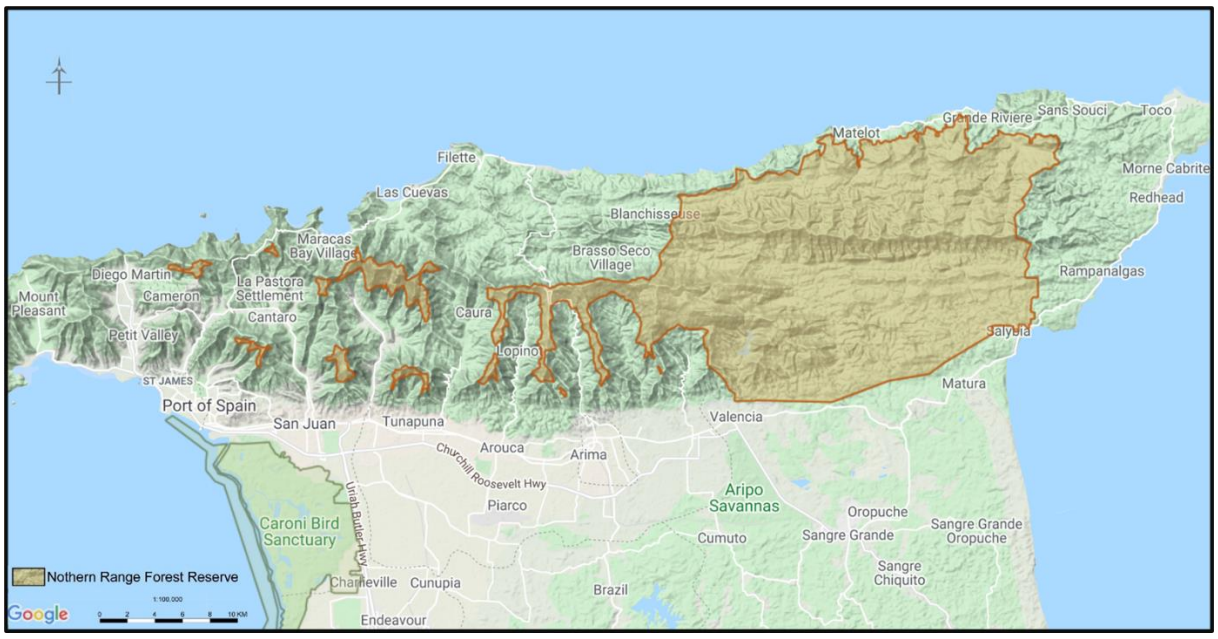


Figure 5-28: Map Showing the Protected Areas in Northern Region of Trinidad (Source: BirdLife International, 2020 http://datazone.birdlife.org/site/factsheet/northern-range-iba-trinidad-and-tobago).

The western section of the Northern Range (with the exception of the Chaguaramas peninsula) is less forested than the eastern section. There are patches of deciduous seasonal forest, dry evergreen forest, agricultural land, burnt sites, and non-forested areas (most probably built-up areas). There is more degradation in the western reaches of the Range and more disturbance around the edges than in the centre of the range. Socio economic pressures as resulted in more hillside developments in a number of the valleys (Northern Range Assessment, 2005). Key flora and faunal species associated with the Northern Range are presented below.

5.2.1.1 Flora

The flora of the Northern Range can be considered important in three ways-as a habitat and food source for wildlife, for the soil-binding capacity of plants, and as heavy contributors to the humic content of soil which relates to soil fertility and structure. The Northern Range is an extension of the Coastal Cordillera of Venezuela which has been declared to be of great plant conservation importance by the World Wildlife Fund (Huber 1997 in Northern Range Assessment, 2005). Some of these floral species important to wildlife are as follows:

- *Miconia sp*. of the family Melastomaceae- a floral species that birds rely on for food;
- The Pawi (*Pipile pipile*) found in the Northern Range which feeds on fruits and berries of a variety of forest trees, including *Ocotea sp*., *Ponteria sp., Bursera sp., Didymopanax sp.,* and *Erythroxylum sp*.

It is anticipated that based on the proposed project activities for the north west zone, clearing of vegetation is unlikely and as such works will not impact floral species in the northern range.

5.2.1.2 Fauna

Figure 5-29: Northern Range, Trinidad and Tobago

The northern range hosts the only known population of the Trinidad Piping Guan, which is widespread throughout the eastern part of the range but with a population limited to an estimated 70-200 birds. A number of species, which represent the Andean component of Trinidad's avifauna are largely restricted to the Northern Range and are likely to occur at each of the Important Bird Areas (IBAs) identified, especially those with higher altitudes. These include Band-tailed Pigeon, Lined Quail-dove, Oilbird, Chestnut-collared Swift, Brown Violetear, Collared Trogon, Scaled Antpitta, Slaty-capped flycatcher, Olive-striped Flycatcher, Orange-billed Nightingale-thrush, Yellow-legged Thrush, Speckled Tanager, Blue-capped Tanager and Hepatic Tanager. The near- threatened Olive-sided Flycatcher also prefers the higher altitudes of the Northern Range (Assessment of Northern Range, 2005).

The Golden Tree frog, *Phylodytes auratus,* is critically endangered and endemic to the highest peaks of Trinidad's Northern Range where it lives in close association with the *Tank Bromilliad Glomerulopitcairnia erectifolia*. Also thought to be endemic to the Northern Range is the Luminous lizard *Proctoporus schrevi*, the snake *Leptophis stimsoni* and an un-described snake *Helminthophis sp*. known only from a single specimen. The frogs *Eleutherodactylus urichi* and *Mannophryne trinitatis*, which are endemic to Trinidad and Tobago are particularly abundant in the Northern Range. Of the 59 endemic plants recorded for Trinidad, 32 species have been collected within the Northern Range and many restricted to the highest altitudes (Assessment of Northern Range, 2005).

Table 5-2 below shows estimated figures for national biodiversity, along with some estimates for species diversity in the Northern Range, and on the islands off the north-west coast of Trinidad. The eastern section of the Northern Range is the largest block of undisturbed forest remaining, and it can be expected to contain a high level of biodiversity. It is expected that many of the faunal species discussed, in the project area, exist mostly in the highest sections of the Northern Ranges, in the north west section which is part of the study area and in the Eastern sections of the Northern Range, which is outside of the study area.

Table 5-2: Species Diversity in Trinidad and Tobago (Source: Assessment of the Northern Range, 2005)

Major groups	Number of recorded species in Trinidad and Tobago	Northern Range No. of species recorded	Data source(s)	North -west Islands No. of species recorded	Data source(s)
Mammals	95	29 bats	AWNC 1999	4	Lall and Hayes 2000
Reptiles **Snakes**	140 55	57 35	Murphy 1997 Murphy 1997	14 3	Lall and Hayes 2000; Boos 1983; Boos Quesne 1993; Lall and Hayes 2000
Amphibians	30	18	Murphy 1997	—	—
Birds	450	159 99	AWNC 1999; ffrench and ffrench 2000	135 14	Hayes and Samad 1998, 2002; ffrench 1967, 1969
Freshwater fishes	45	23	Kenny 1995; Phillip 1999	—	—
Marine fishes	354	—	—	—	—
Butterflies	600	42 12 Families 35	AWNC 1999 Barcant 1970 Garcia 1999	—	—
Nematodes	200 – 300	—	—	—	—
Vascular plants **Ferns**	2,160 13	— 12	— Baksh - Comeau 2000	— —	— —
Marine algae	198	59	Duncan and Lee Lum 2004	5	Duncan and Lee Lum, 2004

It is anticipated that based on the proposed project activities for the north west zone, works are not likely to impact wildlife in the northern range as these faunal species tend to move away from noisy areas when there is activity. They will likely return to the area once disturbing activities have ceased.

5.2.2 Matura National Park

The Matura National Park found in the north-eastern Peninsula of Trinidad covers an estimated 9,000 ha encompassing the Matura and St. David Forest Reserve. This site contains three watershed which produces the highest water quality in the country. (EMA, 2020a). This area is also used by the 14 surrounding communities with 5, 325 people to provide livelihood from conversation, ecotourism, hunting and fishing (FAO/UN, 2019a)

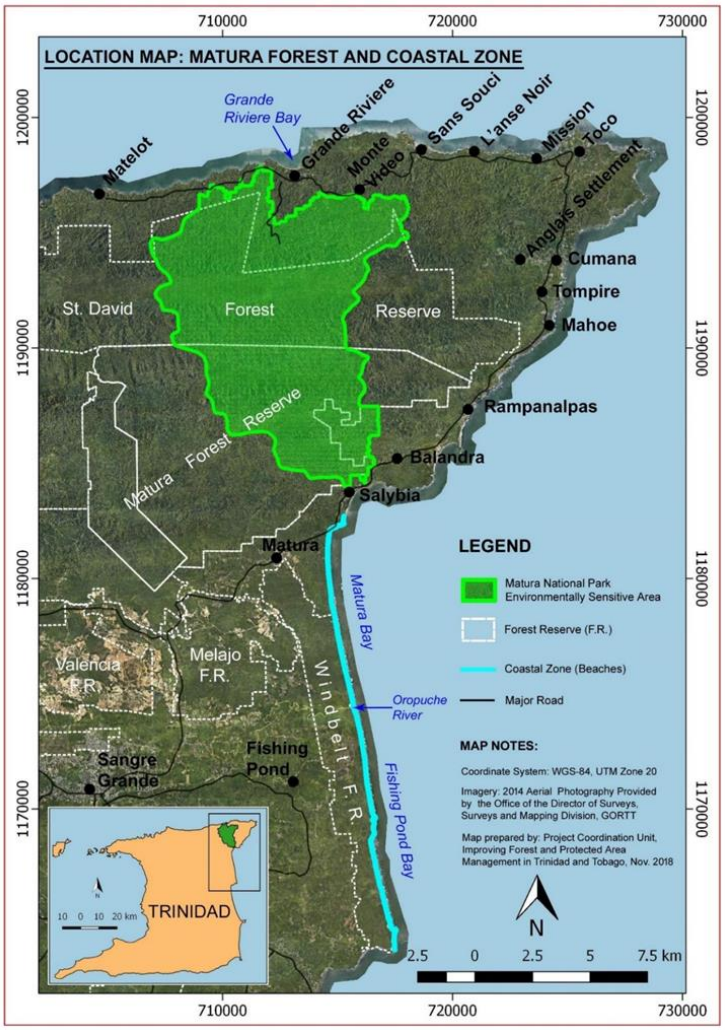


Figure 5-30: Map showing the location of Matura National Park (Source: PCU IFPAMTT,2018)

5.2.2.1 Flora

The Matura National Park consist of moist tropical forest and premontane sub-tropical forests (Nelson, 2004). The Tropical Forest primarily consists of Carapa-Mora faciation while the Premontane Sub-Tropical Forests *Brysonima-Licania* faciation (Beard, 1946). This area rises from sea level to elevations up to 575m.

The gradient of the slop results in in 5 distinct plant community clusters within the National Park (Van den Eynden et al., 2007). Within the area, there are over 200 known tree species of which the following are identified as endangered: *Clusia aripoensis, C. tocuchensis* and *Macrolobium trinitense.*

Within the National Park is the largest intact Mora Forest, dominated by the Mora (*Mora excelsa*), which can reach 40 m in height, in the Matura Forest. The Mora forests of Matura have been estimated to be over 30,000 years old (Beard, 1944) despite the low tree diversity within the Mora Forest, there is considerably plant diversity including the rare and endangered orchids like *Onicidium citrinum*.

Figure 5-31 Mora (Mora excelsa) Tree located within Mora Forest, Trinidad (Source: Tropical Plants Database 2014, 2021)

5.2.2.2 Fauna

The Matura National Park is home to the globally endangered Trinidad piping guan (*Pipile pipile*) (Hayes et al., 2009), the ocelot (*Leopardus pardalis*) (Thelen and Faizool, 1980), the anteater, the Neotropical River otter and the Red Howler Monkey (*Alouatta macconnellii*) (Figure 5-32). Many of these animals are identified as Environmental Sensitive Species (Figure 5-32). Additionally, within this ESA and National Park Blue and Yellow macaw and the West Indian Manatee have been sighted. The rivers within this area are known as habitats to relic South America fish species (EMA, 2020a). This area also has numerous other species of wildlife, including Trinidad's five terrestrial species of game animals: the agouti *Dasyprocta leporina*, the Lappe Agouti *Cuniculus paca*, the red brocket deer *Mazama americana*, the collared peccary *Peccari tajacu*, and the tattoo Dasypus novemcinctus. All of which are hunted, along with native finches (*Oryzoborus angolensis, Sporophila bouvronides and S. intermedia*) from this site (Van den Eynden et al., 2007). Along the coastal zone are 14 surrounding communities with nesting beaches for the Leatherback Turtle.

Figure 5-32 Animals found within the Matura National Park (an ESA): A) Pawi (ESS) B) Red Howler Monkey C) Ocelot (ESS)

5.2.3 The Aripo Savannas

The Aripo Savannas, located in the North Central Trinidad is the largest remaining natural savanna. This area lies between Arima and Sangre Grande extending from the southern hills of the Northern Range (Figure 5-37). This ESA expands an estimated area of 1,788 ha with a mosaic of marsh forest, palm marsh and savanna ecosystems (EMA, 2008).

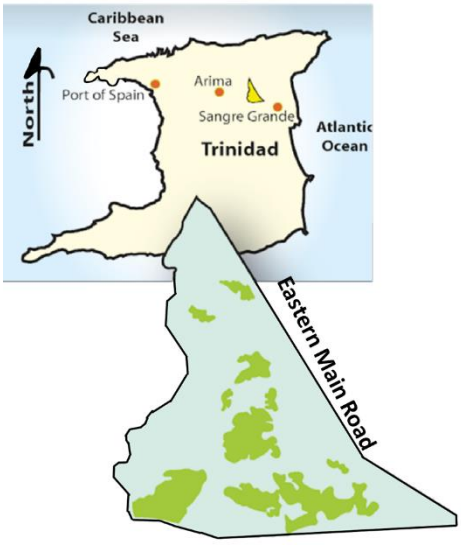


Figure 5-33: Map showing the location of the Aripo Savannas (EMA, 2020)

5.2.3.1 Flora

The Aripo Savannas has a total of 457 plant species found in the distinct vegetation communities (EMA, 2020b). Within this site are 10 open savannas (Figure 5-39) of varying site and community of plant species. In these open savannas there are over 90 species most commonly the grasses and sedges (EMA, 2020b). In the Marsh Forest plant community, approximately 118 species are found. This community covers the largest area within Aripo Savannas primarily in areas that turn marshy in the wet season (EMA, 2020b). The species found within this site can tolerate water saturated conditions up to a year. The Palm Marsh vegetation communities, dominated by the Moriche Palm (Mauritia flexuosa) are found along the fringes and isolated patches within the open savannas (EMA, 2020b).

5.2.3.2 Fauna

The Marsh Forest and Palm Marsh are habitats and source of food for five bird species within the Aripo Savannas: Rufescent Toger-heron (*Tigrisoma lineatum*), Red-bellied Macaw (*Orthopsittaca manilata*),

Epaulet (*Moriche*) Oriole (*Icterus cayanensis chrysocephalus*), Sulphury flycatcher (*Tyrannopsis sulphurea*) (EMA, 2020b). The Fork -tailed Palm-swift (*Tachornis sqamata*) is also found within this area. Additionally, previous faunal research has identified a rich fauna consisting of 78 insect species, 8 Amphibians species, 26 reptile species, 132 bird species, 25 mammal species (Schwab, 1988).

5.2.4 The Caroni Swamp

The Caroni Swamp Protected Area and Bird Sanctuary is 3,258 ha and is located along the west coast of Trinidad (Figure 5-40). This area has been designated as a Ramsar site (8,398 ha.) since 2005 (Figure 5-41)

Figure 5-35: Caroni Swamp, Trinidad

The Caroni Swamp is the largest mangrove wetland in the country accounting for 56% of this forest type (Juman and Ramsewak, 2013). The swamp hosts a diverse ecosystem consisting of mangroves, marshes, lagoons and mudflats that supports a rich diversity of flora and fauna (Figure 5-34).

The dominant mangrove species is the red mangrove *(Rhizophora mangle).* This mangrove area serves as a breeding/nursery habitat for fish (marine and freshwater species) and shrimp, which sustains fisheries in the Gulf of Paria. Additionally, it is of great hydrological value, as it provides flood water interception, sediment trapping and shoreline stability (Alleng, 1997). The system also serves as a receiving and absorbing body for land-based run-off and pollutants (Government of the Republic of Trinidad and Tobago, 2020).

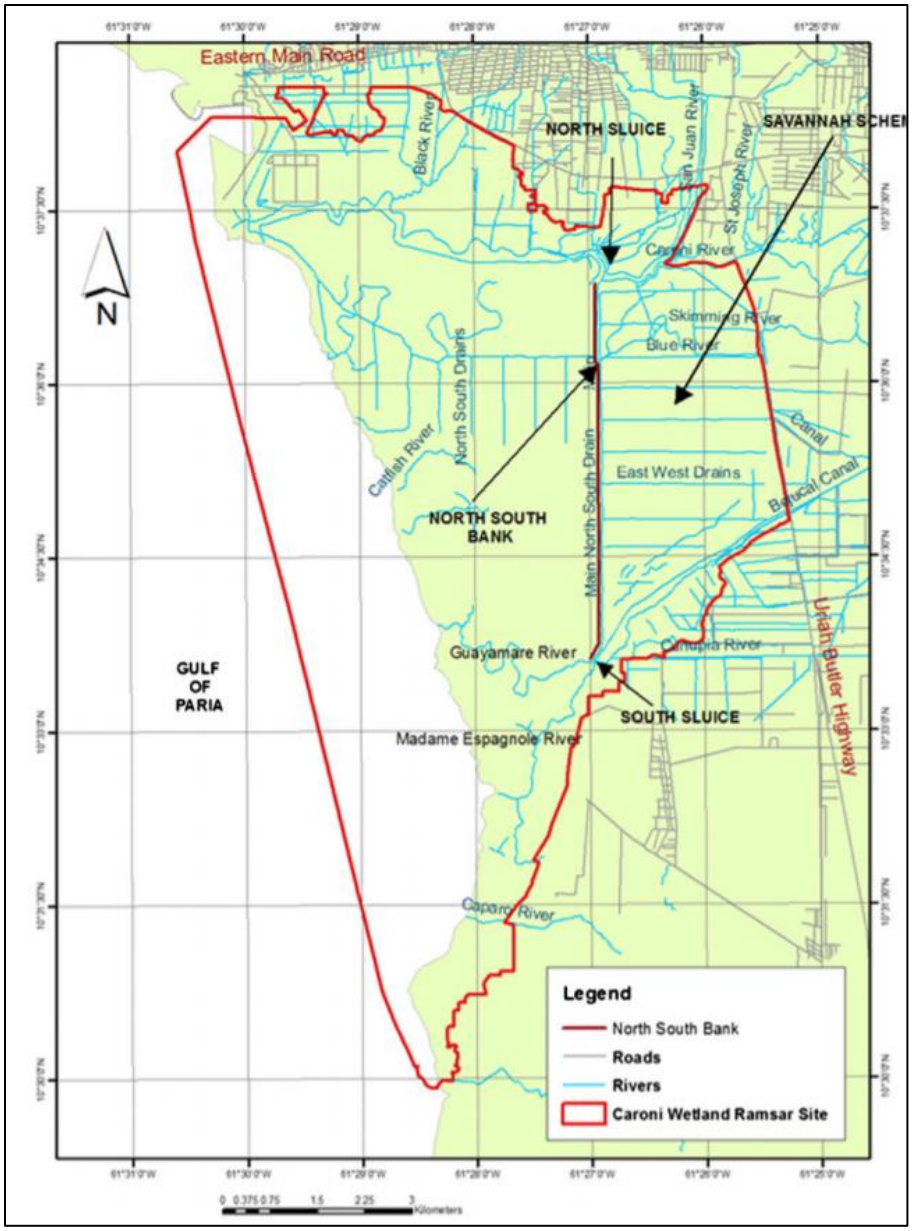


Figure 5-36: Caroni Wetland Ramsar Site, Trinidad (Source: Juman & Ramsewak, 2013)

5.2.4.1 Flora

The Caroni mangrove system is the most extensive on the island and is dominated by estuarine and basin *Rhizophora*, mainly *R. mangle (*red mangroves), but *R. harrisonii* and *R. racemosa*. There is evidence of rapid pioneering by *R. mangle* in the internal lagoons with retreat/erosion of forest on the Gulf of Paria coast. There are extensive stands of *Avicennia germinans* forming woodland and basin communities (Nathai-Gyan and Juman, 2005).

Avicennia schaueriana (black mangrove) is present but uncommon. *Laguncularia racemosa* (white mangrove) is common in mixed basin forest but do not form stands (Bacon, 1970 in Nathai-Gyan and Juman, 2005). To the west of the swamp (Gulf coast), there are extensive mudflats. Brackish marsh with *Eleocharis, Fimbristylis* and other cyperaceae are found on the east and south sides grading into freshwater marsh and cultivation (Nathai-Gyan and Juman, 2005).

Although the project activities will not require the removal of any part of this environmentally sensitive ecosystem, improper management of solid waste, soil loss and improper storage of construction material or excavated material can result in sedimentation washing into the St. Annes and Caroni Rivers and eventually settling in the Caroni Swamp which will negatively impact wetland vegetation. This may result in the drying of the wetland overtime which may cause the death of floral species such as red mangroves (*Rhizophora mangle)* that are most sensitive to drying.

5.2.4.2 Fauna

A wide variety of aquatic, estuarine invertebrates are present, including commercially important resource organisms such as the mangrove oyster (*Crassostrea rhizophorae*), mussels (*Mytella guyanensis* & *M. falcata*), clams (*Phacoides pectinatus*), conch (*Melongena melongena*), and shrimp (*Penaeus spp*.). The Caroni Swamp is habitat to 24 species of fin fish, including several commercially important species such as tarpon (Megalops atlanticus), grey snapper (*Lutjanus griseus*). Other important fauna includes, the silky anteater (*Cyclopes didactylus*), the crab eating racoon (*Procyon cancrivorous*), mangrove crab (*Aratus pisonii*), hairy crab (*Ucides cordatus*), the caiman (*Caiman crocodylus*) and the tree boa (*Corallus ruschenbergerii*).

Some 190 species of birds have been reported in Caroni Swamp; which include resident and nesting water birds, plus migratory species, and a number of forest and pasture birds that roost in the mangroves (Bacon, 1970 in Trinidad Biodiversity, 2012). The site is also an important habitat for the scarlet ibis (*Eudocimus ruber*), which is the national bird (Bildstein, 1990 in Trinidad Biodiversity, 2012). The Swamp is a breeding passage for several waterfowl species (Figure 5-37). A species list of fauna observed in the Caroni Swamp in 2018 is presented in Appendix 2.

Figure 5-37: Birds in Caroni Swamp (Scarlet Ibis, Flamingoes, Egrets) (Source: Destination Trinidad and Tobago Ltd, 2020)

Improper management of solid waste, soil loss and improper storage of construction material or excavated material can result in sedimentation in the St Annes and Caroni Rivers thus negatively impacting aquatic life in these river systems. Additionally, this may likely also result in increased sediments being emptied into the Caroni swamp which can result in the reduction in numbers of important commercially viable aquatic species as well as important habitats for wildlife as a result of vegetation lost due to the drying out of the wetlands.

The Caroni swamp is already threatened by development and activities from industrial operation, it is important that construction activities and maintenance works during operations are properly managed to minimize the potential negative ecological impact that these activities can have.

5.2.5 The Narvia Swamp

The Nariva Swamp is located on the east coast of Trinidad. This area is the largest wetland in Trinidad covering 11, 343 ha (Juman and Hassanali 2013). The Nariva Swamp is predominately flat, with 40% being less than 1 m above mean sea level resulting in the area being highly susceptible to storm surge and sea level rise (FAO/UN 2019a). This ESA supports a wide range of goods and services including non-consumptive uses such as tourism and scientific research (FAO/UN, 2019a). Additionally, this area has a rich biodiversity of plants and animals influence by the hydrology of the swamp and the undulating topography (IMA, 1999). There are 11 community settlements located directly around the swamp. A

livelihood assessment of the ESA, indicate that agriculture and fishing re the main uses of the Swamp in addition to being a primary source of food for households (FAO/UN, 2019a).

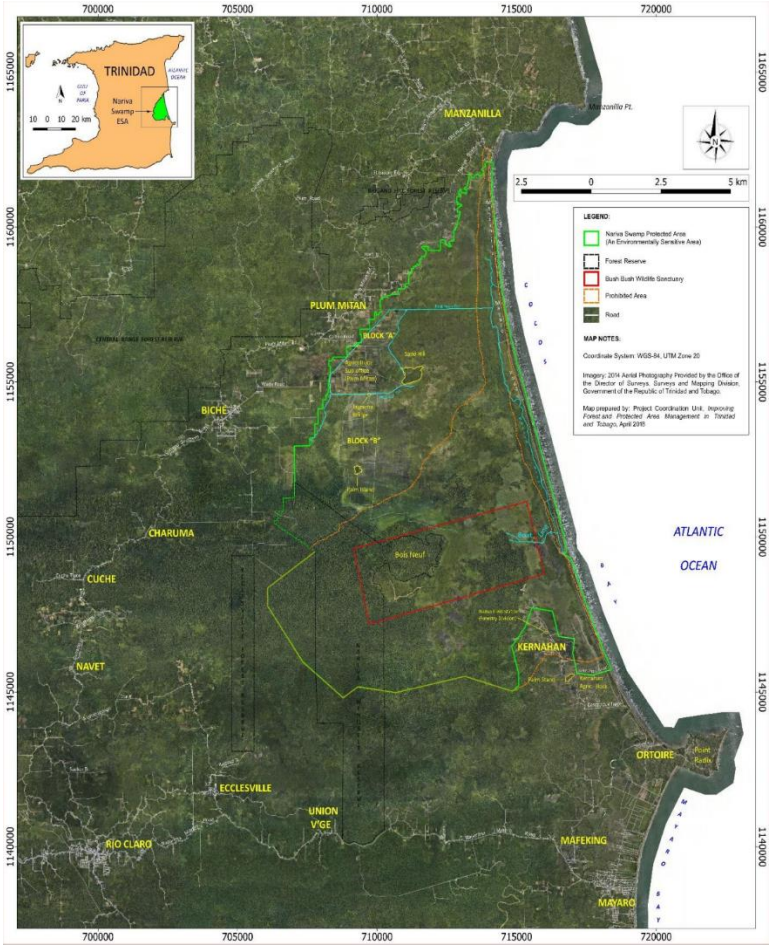


Figure 5-38: Map showing the location of the Nariva Swamp, Trinidad (FAO/UN, 2019a)

5.2.5.1 Flora

The Nariva Swamp consists of a complex system of swamp forest, permanent herbaceous swamp, seasonally flooded marshes, and mangrove forest (IMA, 1999). This rich biodiversity also included endemic species (FAO/UN, 2019a). The freshwater marsh is the predominant vegetation type consisting of floating and rooted grasses. The freshwater swamp woods are in the north-eastern section and the elevated areas of Bois Neuf, Sand Hill and the Bush Wildlife Sanctuary. The palm swamp consists primarily of Royal/Palmiste and Moriche palms and Roseau (FAO/UN, 2019a). The mangrove forest is restricted to the eastern part of the swamp along the Nariva River, with seven species being present (IMA, 1999; Juman and Hassanali 2013). Studies have suggested areas that are regenerating allowing for ecosystem to gradually returning to its natural structure (FAO/UN, 2019a).

5.2.5.2 Fauna

The area is a habitat for various species of mammals, birds, fish, reptiles, and amphibians, some of which are rare and threatened. According to the Institute of Marine Affaires (1999) 176 species of birds, 45 species of mammals, 39 species of reptiles, 19 species of frogs, 33 species fish, 28 species of spiders, 15 species of snails/conch, 213 species of insect can be found in this site. However, the population of animal

species has been negatively impacted due to human activities. Table 5-3 lists the threatened or endangered species within the Narvia Swamp.

Table 5-3 Protected or threatened Fauna Species within the Nariva Swamp (FAO/UN, 2019a)

Scientific Name/Local Name	Current National Designation
***Ara manilata*/ Red-bellied Macaw**	Protected
***Ara ararauna*/ Blue and Yellow Macaw**	Protected
Oryzoborus crassirostris/ Large-billed Seed-Finch	Protected
***Amazona oratrix*/ Yellow-Headed Parrot**	Protected
***Trichechus manatus*/ West Indian Manatee**	Protected -ESS
***Alouatta seniculus*/ Red Howler Monkey**	Protected
***Leopardus pardalis*/ Ocelot**	Protected -ESS
***Cebus albifrons*/ White-Fronted Capuchin**	Protected
***Coendou prehensilis*/ Porcupine**	Protected
***Spiza americana*/ Dickcissel**	Protected
***Forpus passerines*/ Green-rumped Parrotlet**	Protected
***Cyclopes didactyus*/ Silky Anteater**	Protected
***Eunectes murinus*/ Green Anaconda**	Protected
***Lachesis muta*/ Mappepire Zanana**	Protected
***Mappepire Zanana*/ Morocoy**	Protected
***Roystonea oleracea*/ Caribbean Royal Palm (Palmiste)**	Threatened
***Dermochelys coriacea*/ Leatherback Sea Turtle**	Protected-ESS
Duguetia tobagensis	Protected

Recent baseline ecological studies conducted by the University of the West Indies found the species in Figure 5-39within the ESA.

Figure 5-39 Fauna Species Richness in Nariva Swamp (Source: FAO, 2017)

5.2.6 Victoria Mayaro Reserve

The Victoria-Mayaro Forest Reserve in the south-eastern region of Trinidad covers approximately 5,000 ha (BirdLife International, 2021a). This area is predominantly covered with forests with dispersed areas of farming and small settlement. Most of the land is government owned providing some form of protection against bushfires and shifting agriculture. The highest peak within the site associated with Trinity Hill at 303m.

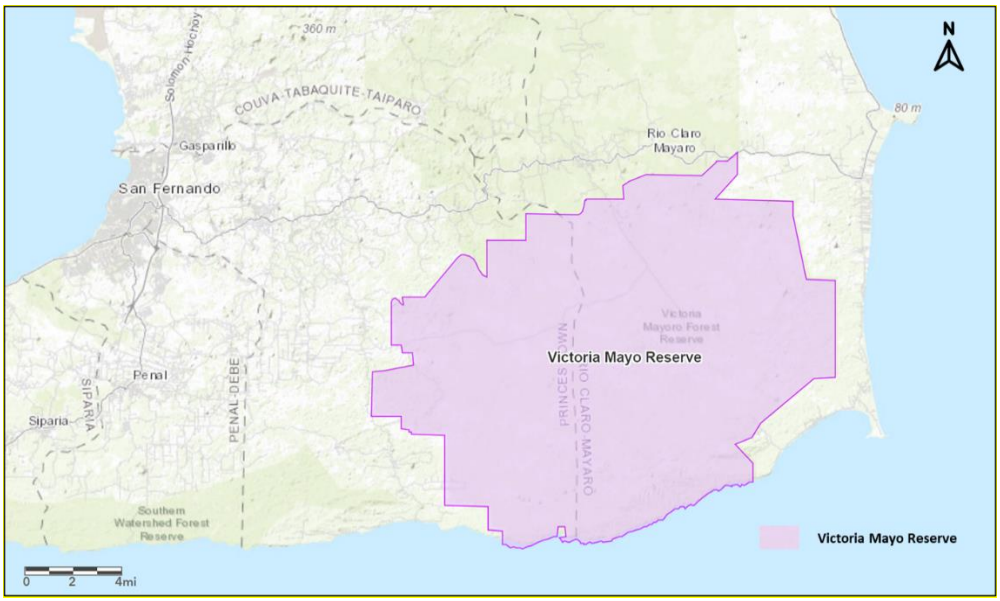


Figure 5-40: Map showing the location of Victoria Mayaro Reserve in Trinidad (Source: BirdLife International, 2021a: http://datazone.birdlife.org/site/factsheet/victoria-mayaro-forest-reserve-iba-trinidad-and-tobago/map)

5.2.6.1 Flora

This Forest reserve represent one of the intact forests in Trinidad. There are two major types of evergreen seasonal forest consisting of *Eschweilera subglandulosa - Carapa guianensis* (Crappo-Guatacare) (BirdLife International, 2021a). Within the evergreen seasonal forest there are various tree species creating canopy layers of varying continuity within the forest. The Mora Forest has a continuous and dense canopy at 36-42m with Mora (*Mora excelsa)* accounting for 85-95% of the canopy layer (BirdLife International, 2021a). For non-forested areas within and along the boarders the reserve agricultural fields represent an estimated 50 ha (BirdLife International, 2021a).

5.2.6.2 Fauna

Majority of the island's mammals (Ocelots, tamandua anteaters (*Tamandua tetradactyla*) both species of monkeys (*Alouatta seniculus* and *Cebus albifrons*) can be found within the site (Biodiversity Trinidad and Tobago, 2021b). Additionally, reptiles including Morocoys, Galaps, Iguana, Matte, Bush master, Fer de Lance, Cascabel, Macajuel. Approximately 31 bird species, and over half of Trinidad's 67 bat species in the forest reserve (Clarke and Downie, 2001).

5.2.7 The Main Ridge Forest Reserve

The Main Ridge Forest Reserve is located in the northeastern coast of Tobago. This area encompasses 3,937 ha and reaches an elevation of 549m (Biodiversity Trinidad and Tobago, 2021b). The Main Ridge

comprises of forested ridges from the North coast to, gentler slopes with deep valleys which lead to a narrow fertile coastal plain in the South (Thelen and Faizool 1980) Surrounding the Main Ridge Forest Reserve are more than 10 villages (Government of the Republic of Trinidad and Tobago, 2013). The natural resources are of Main Ridge Forest Reserve are used for ecotourism. However, the animals within this are vulnerable to local hunters.

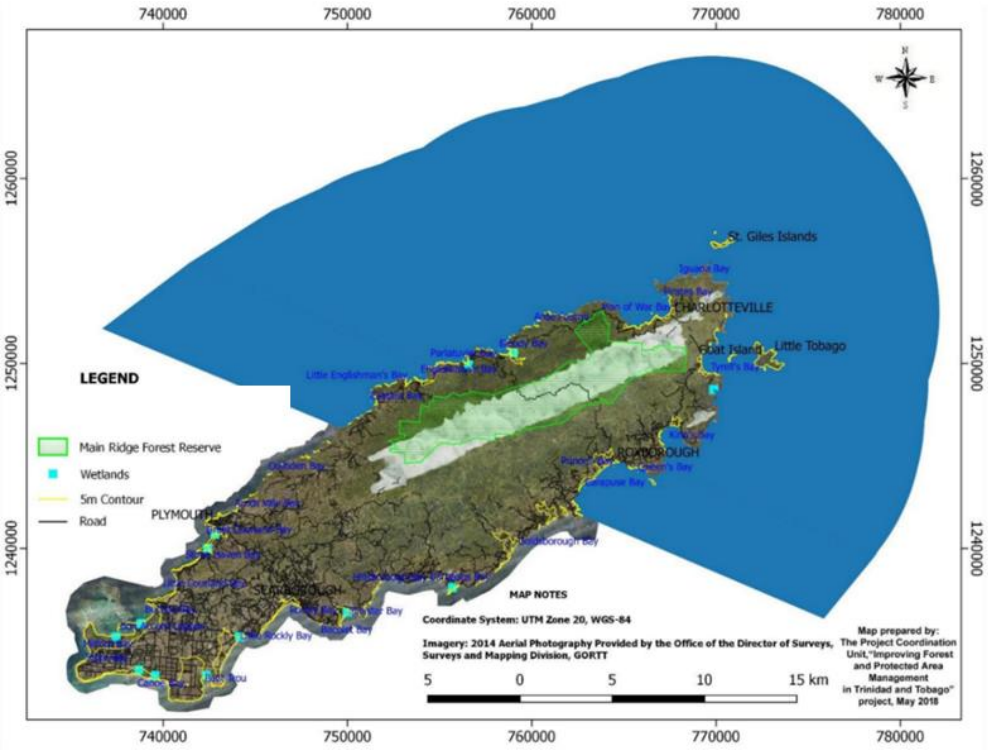


Figure 5-41: Map showing the location of the Main Ridge, Tobago (FAO/UN, 2019c)

5.2.7.1 Flora

The Forest Reserve has 3 main plant communities/vegetation types: lower montane, lowland rainforest, and xerophytic rainforest. Throughout the area, over 160 tree species have been identified, with 16 endemic plants (Biodiversity Trinidad, 2021b). Majority of the reserve is lower montane found above 244m (UNSECO, 2011). In these areas, the plant species receive more rainfall, lowest temperatures, and highest exposure to winds, making it an Evergreen Forest (Biodiversity Trinidad, 2021b). The lowland rainforest is characterized by copious growth and is said to be the most prolific of all forest types, occurring here to a maximum of 366 m (UNESCO, 2011). The xerophytic rainforest is found on the southern slopes of the Forest Reserve at heights above 244 m and is the driest compared to the other types (UNESCO, 2011).

Figure 5-42: Vegetation in the Main Ridge Forest Reserve (Source: Biodiversity Trinidad and Tobago, 2021b)

5.2.7.2 Fauna

The Main Ridge Forest Reserve as a site of high biodiversity in Tobago, is home to 266 animal species. This includes 16 species of mammals, 24 species of snakes, and 16 species of lizards (Biodiversity Trinidad, 2021b). The national bird Rufous-vented Chachalaca (*Ortalis ruficauda*) and 209 other species of birds can be found within the reserves (Biodiversity Trinidad, 2020). Additionally, threatened and endemic animals like the White-tailed Sabre-wing Hummingbird (*Campylopterus ensipennis*), Bloody Bay Poison Frog (*Manophryne olmonae*), and Pristimantis turpinorum , and *Erythrolamprus ocellatus* can also be found in this area(Biodiversity Trinidad, 2021b). However, alien invasive species pose a threat to many of the animals specifically the endemic species. within the forest reserve (Biodiversity Trinidad, 2021b).

5.2.8 Developed Urban Area

The municipalities of Diego Martin, Port of Spain and San Juan/Laventille have been developed with housing, commercial entities, industries, agriculture, roads and ports. These built-up areas are often planted with species that are both native and non-native/introduced.

5.2.8.1 Flora

With respect to flora in the developed urban area, most are either ornamental plants or crop species that were planted in the area. The native species are mainly weedy invasive species or remnant species that are typical of the original Northern Range deciduous seasonal forest or dry evergreen forested vegetation in this part of the island. As expected, the more urbanized areas are characterized by non-native fruiting or ornamental trees mixed with various weeds and invasive trees. These species are present more in large green spaces (e.g., As seen in Figure 5-43) as listed below and in some residential areas:

1. Emperor Valley Zoo
2. Queens Park Savannah
3. Nelson Mandela Park
4. Fort George
5. Proposed Chaguaramas National Park

Figure 5-43: Samaan Park (left) and The Arboretum in Chaguaramas (right) which are part of the Proposed Chaguaramas National Park

Small farms are located in the hills, and larger farms in Chaguaramas and San Juan/Laventille. A variety of plants are typically grown, some of which are listed below:

- **Orchard plants** – cocoa, coffee, breadfruit, citrus, mango, avocado, assorted minor fruit crops (guava, carambola, cherry, pommerac, pommecythere, plum etc.),
- **Herbs and spices** – thyme, basil, tarragon, mint, neem, clove etc.
- **Ornamentals** – allamanda, ixora, duranta, croton, dracaena etc.
- **Seed crops** - corn, pigeon pea, bodi, sorrel, pumpkin, ochro, melongene, hot pepper.
- **Root Crops** - cassava, yam, sweet potato
- **Banana plants** – Plantain, soucrier, silk

None of these species have a protected status.

5.2.8.2 Fauna

Various birds, mammals, reptiles and amphibians, mulluscs and insects are found in the developed area throughout Trinidad and Tobago. It is unlikely that rare or endemic species reliant on food provided in the Environment Sensitive Areas or other protected areas are found in the developed urban area.

Tucker Valley BioBlitz (2012) captured likely species found within the project area. With respect to birds, a total of 98 species of birds from 41 families were seen or heard during the 2012 BioBlitz assessment. This represented the identification of 22% of the species and 57% of the families known from Trinidad and Tobago. In terms of mammals, 11 species from 9 families were recorded, which represents 11% of species and 65% of families known for Trinidad and Tobago. With respect to reptiles and amphibians, 12 species from six families were found which is equivalent to 36% of the known species in the country. The species list is presented in Appendix 2. Outside of these, there is the Chaguaramas Petting Zoo and the Emperor Valley Zoo in Port of Spain which carry both native and non-native fauna.

5.3 SOCIO-ECONOMIC ENVIRONMENT

5.3.1 The Locational Setting

The area of influence is defined by the immediate and wider project area. The immediate project area includes Trinidad's northwest, northeast, central and southern zones. The population that will benefit from project interventions reside in the municipalities of Couva/Tabaquite/Talparo, Diego Martin, Penal/Debe, Princes Town, Sangre Grande, Siparia, and Tunapuna/Piarco, and the boroughs of Arima and Point Fortin. One of the communities in the project area also falls within the city of San Fernando.

The project area consists of 76 communities from 10 municipalities. The communities that stand to be impacted by the proposed project are distributed throughout the country. However, most communities are located in the southern and southwestern municipalities of Princes Town (15 communities), Penal/Debe (5 communities) and Point Fortin (3 communities), with the majority belonging to Siparia (19 communities). There is also one project community in the city of San Fernando. Twelve of the 76 communities are situated centrally in the municipality of Couva/Tabaquite/Talparo. Dispersed across northern Trinidad, the bulk of the remaining communities, found in Tunapuna/Piarco (9 communities) and Arima (2 communities), are flanked by 6 communities in Diego Martin to the west and 8 communities in Sangre Grande to the east. Project communities in Couva/Tabaquite/Talparo, Penal/Debe, Princes Town, Sangre Grande and Siparia are essentially rural in character while those in Arima, Diego Martin, Point Fortin, Tunapuna/Piarco and San Fernando are more urbanised. Regardless, communities are generally located along, or just off, the major road arterial network and at their main intersections

This project will have an overall effect on the country's water supply and, therefore, the wider project area has been defined as the nation of Trinidad and Tobago.

5.3.2 Socio-Economic Description of the Project Area

5.3.2.1 Population and Demography

The immediate project area is among the most populous in Trinidad and Tobago. According to the latest Population and Housing Census Report for Trinidad and Tobago, the population of this area stood at 247,034 persons in 2011, accounting for almost one-fifth of the national population (Table 5.4). Between 2000 and 2011 Diego Martin and the City of San Fernando showed a population decline of 2.6% and 11.9% respectively (Figure 5-44 and Table 5.5). However, additional construction of residential structures in Diego Martin suggests that the population in the municipality is once again on the increase.

The female population size (122,476 women and girls) living in the project area was slightly higher than the male population (men and boys). The 2011 Census indicates that an average of 3.3 persons lived in the recorded 73,964 households, comparable to the country's average household size of 3.3 persons in each household. Approximately 30% of households in the project area were headed by women (39.4%), with the communities in the four municipalities having a higher proportion of female-headed households than noted at the national level (30.7%). The proportion of women-headed households were highest in the community found in the City of San Fernando (37.1%).

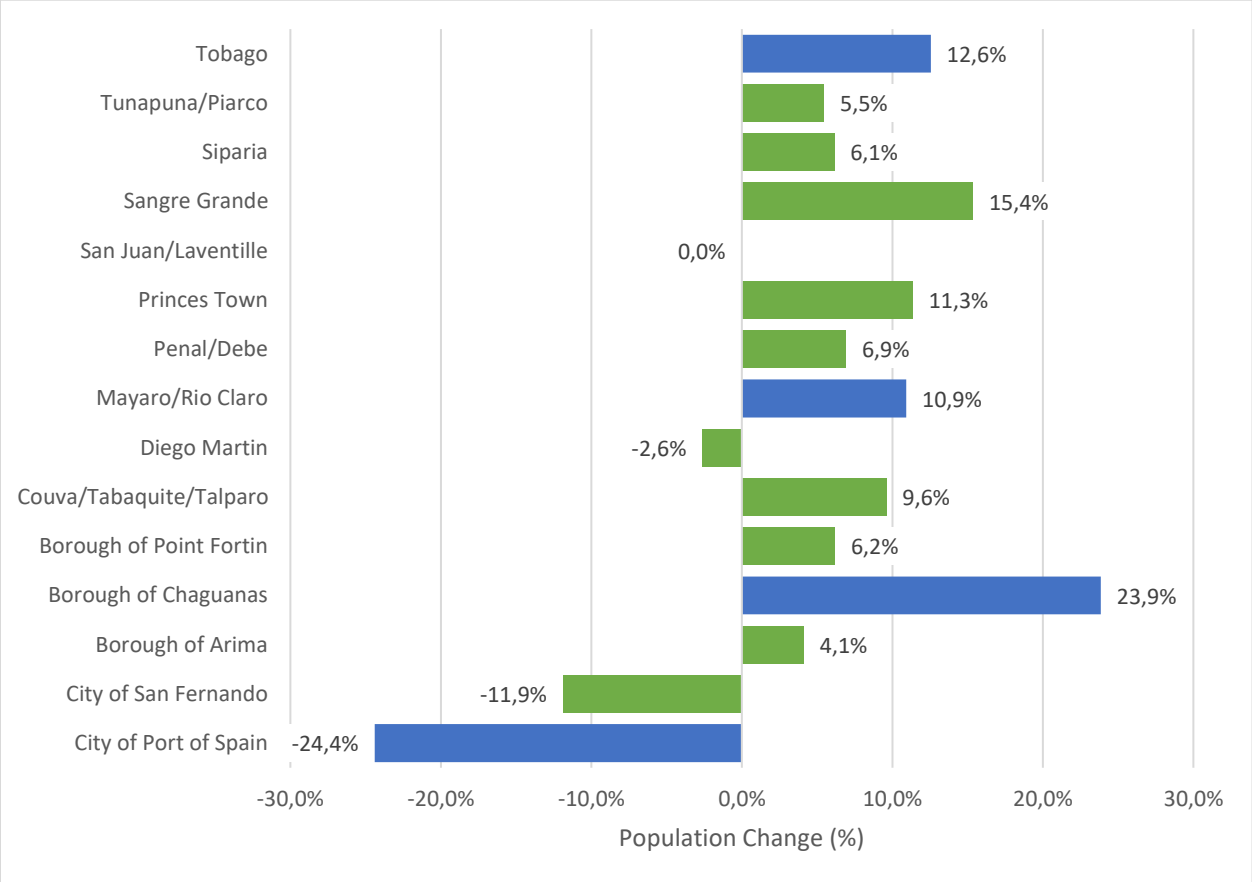


Figure 5-44: 2000 – 2011 Population Change by Municipality

Source: Trinidad and Tobago 2011 Population and Housing Census, CSO

Table 5.4: Population Size and Total Households in the Project Area in Relation to the Municipalities, 2011

Project Area Communities by Municipality	Number of Project Area Communities	Project Area Population	Municipal Population	Percentage Municipal Population	Total Number of Households	Percentage Municipal Households	Average Household Size
Borough of Arima	2	17,409	33,404	52.1	5,135	52.5	3.4
City of San Fernando	1	9,810	48,635	20.2	3,141	20.8	3.1
Couva/Tabaquite/Talparo	12	37,480	178,160	21.0	10,866	21.0	3.4
Diego Martin	6	11,419	102,340	11.2	3,878	12.0	2.9
Penal/Debe	5	12,120	89,342	13.6	3,638	14.0	3.3
Point Fortin	3	6,630	20,161	32.9	2,137	32.0	3.1
Princes Town	15	43,260	102,369	42.3	12,482	42.1	3.5
Sangre Grande	8	36,427	75,605	48.2	10,741	47.3	3.4
Siparia	19	27,922	86,898	32.1	8,571	32.8	3.3
Tunapuna/Piarco	9	44,557	212,825	20.9	13,376	20.8	3.3
Total Project Area	80	247,034	949,738	26.0	73,964	26.0	3.3
Trinidad and Tobago	594	-	1,322,546	-	401,382	100.0	3.3

Source: Trinidad and Tobago 2011 Population and Housing Census, CSO

Table 5.5: Population Head of Households by Sex in the Project Area, 2011

	Population by Sex				Total Population	Sex of Head of Households				Total Households
	Female		Male			Female-Headed		Male-Headed		
	Number	%	Number	%		Number	%	Number	%	
Borough of Arima	8,833	50.7	8,575	49.3	17,409	1,794	34.9	3,341	65.1	5,135
City of San Fernando	4,977	50.7	4,833	49.3	9,810	1,165	37.1	1,976	62.9	3,141
Couva/Tabaquite/Talparo	18,311	48.9	19,169	51.1	37,480	2,565	23.6	8,301	76.4	10,866
Diego Martin	5,677	49.7	5,742	50.3	11,419	1,359	35.0	2,519	65.0	3,878
Penal/Debe	5,873	48.5	6,247	51.5	12,120	820	22.5	2,819	77.5	3,638
Point Fortin	3,333	50.3	3,297	49.7	6,630	733	34.3	1,404	65.7	2,137
Princes Town	21,305	49.2	21,955	50.8	43,260	3,303	26.5	9,178	73.5	12,482
Sangre Grande	17,982	49.4	18,444	50.6	36,427	3,426	31.9	7,315	68.1	10,741
Siparia	13,703	49.1	14,219	50.9	27,922	2,693	31.4	5,877	68.6	8,571
Tunapuna/Piarco	22,481	50.5	22,076	49.5	44,557	4,828	36.1	8,548	63.9	13,376
Total Project Area	122,476	49.6	124,557	50.4	247,034	22,686	30.7	51,278	69.3	73,964
Trinidad and Tobago	661,714	49.8%	666,305	50.2	1,328,019	131,519	32.8	269,864	67.2	401,382

Source: Trinidad and Tobago 2011 Population and Housing Census, CSO

Table 5.6: Population growth in Trinidad and Tobago and by Municipalities, 2011

Municipality	Total Population		Population Growth per Annum
	2000	2011	
Trinidad and Tobago	1,262,366	1,328,019	0.5
Trinidad	1,208,282	1,267,145	0.4
Project Area			
Borough of Arima	32,278	33,606	0.4
City of San Fernando	55,419	48,838	-1.1
Couva/Tabaquite/Talparo	162,779	178,410	0.9
Diego Martin	105,720	102,957	-0.2
Penal/Debe	83,609	89,392	0.6
Point Fortin	19,056	20,235	0.6
Princes Town	91,947	102,375	1.0
Sangre Grande	65,680	75,766	1.4
Siparia	81,917	86,949	0.6
Tunapuna/Piarco	203,975	215,119	0.5

Source: Trinidad and Tobago 2011 Population and Housing Census, CSO

Comparison between the age structure of the population of the municipalities in the project area in 2000 and 2011 showed that the municipal populations were ageing, with some differences noted in the distribution of ages between the sexes for persons 70 years and over (Figure 5-45).

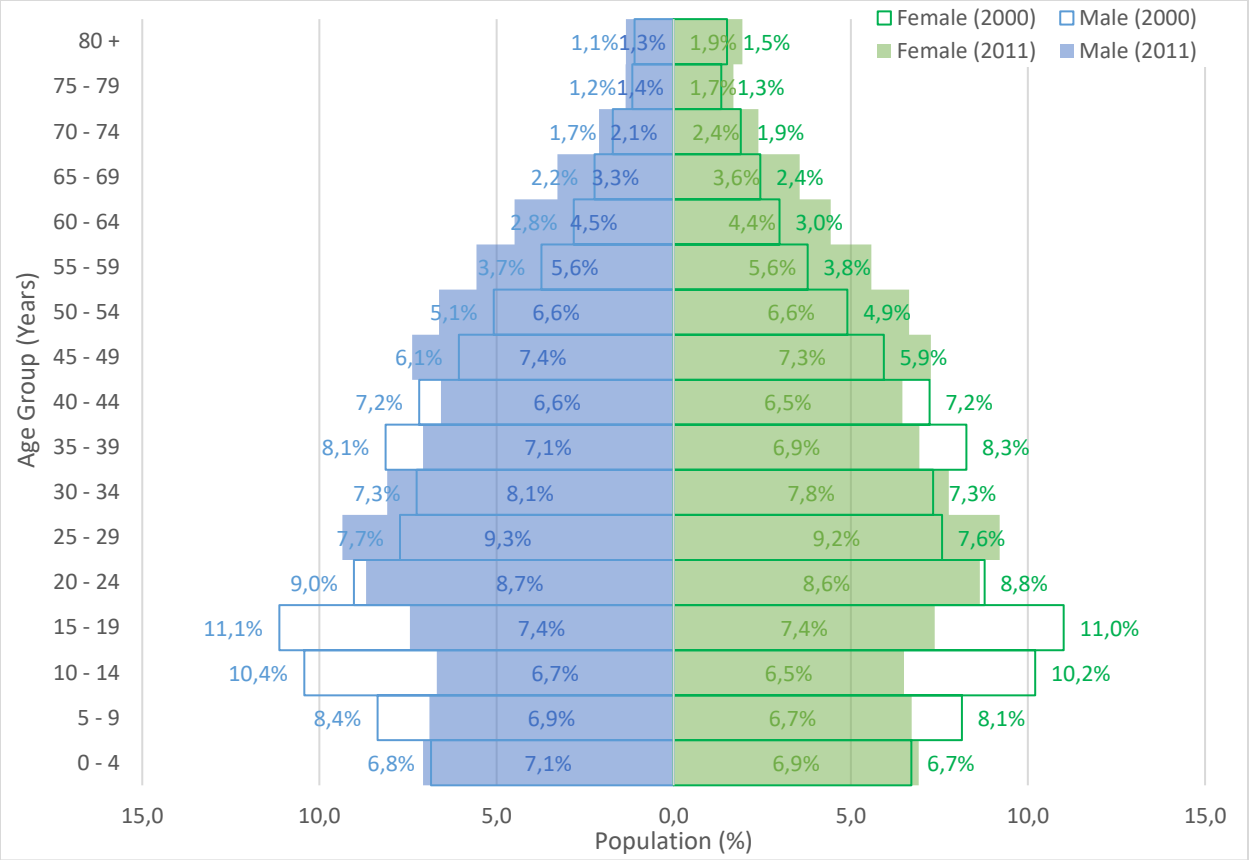


Figure 5-45: Age and sex structure of Municipalities within Project Area (2000, 2011)

The 2011 census shows that the project area population was relatively young, with more than half of the population, both females and males, under 40 years and 20.6 % younger than 15 years old (Figure 5-46). The age group between 5 and 19 years, most of whom make up the primary and secondary school-age population, accounted for 21.1% of the project area population. The working-age population between 15 and 65 years, accounted for 71.3% of the impacted communities' population.

The project area reflects the plurality of the Trinidad and Tobago society, with more than nine ethnic groups represented in the municipalities. East Indians (38.3%), Africans (27.3%), Mixed – Other (16.8%) and Mixed – African/East Indian (7.2%) were the four largest ethnic groups noted across the project area.

The project area population were mainly Christians, made up mostly of persons of Roman Catholic (20.2%), Pentecostal/Evangelical/Full Gospel (16.0%), Anglican (4.0%) and Spiritual Shouter Baptist (4.6%) and Seventh Day Adventist (4.0%) denominations. Hinduism (19.2%) and Islam (5.3%) were the other main two religions to which the project area population were affiliated. Both at the national and municipal level, roughly 3 in 20 persons neither followed a religion nor stated their affiliation.

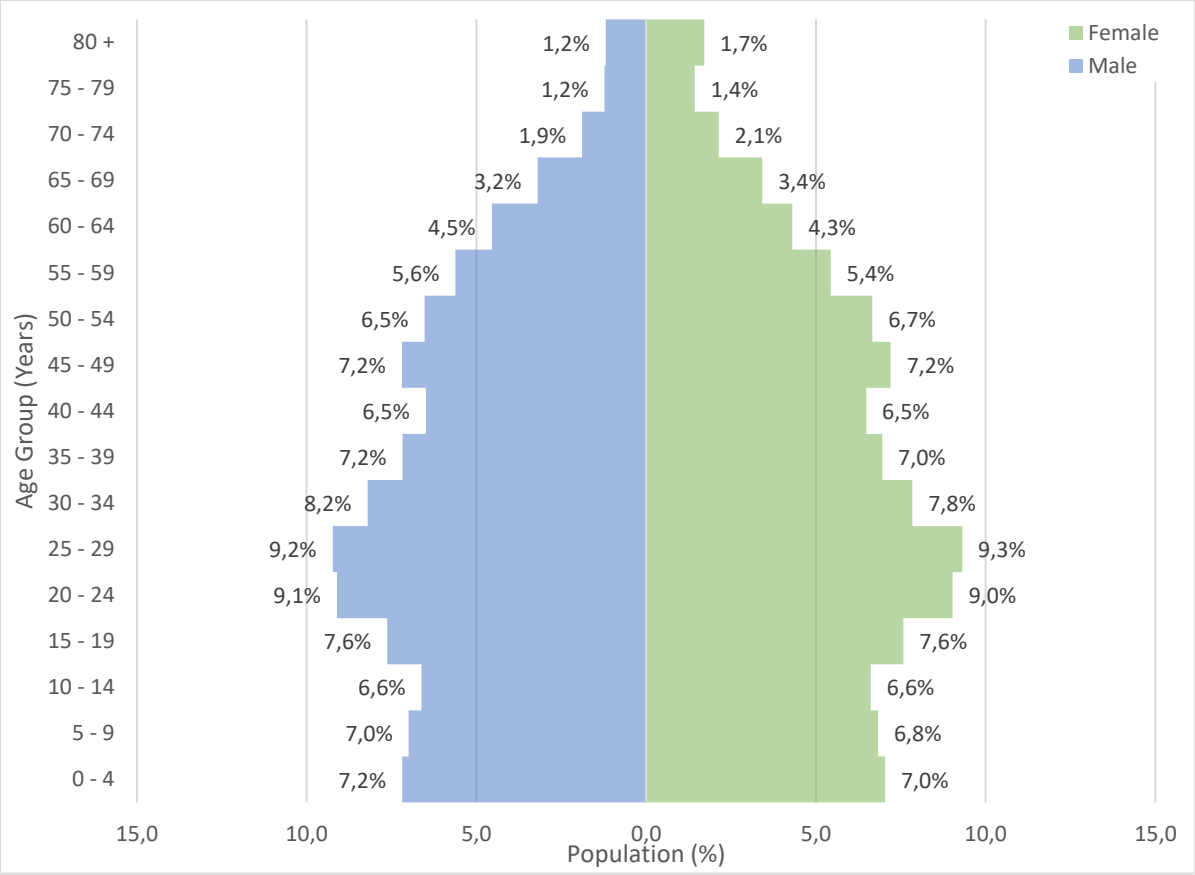


Figure 5-46: Age and Sex Structure of Population in Project Area (2011)

5.3.2.2 Persons with Disabilities

The 2011 census revealed that 3.9% of the project area population or 13,231 residents were persons with disabilities (PWDs) (Table 5.7), comparable to the national average of 3.9%. People reported various types of disabilities, but mobility and visual disabilities comprised the largest type of disabilities reported, with 24.8% and 29.5% of PWDs living with either seeing or walking disability respectively.

Table 5.7: Project Area Population and Share of Population of Persons with Disabilities by Type of Disability, 2011

All Persons with Disabilities/Types of Disability	The Proportion of Project Population of People of Disabilities					
	Female		Male		Total	
	Number	%	Number	%	Number	%
All PWDs	6,586	4.0	6,645	3.9	13,231	3.9
- **Seeing**	1,818	1.1	1,468	0.9	3,286	1.0
- **Hearing**	574	0.3	592	0.3	1,166	0.3
- **Walking**	2,035	1.2	1,871	1.1	3,907	1.2
- **Remembering**	727	0.4	764	0.5	1,491	0.4
- **Gripping**	419	0.3	554	0.3	973	0.3
- **Speaking**	775	0.5	981	0.6	1,756	0.5

Source: Trinidad and Tobago 2011 Population and Housing Census, CSO

5.3.2.3 Education

Generally, the population in the municipalities within which the project area extends has attained qualifications comparable to the national average (Figure 5-47). According to the 2011 Census, 38.7% of persons over 15 years old in the nation did not achieve any academic qualifications compared to less than 35% of adults in the Borough of Arima, the City of San Fernando and the municipalities of Diego Martin and Tunapuna/Piarco. The city of San Fernando specifically had the highest proportion of persons with some qualifications (53.9%) compared to the national average (47.4%) with 8.1% of persons over 15 years completing either a bachelor's degree, Master's, doctorate, or some other postgraduate program.

In 2011, 27.5% of the project area population were attending educational institutions, and of those 61.4% were attending either primary or secondary schools. Table 5.8 shows the educational attainment of the project area population. Some 41.2 % of the project area population attained secondary level education while 30.7% had a primary level education. Additionally, tertiary level education, be it university or non-university, was attained by 13.9% of the population. More frequently, women (15.8%) had attained tertiary level education compared to men (12.3%). Roughly two percentage (2%) of the project area population did not attain any type of schooling, with higher percentages noted in older adults.

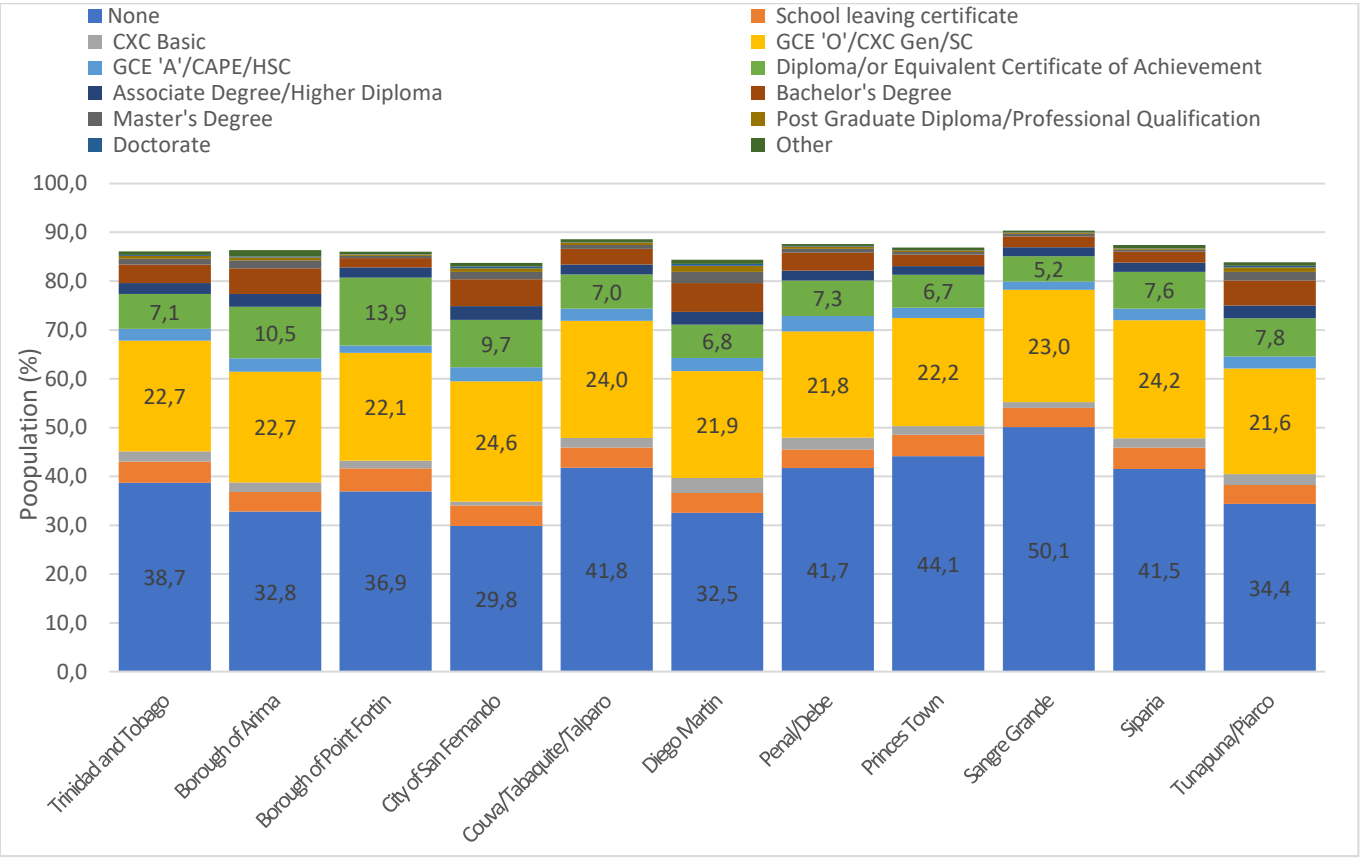


Figure 5-47: Qualifications attained by Municipal Populations over 15 Years (2011)

Source: Trinidad and Tobago 2011 Population and Housing Census, CSO

Table 5.8: Population of the Project Area by Highest Level of Educational Attainment

Highest Educational Attainment	All Project Area Communities					
	Female		Male		Total	
	Number	%	Number	%	Number	%
None	2,179	1.8	1,870	1.5	4,026	1.6
Early Child Care & Education/Nursery School/Kindergarten	4,002	3.3	4,081	3.3	8,055	3.3
Primary	36,893	30.1	38,868	31.2	75,416	30.7
Secondary	49,347	40.3	52,315	42.0	101,221	41.2
Post-Secondary	2,603	2.1	2,977	2.4	5,428	2.2
Tertiary/Non-University	8,278	6.8	7,223	5.8	15,435	6.3
Tertiary/University	10,689	8.7	8,062	6.5	18,664	7.6
Other	1,124	0.9	1,161	0.9	2,284	0.9
Not Applicable	5,823	4.8	6,147	4.9	11,901	4.8
Not Stated	1,539	1.3	1,854	1.5	3,377	1.4

Source: Trinidad and Tobago 2011 Population and Housing Census, CSO

5.3.2.3.1 Educational Facilities

The governance, management and administration of education in Trinidad and Tobago is done at a regional or zonal level by leadership teams distributed across distinct districts across the country. The project communities are dispersed across six of the eight education districts in the nation. Most of the project community population is served by the St. Patrick education district, which spans the municipalities of Siparia, the borough of Point Fortin and the southern communities of Penal/Debe. The neighbouring district of Victoria serves the project communities of San Fernando, Princes Town and northern communities of Penal/Debe. After St. Patrick, the St. George East district is responsible for the education of just over one-quarter of the project area population. This includes all project communities from the borough of Arima, most from Tunapuna/Piarco and several from Couva/Tabaquite/Talparo. The education system in the project communities centrally located in the municipality of Couva/Tabaquite/Talparo is overseen by the Caroni district. Communities in Diego Martin fall within the Port of Spain and environs district while communities in Sangre Grande are within the Northeast district.

Although each education district offers varying degrees of availability of primary and secondary educational facilities, there is reasonable access to education for all. The districts of St. George East and Port of Spain have the most public educational facilities available for the provision of primary and secondary education to their school-going population. The 106 primary schools in St. George East and 95 primary schools in the Port of Spain and environs district are situated along the East-West corridor in Arima, Arouca, Tunapuna, St. Joseph, Curepe, Port of Spain and Diego Martin. However, the 37 and 39 secondary schools in St. George East and Port of Spain and environs respectively are concentrated in areas such as Port of Spain, St. Augustine, St. Joseph and Tunapuna. The St. Patrick district has documented 60 primary schools within its boundaries but less than 15 secondary schools with 5 found in Siparia and 3 in Point Fortin. Comparably, the North East district features the least number of primary schools (44) and 21 secondary schools located along the Eastern Main Road and Toco Main Road in the municipality of Sangre Grande. The districts of Victoria and Caroni each have more than 70 primary schools and 25 secondary

schools concentred around Chaguanas, Couva, and San Fernando, allowing relatively ease of access to education.

Post-secondary and tertiary education is accessible to the project communities in widely distributed locations. In northern Trinidad, higher-level institutions are clustered in St George East, particularly in the municipality of Tunapuna/Piarco. The main campus of the University of the West Indies (UWI) is located in the municipality along with other higher post-secondary institutions such as the University of Trinidad and Tobago (UTT), Cipriani Labour College and Co-operative Studies, University of the Southern Caribbean and some privately run institutions. There are also UTT campuses in Wallerfield, Piarco, Port of Spain and Chaguaramas. In central and southern Trinidad there has been some expansion for post-secondary and tertiary education with UWI Open Campus site locations in Chaguanas, Carapichaima, San Fernando, Princes Town, and Point Fortin; UTT Campus sites in Couva, Point Lisas and San Fernando; and other distance education programmes offered by a wide range of tertiary, or post-secondary, institutions. There are also many private colleges offering franchised North American and British degree and diploma programmes throughout the country.

5.3.2.4 Informal Settlements

There are 80 informal settlements within the project areas with the largest amount in the rural municipalities of Siparia (17), Princes Town (12), Point Fortin (12) and Penal/Debe (10). Similar to what is observed nationally, the increasing housing demand amid inadequate housing supply and the high availability of vacant state lands in rural municipalities has led to the recent growth in squatter and informal settlements as villages and towns transition from agricultural to urban centres. The informal settlements within the project areas are largely residential in nature and concentrated along major transportation routes but some agricultural informal settlements can be found in the rural regions (Table 5.9).

Table 5.9: Informal Settlements within Project Area

Municipality	Informal Settlement
Borough of Arima	Ackbarali Trace (Arima) Old Malabar and India (Arouca South)
City of San Fernando	Bayshore TGR (Marabella)
Couva/Tabaquite/Talparo	Base Road and Arena Road (Freeport) Brazil Lome, Brazil Village (San Raphael) John Boodoo, Brazil Village (San Raphael) Soriah Trace, Brazil Village (San Raphael) Mac Lean Trace (Las Lomas #1) Preysal Sesame Street (Preysal)
Diego Martin	Big Yard, Carenage Scorpion Village, Upper Carenage
Penal/Debe	Barrackpore Trace East and West (Barrackpore) Carrat Hill Trace (Barrackpore) Diamond/Picton GP Extension (Barrackpore) Manohar Road, Rochard Road (Penal) Massa Trace (Barrackpore)

Municipality	Informal Settlement
	Mussarap Trace (Barrackpore) Oli Mohammed Trace (Barrackpore) Sandy Hill (Barrackpore) Tin Pan Alley (Barrackpore)
Borough of Point Fortin	Butler's Park, (New Village) Dam Road Extension, Dam Road (Point Fortin) Egypt Avenue (Point Fortin) Gerald Street Extension, (Point Fortin) La Fortune Extension, (New Village) Osbourne Trace, (Point Fortin) Ravine Ranch (New Village) Red Road-Cemetery Block Road, (Point Fortin) Reid Road and Reid Road Extension, Seedon Alley (Point Fortin) Reservoir Hill, (Point Fortin) Roberts Street (Point Fortin) Springle Avenue, Springle Street (New Village)
Princes Town	Buen Intento (Princes Town) Buen Intento (LFL), (Princes Town) Corner Realise and Cunjal Roads (Barrackpore) Cox Trace and Woodland Road (Off Cipero Road) Derrick Aenue (Off Manahambre Road) Friendship Village Glenroy (Princes Town) Kimkeran Trace (Off Naparima Road) Malgretoute Branch Road (Princes Town) St. Mary's Village (Moruga) St. Julien (New Grant) Stanleyville (Ste. Madeleine)
Sangre Grande	Blake Avenue (Guiaco) Bois Bande (Sangre Grande) Cumuto Road (Cumuto) Graham Trace (Sangre Grande) Graham Trace Extension (Thin Strip) (Sangre Grande) North Eastern Settlement (Sellier Road) Ojoe Road, Pine Settlement (Sellier Road) Picton Road Extension (Sangre Grande) Quash Trace (Off Foster Road)
Siparia	# 4 Road,Webber Trace (Palo Seco) # 7 Road (Palo Seco) # Nine Road (Palo Seco) Beach Road (Palo Seco) Chin Yuen Kee Trace (Point Fortin) Coora Branch Road (Siparia) Fly-Over (Santa Flora) Gambal Street (Siparia) Guerra Trace (Quarry Village)

Municipality	Informal Settlement
	Jacob Alley # 2 (Los Bajos) Lily Trace (Siparia) Los Bajos (Los Bajos) Opposite South Central Road (Point Fortin) Quinam Road (Siparia) San Fernando Siparia Erin Road (Palo Seco) School Road, Agapito Trace (Santa Flora) Taylor Avenue, Rito Ville (Siparia)
Tunapuna/Piarco	Moonan Road (Wallerfield) Bon Air North (Arouca North) Demerara Road (Arima) Heights of Aripo (Wallerfield) Moonan Road, Agua Santa (Wallerfield) Off Churchill Roosevelt Hwy, Jacob Hill (Wallerfield) Piarco Village (Piarco) Rice Mill Road (Arima)

Source: Land Settlement Agency (2010)

5.3.2.5 Housing Stock

According to the 2011 Population and Housing Census, the majority (52.0%) of the housing stock was built before 1989. Separate houses are the most prevalent (81.7%), followed by flat/apartment dwelling units (9.3%). Dwelling units are made mostly of brick/concrete (72.1%). Owner-occupied dwellings constituted a significant proportion of dwellings (82.6%), while rented dwellings accounted for 10.8% and rent-free 4.3%.

5.3.2.6 Water Supply and Demand

According to the Water Sector Improvement Plan, Trinidad and Tobago has an estimated demand of 135 MIG/day and has a production of 232 MIG/day. The estimated water consumption per capita in Trinidad and Tobago was 373 litres (83 gallons) per capita per day. Non-Revenue Water is estimated at 99 MIG/ day or 60% of demand and 43% of production. WASA's service coverage is almost universal for improved water supply services, covering 97% of the population.

In the advent of the COVID-19 pandemic, WASA reported that only 67% of the population of Trinidad and Tobago was supplied with water more than 3.5 days per week with 23% receiving a supply 2 to 3 days per week and 1% receiving a supply less than 2 days per week. The 2011 census provides a look at water supply at the municipal level. The table below presents the water supply of households within the project area (Table 5.10). The census showed that over 89% of project area households had access to an improved water supply. Access to public piped water supply on premises was higher in urban communities compared to rural communities. Although a high proportion of the project population can access a public water supply, just 37.5% of households receive water daily with less than 12%of publicly supplied project households in Penal/Debe and Point Fortin attaining water every day. Generally, approximately one in four project households are said to have received public water supply less than once or twice a week.

According to the 2011 Multiple Indicator Cluster Survey Report, in the regions inhabited by the project communities (Northwest, North Central, East and South West), more than 97% of households used

improved water sources for drinking with between 63% to 80 %of households relying specifically on water piped into their dwelling. Bottled water has become an important water source for drinking, particularly in the north-central region where 16.1% of households used bottled water as their main source of drinking water, compared to less than 10% in the other project areas. Water contamination was cited as an issue by less than 9% of the relevant municipalities but more than half of households in each region reported in the 2011 Multiple Indicator Cluster Survey that they did not use any appropriate water treatment method when unimproved drinking water sources were used. Notably, as much as 94.6% of households in the southwest region did not employ any treatment method when using an unimproved drinking water source.

Table 5.10: Water Supply of Households in Project Area by Municipality

Project Area Communities by Municipality	Public Piped Dwelling		Public Piped Yard		Public Standpipe		Private Piped Dwelling		Private Catchment		Truck Borne		Spring/ River/Well/Pond		Other		Not Stated	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Borough of Arima	4,905	95.5	71	1.4	15	0.3	82	1.6	41	0.8	3	0.1	-	-	16	0.3	2	0.0
City of San Fernando	2,996	95.4	91	2.9	16	0.5	7	0.2	7	0.2	1	0.0	-	-	3	0.1	19	0.6
Couva/Tabaquite/ Talparo	8,362	77.0	1,093	10.1	164	1.5	281	2.6	515	4.7	125	1.2	36	0.3	264	2.4	25	0.2
Diego Martin	2,845	73.3	389	10.0	74	1.9	66	1.7	81	2.1	34	0.9	39	1.0	116	3.0	234	6.0
Penal/Debe	2,207	60.7	804	22.1	65	1.8	48	1.3	311	8.5	63	1.7	3	0.1	134	3.7	3	0.1
Borough of Point Fortin	1,037	48.5	468	21.9	168	7.9	74	3.5	222	10.4	27	1.3	2	0.1	117	5.5	20	1.0
Princes Town	8,313	66.6	1,912	15.3	378	3.0	579	4.6	705	5.6	240	1.9	16	0.1	256	2.1	82	0.7
Sangre Grande	8,418	78.4	639	5.9	322	3.0	237	2.2	665	6.2	189	1.8	15	0.1	233	2.2	24	0.2
Siparia	4,615	53.8	1,488	17.4	344	4.0	559	6.5	949	11.1	105	1.2	31	0.4	398	4.6	82	1.0
Tunapuna/Piarco	12,050	90.1	331	2.5	194	1.4	188	1.4	377	2.8	67	0.5	28	0.2	106	0.8	34	0.3
Total Project Area	55,749	75.4	7,285	9.8	1,739	2.4	2,121	2.9	3,872	5.2	855	1.2	171	0.2	1,645	2.2	527	0.7
Trinidad and Tobago	304,010	75.7	35,921	8.9	10,773	2.7	15,783	3.9	18,619	4.6	4,409	1.1	3,016	0.8	7,206	1.8	1,637	0.4

Source: Trinidad and Tobago 2011 Population and Housing Census, CSO

The latest published Survey of Living Conditions Report for Trinidad and Tobago in 2005 provides a look at the country's water supply through a poverty lens. The Report revealed that over 70% of households had water piped to their dwelling from a public source and another 4.4% had water piped to their dwelling from a private source. The likelihood of piped water to dwelling increased with household quintile with 51.5% of those in the poorest quintile had water piped to the dwelling compared to 90.3% of those in the richest quintile. Of the total households surveyed, 7.1% had a supply of water piped into the yard in which their dwelling was located. As much as 5.9% of all households sampled still depended on public standpipes, with 11.5% of the poorest quintile relying on this source. Within the poorest quintile, 3.9% relied on truck borne water supplies, and 11% depended on private catchments (non-piped). The second quintile displayed a pattern that was only marginally better. It should be noted that large proportions of the two lowest quintiles used springs/rivers or 'other' sources of water supply, 9.0% of those in quintile I and 5.3% of those in quintile II respectively (Table 5.11).

Table 5.11: Distribution of Dwellings by Main Source of Water by Quintiles

Main Source of Water	Household Quintiles					
	Poorest	II	III	IV	Richest	Total
	%	%	%	%	%	%
Public piped into Dwelling	47.8	66	71.7	79.8	87.3	70.7
Public Piped into Yard	11.9	7.8	8.4	6.2	1.6	7.1
Public Standpipe	11.5	6.3	6.1	3.5	2.6	5.9
Private Piped into Dwelling	4.7	5.8	4.7	3.9	3	4.4
Private Catchment not Piped	11	6.6	3.7	3.5	2.1	5.4
Truck Borne	3.9	2	0.9	1	1.7	1.9
Spring/River	2	0.9	1.8	0.6	0.1	1.1
Other	7	4.4	2.5	1.5	1.4	3.3
Not Stated	0.2	0.3	0.1	-	.1	0.2
Total	**100**	**100**	**100**	**100**	**100**	**100**
Total (n)	**834**	**847**	**855**	**854**	**869**	**4,258**

The challenge in the provision of water was also demonstrated in the frequency of water supply (Table 5.12). Although 95% of households received water from public/private piped, public standpipe, private catchment and truck borne sources, further analysis of the data show that only 58.4% of households received a continuous supply of water, while 20.1% indicated that they received a water supply three or more times weekly. Households receiving a continuous supply of water and three or more times a week increased across quintiles - from the poorest (69.2%) to the richest (85.4%). Of households in the poorest quintile 11% of those sampled stated that the frequency of their water supply fell into the category 'other' which suggests that, at best, it was not as good as the mentioned delivery mode. If having access to water three or more times weekly is set as the standard, more than 20% of the population was under-provided with running water.

Table 5.12: Frequency of Pipe Borne Water Supply by Quintiles

Frequency of Water Supply	Household Quintiles Poorest %	II %	III %	IV %	Richest %	Total %
Continuous Supply	52.2	53.8	59.1	62.5	64.1	58.4
Three or more Times Weekly	17	20.4	20.6	21.4	21.3	20.1
Twice Weekly	9	9.3	7.6	5.4	5	7.3
Less than Twice a Week	9.8	8.6	7.1	6.5	4.1	7.2
Other	11	6.7	5.3	3.7	4.5	6.2
Not Stated	0.9	1.2	0.3	0.6	0.9	0.8
Total	**100**	**100**	**100**	**100**	**100**	**100**

Given the problems of securing a continuous supply, many households in Trinidad and Tobago have invested in on-site storage. The 2005 report showed that on average 83% of all households used water tank storage facilities: 72.6% of the poorest invested in such storage facilities, compared to 91.3% of the richest quintile. It is not uncommon for households to invest in more than one source of storage. The use of barrels for water storage decreases, the higher the quintile.

Table 5.13: Type of Water Storage Facility by Quintile

Type of Water Storage Facility		Household Quintiles Poorest	II	III	IV	Richest	Total
Water Tank	***N***	524	572	594	624	656	2,969
	%	72.6	79.8	82.8	88.6	91.3	83.0
Barrel	***N***	290	190	136	91	62	768
	%	40.3	26.5	18.9	12.9	8.6	21.5
Other	***N***	99	69	71	46	38	324
	%	13.8	9.6	9.9	6.6	5.3	9.1

The water tariff structure is as presented in Figure 5-48. There is no readily available data on the ability of the low-income households in Trinidad and Tobago to pay for their water supply. It should be noted, however, that poor and vulnerable households may have difficulty paying for their water supply. However, an exercise in benchmarking the performance of WASA against water utilities in other Caribbean countries show that 0.6% of the average expenditure for the poorest households (in the bottom quintile) was used to pay water utility bills compared to 0.1% in Jamaica Table 5-14).[2]

[2] Quarterly expenditure of TTD15,904 for the bottom income quintile and TTD28,258 for the median income quintile were derived from the 2008-2009 Household Budget Survey Report prepared by the Central Statistical Office (CSO) (Volume II, Table 5.22). Reported household expenditure from the 2008-2009 survey (TTD3,338/month or TTD10,013/quarter for the bottom income quintile and TTD5,930/month or TTD17,792/quarter for the median income quintile) has been adjusted for inflation of 59 percent from 2009 to 2018 (to TTD5,301/month or TTD15,904/quarter for the bottom income quintile and to TTD9,419/month or TTD28,258/quarter for the median income quintile). Inflation data was obtained from the International Monetary Fund, World Economic Outlook, accessed 11 October 2018.

Table 5-14: Benchmarking WASA's Performance Against Regional Utilities

Key Performance Indicador	WASA T&T	NWC Jamaica	WSC The Bahamas	GBUC Grand Bahamas	BWSL Belize	Target
Metered Customers	5%			100%	100%	100%
Consumption (1/capita-day)	377	162	101	80	110	<200
Affordability (% of Average Expenditure by Households in the bottom quintile)	0.6%	0.10%				

Sources: Castalia Final Report on the Transformation Process Roadmap, Safege, 2017; Presentation TECHNICAL EXCHANGE National Water Commission, Jamaica 2019; Presentation by Mario Tavera, Project Manager, Miya Bahamas, 2019; WHO/UNICEF Joint Monitoring Program, 2017; Smart Water Analytics, Master Plan for Grand Bahama Utility Company, 2018; CASTALIA (2019); Belize Water Services Ltd., Annual Report (2019).

One of the principles of the National Integrated Water Resources Management Policy guarantees that: "*Potable water of such quality and quantity as to sustain life should be available to all citizens, irrespective of the citizen's ability to pay. This minimum service is a requirement for reasons of public health and environmental condition*."

The Regulated Industries Commission (RIC) is responsible for price setting for the water sector and does so within a regulatory framework that is governed by the Regulated Industries Commission Act No. 26, 1998 (RIC Act). The RIC has a responsibility to ensure that its determination of allowed revenues reflects the utility's efficient costs and that there is maximum efficiency in the management of the utility's resources, to ensure the lowest possible rates to customers and sustainable utility service. It is noted by the RIC that established tariffs are likely to have a disproportionate impact on different customers' ability to pay, thereby giving rise to the issue of affordability of the service to particularly vulnerable customers. The RIC, therefore, considers all existing measures of the government and other agencies that affect affordability and develop strategies to manage affordability issues that arise from its price-setting activities. The RIC uses affordability instruments to protect low-income consumers such as the poverty threshold used to calculate the basic needs utility supply.

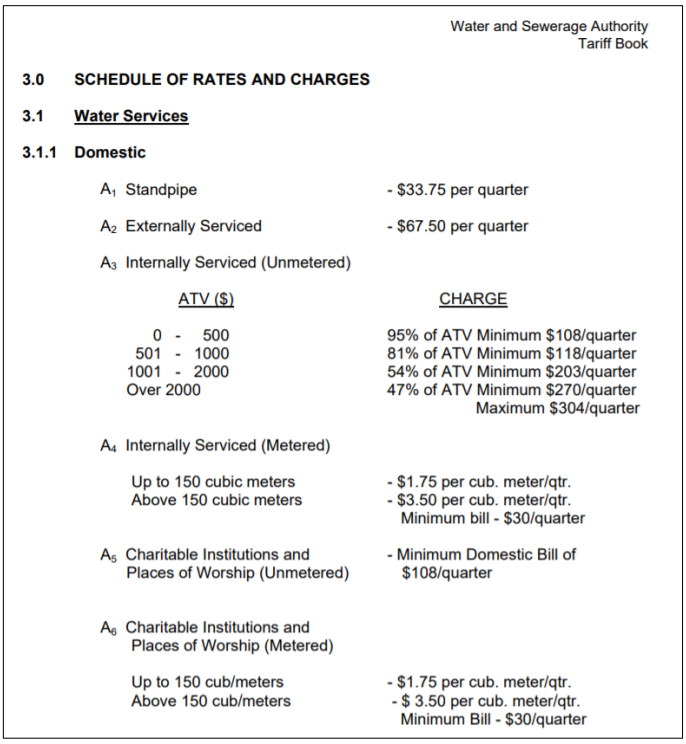
In addition, the Ministry of Public Utilities provides a subsidy programme – the Utilities Assistance Programme (UAP) – aimed at ensuring certain citizens have access to the basic utilities of water and electricity. Specifically targeting the elderly, the poor and vulnerable in underserved areas.

For WASA customers of the Bill Assistance Component the subsidy applies to the following:

- A_2 customers, that is, persons with an external water supply, will receive a credit of TT$140.00 per year; and
- A_3 or A_4 customers, that is, persons with an internal water supply, non-metered and metered, will receive a credit of TT$200.00 per year.

Eligible applicants for this subsidy include persons receiving Senior Citizens' Pension, Disability or Public Assistance Grant, or Trinidad and Tobago Food Card; low-income pensioners over 65 years, who receive a monthly income equal to or less than TT$5,000, inclusive of the pension; and low-income persons with a certified disability.

The Water Tanks Assistance Component provide a one-time assistance of a water tank and fittings to eligible low income households and community-based facilities who earn a monthly income equal to or less than $7,000 that are with or without an adequate supply of pipe borne water supply of 72 hours of less per week. The UAP also comprises of the T&TEC Bill Assistance Component and the Solar Panel Assistance Component.



Water and Sewerage Authority
Tariff Book

3.0 SCHEDULE OF RATES AND CHARGES

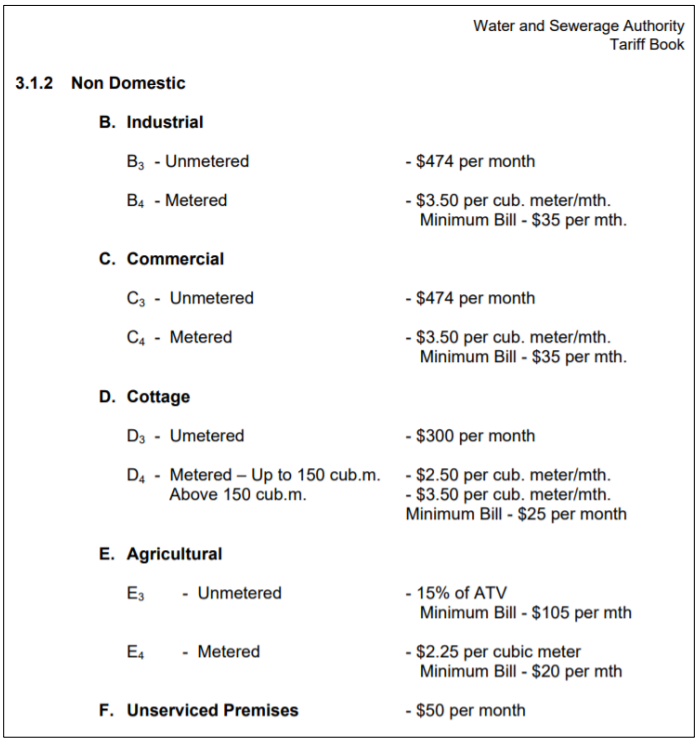
3.1 Water Services

3.1.1 Domestic

A_1 Standpipe	- $33.75 per quarter
A_2 Externally Serviced	- $67.50 per quarter
A_3 Internally Serviced (Unmetered)	

ATV ($)	CHARGE
0 - 500	95% of ATV Minimum $108/quarter
501 - 1000	81% of ATV Minimum $118/quarter
1001 - 2000	54% of ATV Minimum $203/quarter
Over 2000	47% of ATV Minimum $270/quarter Maximum $304/quarter

A_4 Internally Serviced (Metered)	
Up to 150 cubic meters	- $1.75 per cub. meter/qtr.
Above 150 cubic meters	- $3.50 per cub. meter/qtr. Minimum bill - $30/quarter
A_5 Charitable Institutions and Places of Worship (Unmetered)	- Minimum Domestic Bill of $108/quarter
A_6 Charitable Institutions and Places of Worship (Metered)	
Up to 150 cub/meters	- $1.75 per cub. meter/qtr.
Above 150 cub/meters	- $ 3.50 per cub. meter/qtr. Minimum Bill - $30/quarter



Water and Sewerage Authority
Tariff Book

3.1.2 Non Domestic

B. Industrial	
B_3 - Unmetered	- $474 per month
B_4 - Metered	- $3.50 per cub. meter/mth. Minimum Bill - $35 per mth.
C. Commercial	
C_3 - Unmetered	- $474 per month
C_4 - Metered	- $3.50 per cub. meter/mth. Minimum Bill - $35 per mth.
D. Cottage	
D_3 - Umetered	- $300 per month
D_4 - Metered – Up to 150 cub.m.	- $2.50 per cub. meter/mth.
Above 150 cub.m.	- $3.50 per cub. meter/mth. Minimum Bill - $25 per month
E. Agricultural	
E_3 - Unmetered	- 15% of ATV Minimum Bill - $105 per mth
E_4 - Metered	- $2.25 per cubic meter Minimum Bill - $20 per mth
F. Unserviced Premises	- $50 per month

Figure 5-48: Water Tariff Structure Extracted from WASA's Tariff Book, 1993 Revised 2008

5.3.2.7 Economic activity

Just over 60%of the businesses registered as of 2008 were located within the municipalities over which the project area extends, with the highest proportion based in Tunapuna/Piarco, followed by

Couva/Tabaquite/Talparo (Table 5.15). The types of enterprises featured were similar among the project area municipalities with businesses concentrated largely in the Distribution (i.e. retail) sector followed by the Personal Service sector and the Finance, Insurance, Real Estate and Business Services sector.

Table 5.15: Businesses in Operation by Municipality

Municipality	Proportion
Arima	3.7%
Chaguanas	5.8%
Couva/Tabaquite/Talparo	11.4%
Diego Martin	8.1%
Mayaro /Rio Claro	2.4%
Penal/Debe	5.6%
Point Fortin	1.6%
Port of Spain	19.4%
Princes Town	4.3%
San Fernando	7.5%
San Juan/Laventille	10.8%
Sangre Grande	3.4%
Siparia	4.2%
Tunapuna/Piarco	11.7%
Total	100.0%

Source: Central Statistical Office Business Register 2008

The 2011 labour participation rates for the population within the project area are less than the national average of 61.3% (Table 5.16). Apart from Couva/Tabaquite/Talparo, Penal/Debe and Tunapuna/Piarco, the average unemployment rate for the project area communities grouped by municipality was also higher than the national average of 5.1%, with the unemployment rate for communities in the Borough of Point Fortin as high as 10.6%.

Table 5.16: Labour Force and Unemployment Rates of Affected Population within the Project Area by Municipality

Municipality	Labour Force	Labour Force Participation Rate (%)	Unemployed	Unemployment Rate (%)	Outside labour force (%)
Borough of Arima	8,067	58.7	505	6.3	41.3
City of San Fernando	4,092	52.0	272	6.6	48.0
Couva/Tabaquite/Talparo	16,809	55.9	744	4.4	44.1
Diego Martin	5,406	58.2	443	8.2	41.8
Penal/Debe	5,210	53.0	230	4.4	47.0
Borough of Point Fortin	2,641	51.2	281	10.6	48.8
Princes Town	17,669	51.4	1,192	6.7	48.6
Sangre Grande	16,320	57.1	1,098	6.7	42.9
Siparia	11,675	53.4	933	8.0	46.6
Tunapuna/Piarco	16,090	45.5	782	4.9	54.5
Total Project Area	103,981	53.0	6,482	6.2	47.0

Source: Trinidad and Tobago 2011 Population and Housing Census, CSO

5.3.2.8 Poverty and Vulnerability

The 2005 Report on Survey of Living Conditions for Trinidad and Tobago showed that the relative poverty rate averaged 15.5% of the population, of which 1.2% was food poor (indigent). Another 9.0% of the population was vulnerable to poverty. This figure ranged from 4.5% (in Arima) to 39.1% (in Sangre Grande).

The incidence of poverty varied widely across the municipalities containing the project areas (Figure 5-49). Less than 15% of the municipal population of Penal/Debe, the City of San Fernando, the Borough of Arima, Diego Martin, Tunapuna/Piarco and Couva/Tabaquite/Talparo are below the poverty line. Whereas the poverty rate amounted to surpassed 25% in Sangre Grande, Princes Town, Siparia and the borough of Point Fortin. Given the large population size of the project area, 70.8% of the country's poor population is located in the impacted ten municipalities.

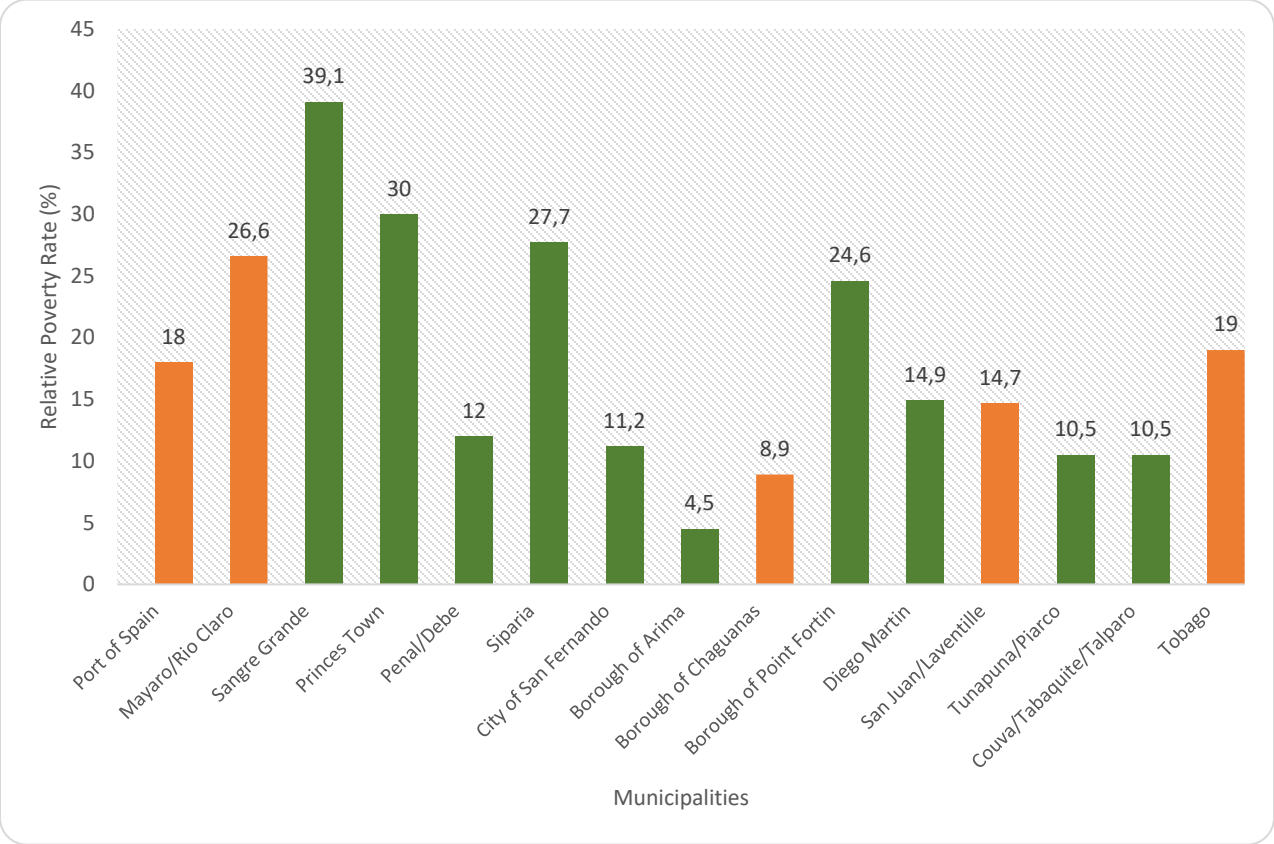


Figure 5-49: Distribution of the Poor as a Percentage of Total Population

Source: Report on Survey of Living Conditions in Trinidad and Tobago, 2005

(Green Bars represent the Municipalities in the Project Area)

Table 5.17: Estimated Poor Population in the Project Area

By Municipality	Relative Poverty per 100 persons (%)	Total Population, 2011	Estimated Poor Population	The proportion of the Poor Population (%)
Borough of Arima	4.5	33,404	1,503	0.8
City of San Fernando	11.2	48,635	5,447	2.8
Couva/Tabaquite/Talparo	10.5	178,160	18,707	7.4
Diego Martin	14.9	102,340	15,249	7.9
Penal/Debe	12	89,342	10,721	3.7
Borough of Point Fortin	24.6	20,161	4,960	2.2
Princes Town	30	102,369	30,711	11.2
Sangre Grande	39.1	75,605	29,562	9.6
Siparia	27.7	86,898	24,071	15.1
Tunapuna/Piarco	10.5	212,825	22,347	10.1
Project Area	-	949,739	163,278	70.8
Trinidad and Tobago	16.7%	1,322,546	220,865	100.0

Source: Report on Survey of Living Conditions in Trinidad and Tobago, 2005

The degree of poverty within the communities can be gauged from the poverty scores derived from a number of household-level indicators provided in the Report on the 2005 Survey of Living Conditions of Trinidad and Tobago. This score is calculated using the results of indicators collected in the 2000 Population and Housing Census. Some of the country's poorest communities (e.g., Los Iros/Erin) and richest communities (Goodword Gardens) were located in the project area (Table 5.17 and Figure 5-50). Most project communities were positioned within the richer half of communities in the country when community poverty scores were ranked, particularly in the borough of Arima, Couva/Tabaquite/Talparo, Diego Martin, Tunapuna/Piarco and the City of San Fernando. However, within the borough of Point Fortin, Sangre Grande and Siparia project communities were more likely to be ranked within the poorer half nationally. The highest incidence of poverty tended to be among large-sized households. Female-headed households were more likely to be poor than male-headed households, and poor women represented 38.8% of the working poor. The poor tended to have lower educational attainment and were heavily concentrated in elementary occupations among men, and low-level services and sales among women. Children, youths, older adults (the elderly), and persons with disabilities were also identified as vulnerable groups.

Figure 5-50: Percentage Population Below the Poverty Line By Regional Corporations
Source: Report on Survey of Living Conditions in Trinidad and Tobago, 2005

5.3.2.9 Security and Safety

Six of the nine police divisions of the Trinidad and Tobago Police Service (TTPS) are responsible for law and order in the project areas. The project communities in the northern region of Penal/Debe and all project communities in the Princes Town and the city of San Fernando fall under the jurisdiction of the Southern police division. Project communities in the neighbouring municipality of Point Fortin and Siparia, in addition to the southern communities in Penal/Debe, are under the purview of the South Western Police Division. Communities in east Trinidad, and by extension Sangre Grande and environs, fall within the Eastern Police Division. Couva/Tabaquite/Talparo is covered by the Central Police Division while the Northern Police Division has jurisdiction over the target communities in Arima and Tunapuna/Piarco. Lastly, the Western Police Division has authority over project communities within the municipality of Diego Martin. Each police division has a divisional headquarters (San Fernando, Siparia, Sangre Grande, Chaguanas, St. Joseph and St. James) and between 5 to 12 police stations or posts dispersed throughout to provide policing services.

Trinidad and Tobago Fire Service facilities are much less numerous compared to facilities dedicated to the police service. In total, 17 fire stations and 3 division headquarters are positioned across 3 divisions to provide efficient and effective public fire protection and emergency services. The Northern Division is the

largest with 10 fire stations along the East-West corridor from Diego Martin to Arima and a headquarters in the city of Port of Spain. The Southern Division has 3 fire stations in Princes Town, Rio Claro and Siparia and a headquarters in the city of San Fernando. The central division has stations posted in Couva, California and Piarco with its divisional headquarters located in Chaguanas.

Crimes in Trinidad and Tobago are categorized as major crimes [3] and minor crimes.[4] Figure 5-51 and Figure 5-52 show major and minor crimes in Trinidad and Tobago between 1990 and 2013. A significant proportion of the reported crimes occur in the project area.

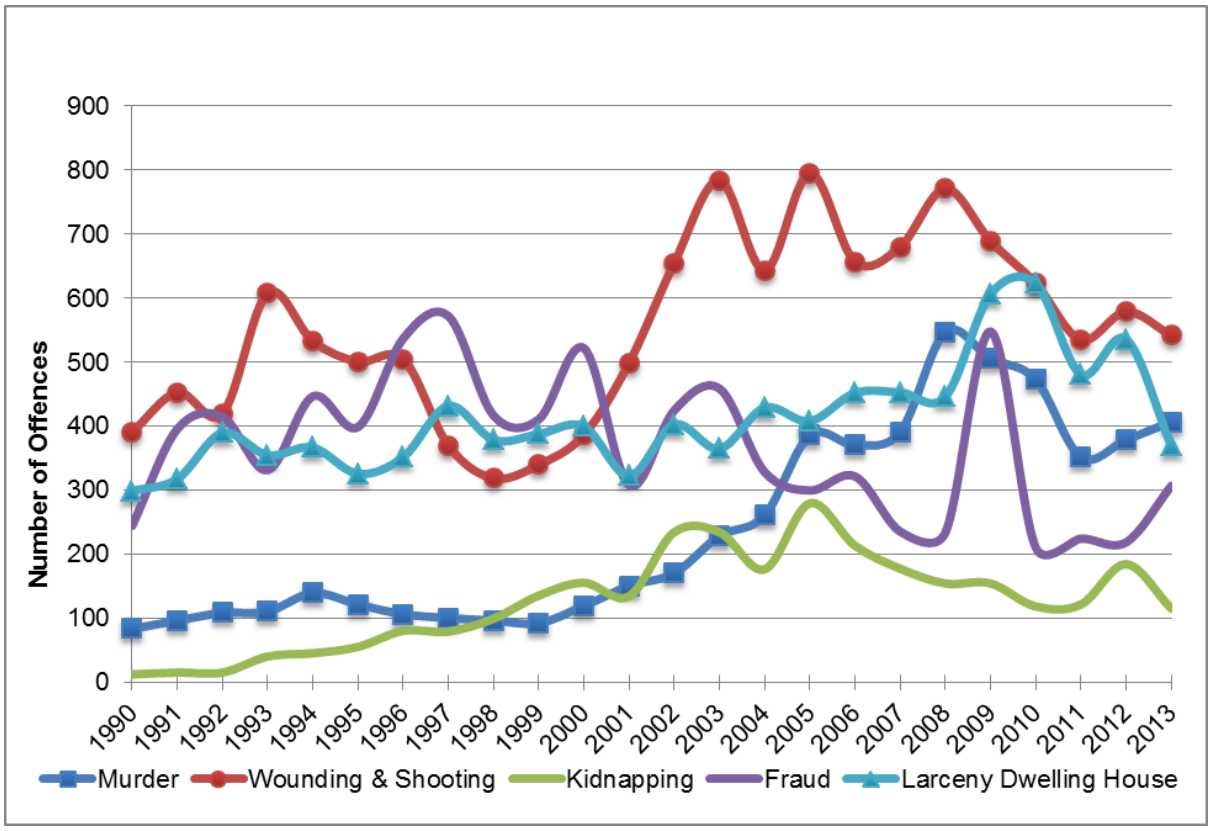


Figure 5-51: Reported Major Crimes in Trinidad and Tobago, 1990-2013 (Source: Crime and Problem Analysis Branch of the Trinidad and Tobago Police Service)

[3] Major crimes include murder, woundings and shootings, rape, incest, serious indecency, kidnapping, burglaries and break-ins, robbery, fraud that exceeds $TT 2000, larceny that exceeds $TT 2000, larceny of motor vehicles, larceny in dwelling houses when the value of the goods stolen exceeds $TT 2000, and narcotics offences beyond a specified quantity.

[4] Minor crimes include indecent assault, assault on police and peace officers, possession of housebreaking implements, embezzlement, false pretence, fraud that is less than $TT 2000, larceny that is less than $TT 2000, larceny in dwelling houses in which the value of the goods stolen is less than $TT 2000, praedial larceny, unlawful possession of goods (i.e., goods that one does not own), malicious wounding, possession of firearms and ammunition, possession of narcotics in which the quantity is less than a specified amount, and possession of apparatus that may be used for the consumption of illegal drugs.

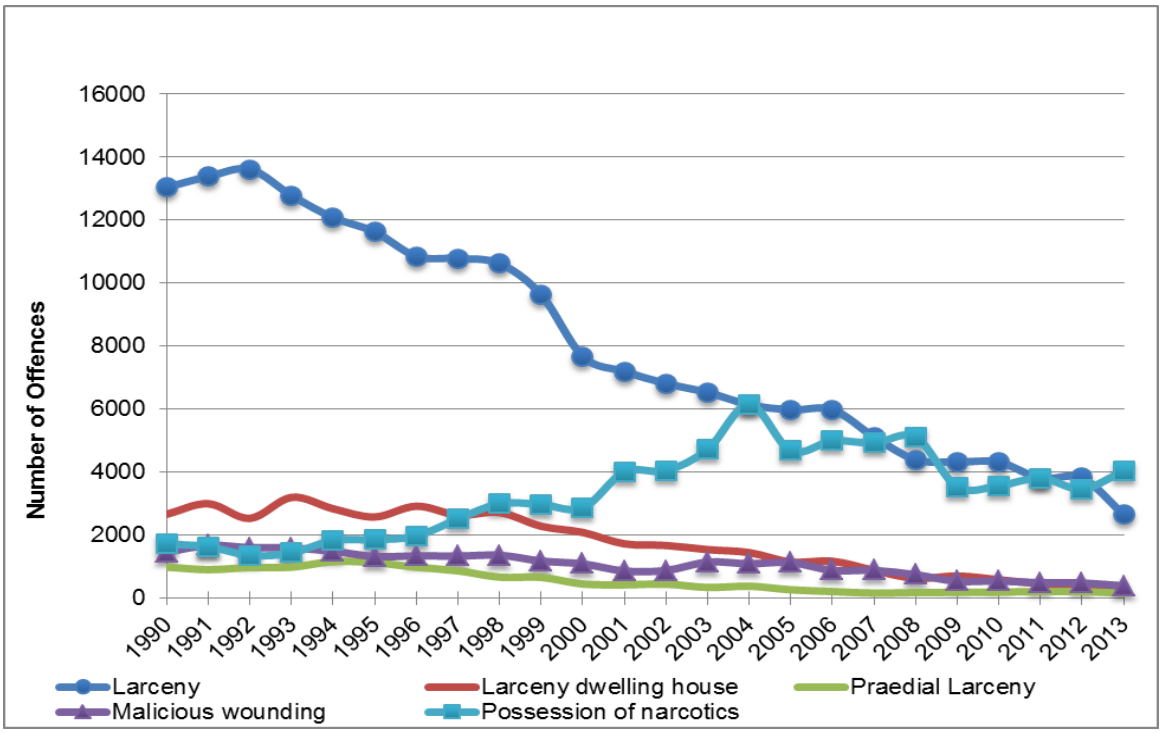


Figure 5-52: Reported Minor Crimes in Trinidad and Tobago, 1990-2013 (Source: Crime and Problem Analysis Branch of the Trinidad and Tobago Police Service)

Between 1990 and 2013, there were 5,805 murders in Trinidad and Tobago, the majority of which occurred in the Port of Spain Police Division (25%), the Northern Division (19.3%), North Eastern Division (13.2%), and Western Division (11.3%). A similar trend is associated with the incidence of gangs and gang violence. The majority of the reported 10,141 domestic violence crimes were assault and beatings (51.1%), followed by threats (28%). Of these, 72.3 per cent of all domestic violence cases, the victims were female and 27.7 per cent were male. Some 8.4 per cent of all murders were because of domestic violence (Crime and problem Branch of the Trinidad and Tobago Police Service 1990 to 2013 data).

From 1990 to 2013 there was an annual average of 553 woundings and shootings, with the average rising to 593.6 per year during the last five years of the period. From 2000 to 2013, the largest proportion of woundings and shootings occurred in the Port of Spain Division (24.4%), Northern Division (17.4%), and Southern Division (11.7%). For the period 1990 to 2013, there was an average of 1,083 malicious woundings per year, with the average decreasing to 559 per year during the last five years of the period. During the last five years of the period, the majority of malicious woundings occurred in the Southern Division (23%), followed by the Central Division (13.7%) and the Northern Division (12.7%) (Crime and problem Branch of the Trinidad and Tobago Police Service 1990 to 2013 data).

5.3.2.10 Health Services

The organisation and delivery of public health services for the project area population are administered by the North West Regional Health Authority (NWRHA), the North Central Regional Health Authority, the Eastern Regional Health Authority (ERHA) and the South West Regional Health Authority (SWRHA). The target communities in Princes Town, Penal/Debe, Point Fortin, San Fernando, Siparia and several from Couva/Tabaquite/Talparo, approximately half of the target population, utilise healthcare facilities and

services in the SWRHA. The NCRHA is another significant health authority as it delivers healthcare to project communities in Arima, Tunapuna/Piarco and most in Couva/Tabaquite/Talparo. The NWRHA is responsible for health services in project communities in Diego Martin while the ERHA is the authority tasked with administering health services in Sangre Grande area.

Each regional health authority provides primary, secondary and tertiary health services through a number of hospitals, district health facilities and health, extended care and outreach centres. The SWRHA is responsible for the administration and management of 2 hospitals, 3 district health facilities, 33 health, outreach and extended care centres clustered around the population centres in the southwest region. The NCRHA governs the 15 health centres in the primary healthcare clusters located along the East-West corridor from St. Joseph to Arima and in Chaguanas and environs. The authority also provides tertiary and/or secondary healthcare through the Eric Williams Medical Science Complex, the Mount Hope Women's Hospital and the Caura Hospital. The ERHA has one hospital located in Sangre Grande and 3 of their 15 health centres are found in project communities. The NWRHA provides primary and secondary health care services through 26 health centres and 3 hospitals located along the main transportation routes in the region. Tertiary healthcare services are also offered by NWHA facilities such as the St. James Medical Complex (specialising in cancer care), St Ann's Hospital (psychiatric care) and the Port of Spain General Hospital. There are also several private hospitals, clinics and specialised medical providers found in the NWHA.

The universal healthcare system in Trinidad and Tobago operates in a two-tier fashion where the primary tier is the public sector that provides basic medical services through the regional authorities and the secondary tier is the private sector which offers persons with adequate funds the ability to obtain medical services that go beyond the coverage provided by the publicly financed sector. The private health sector is smaller and includes a variety of private health care providers, such as physicians, dentists, pharmacists, opticians, etc., along with private health care facilities, e.g., private hospitals and nursing homes, clinical laboratories and diagnostic testing facilities. However, private facilities are still not capable of handling serious illnesses, injuries, as well as long term care. There are only four private medical hospitals in Trinidad and Tobago including nursery homes, located in either city of Port of Spain or San Fernando.

5.3.2.11 Community Development, Recreation and Sporting Facilities

Availability, accessibility and nature of sporting facilities and recreational spaces are related to the urban character of the region. Generally sporting and recreation grounds and parks in populated areas of urban municipalities are limited. In Diego Martin residents visit Port of Spain for outdoor sporting activities and recreation. The natural environment in Chaguaramas is also a source of recreation for families and 0individuals in Diego Martin. The populations of the borough of Arima and the city of San Fernando have access to indoor sports complexes and stadia for recreational activity given that they only have a few public fields and parks. In contrast, there are facilities for the popular sports of cricket and football in most of the major population concentrations of Tunapuna/Piarco (95 recreation grounds and play parks), Sangre Grande (45 recreation grounds and play parks), Penal/Debe (36 recreational grounds and parks), Princes Town (42 recreation grounds and play parks) and Point Fortin (19 recreational grounds and parks). In Couva/Tabaquite/Talparo there are public grounds in most communities. Moreover, several of these municipalities (Couva/Tabaquite/Talparo, Point Fortin and Siparia), as centres of sports tourism and sporting incubators, have adequate facilities to host major regional or national sporting events.

Apart from municipalities that have major cultural events (San Fernando, Point Fortin and Siparia), regions lack major public cultural facilities. Where private facilities are available, they are heavily utilised. However, there are some 240 community centres dispersed across the counties that contain the project communities, with the most (46) located in the country of Victoria. In addition, most communities have privately owned locations, such as bars, for recreation and entertainment.

5.3.2.12 Heritage and Cultural Resources

The National Trust of Trinidad and Tobago is responsible for formally listing any monument, fossil, place or site of natural beauty or national, historic, scientific or archaeological interest which is important to the country's national heritage. Once listed, a site is protected under the National Trust of Trinidad and Tobago Act 1991 against any unauthorised change, alteration, damage, injury, or defacement. Before a site is listed it is added to the Heritage Asset Register. Currently, there are 42 listed sites and 450 registered sites on the Heritage Asset Register nationally. There are 38 heritage sites within the project areas with more than 5 found in the municipalities of Diego Martin, Sangre Grande and Princes Town.

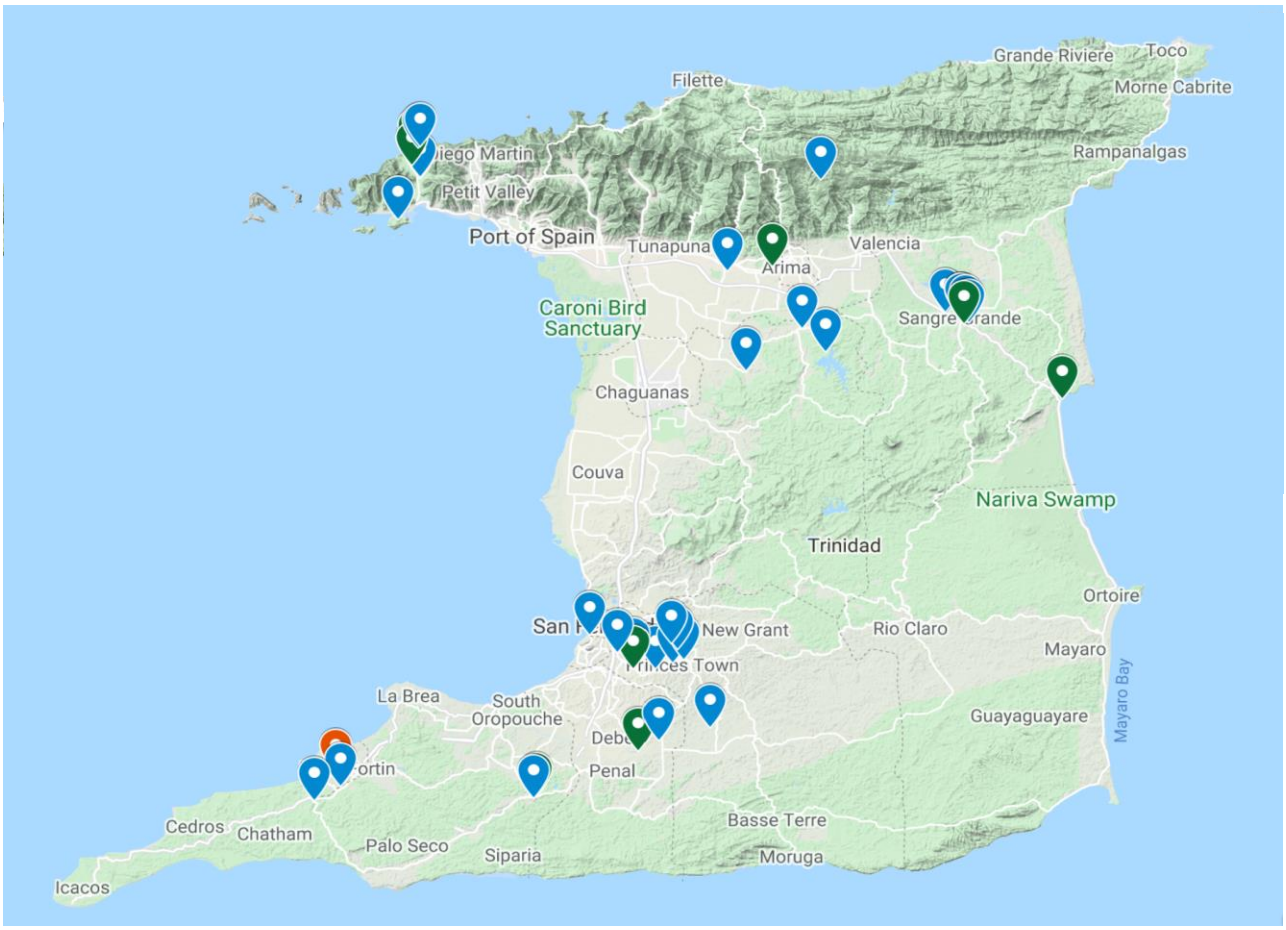


Figure 5-53: Map of Cultural and Natural Heritage Sites in Project Area

The map above shows the known historical and cultural resources but there are instances where unidentified locations have been unearthed when development projects are being implemented. It is not likely that the project will affect the known cultural resources. However, even on established sites where new projects have been implemented new artefacts have been found. The impacts and mitigation measures are further presented in Table 5.18.

Table 5.18: Listed Heritage Sites and Heritage Assets in Project Area by Municipality

Municipality	Registered Asset		
	Natural	Cultural	Mixed
Borough of Arima	-	-	-
City of San Fernando		Rodriguez Building	
Couva/Tabaquite/ Talparo		Doon Pundit Tomb Arena Historical Site/Amerindian mission of San Francisco de los Arenales Haunted Tomb/ San Raphael's Mystery Tomb	
Diego Martin	Edith Falls Bamboo Cathedral Tucker Valley	Point Gourde Battery Positions St. Chad Church Tracking Station Tunnel Factory Tunnel	
Penal/Debe	Digity Mud Volcano	Scale House Hanuman Temple/ Shree Pavan Putra Hanuman Shiv Shakti Mandir	
Point Fortin		WWII Military Base Bunker Concrete Sculptor Samuel Waldrond/ Samuel Waldron Sculptures	La Fortunee Dam
Princes Town	Ste. Madeleine Pond	Ramleela Site Islamic Mosque Glenroy Tunnel/Malgretoute Railway Tunnel Iere Village Islamic Mosque/ASJA Mosque St. Stephen's AC Church and Pouis Trees	

Municipality	Registered Asset		
	Natural	Cultural	Mixed
		Holocaust Monument/African Holocaust Memorial Park Ste. Madeleine Sugar Factory	
Sangre Grande	Central Forest Reserve The Cocal	Morton Memorial Presbyterian Church Railway Turnstile Old Fire Station (demolished) Old Sangre Grande Post Office* Old Warden's Office (demolished) St. Mary Magdaline Anglican Church	
Siparia	Erin Bouffe	Daisy Voisin Tomb	
Tunapuna/Piarco	Cleaver Woods/ Cleaver Woods Recreational Park	Spanish Jail Cells Aripo Cocao Estate/ Aripo Cottage Eco Resort	

*Listed site

Source: The National Trust of Trinidad and Tobago, 2021

6 IMPACT ASSESSMENT AND PROPOSED MITIGATION MEASURES

This section presents an assessment of the potential environmental and social impacts using a framework approach for the three components of the first operation for the TT Water Supply Program during construction and operation. It also proposes mitigation measures to reduce the possible negative impacts based on the available information. The detailed mitigation measures, however, are included in the Environmental and Social Management Plan (ESMP) which is a separate deliverable. The analysis considers the physical, ecological and socio-economic impacts of the components as outlined below:

- Component 1. Water Stabilization and Improvement: (US$44 Million)
- Component 2. Support for Water Sector Transformation Plan: (US$2.74 Million)
- Component 3. Network Optimisation (US$31 Million)
- Project management and other costs (US$2.26 Million).

The ESA assesses the probability and magnitude of impacts from project activities on the receiving physical environment, ecological resources and social environment broken down to a project phase basis. The various activities within each phase are then analysed and impacts evaluated based on their probability, magnitude, duration, reversibility and net positive or negative impact.

6.1 CONSTRUCTION PHASE

The Construction Phase of the project considers all three components listed above. Further details are included in the ESMP.

Table 6-1: Impacts, Proposed Mitigation Measures, Management Plans and Responsible Party for the Construction Phase of the Activities in the First Operation

RISKS	PROBABILITY OF IMPACT	POTENTIAL IMPACTS	DIRECTION OF IMPACT	PERMANENCE	MAGNITUDE OF IMPACT	IMPACT DURATION	PROPOSED MITIGATION MEASURES	MANAGEMENT PLANS REQUIRED	RESPONSIBLE PARTY
PHYSICAL ENVIRONMENT									
Soil erosion Soil stripping and the clearing of trees and vegetation during construction preparation and excavation creates unprotected soils that are prone to erosion when disturbed. Erosion is primarily associated with the construction of intake structures and the installation of pipelines. Compaction of topsoil from construction activities can increase rates of runoff and impact water flow patterns leading to downstream erosion.	High	Soil erosion can lead to loss of topsoil, blocked drains from sedimentation and water pollution. Erosion can also lead to the deterioration of riverbanks.	Negative	Reversible	Minor	Medium	• Only clear topsoil from areas to be used. • Place berms around stockpiles of topsoil and aggregate (sand, gravel, etc.) • Avoid steep cuts and where there are steep cuts, they must be shored. • Utilise sediment traps to minimise sediment runoff. • Replant trees in affected areas of the project site or other areas. • Construction vehicles must be restricted to designated paths and must not be allowed to drive all over the cleared site. • Compacted soils should be routinely ripped during construction until they are revegetated	Environmental Health and Safety Management Plan Contractor Management Plan	Implementing Agency Contractor

RISKS	PROBABILITY OF IMPACT	POTENTIAL IMPACTS	DIRECTION OF IMPACT	PERMANENCE	MAGNITUDE OF IMPACT	IMPACT DURATION	PROPOSED MITIGATION MEASURES	MANAGEMENT PLANS REQUIRED	RESPONSIBLE PARTY
							after construction is complete. • Proper implementation and/or enforcement of the National Physical Development Plan (1984) and the National Spatial development Strategy for T & T (2014); the National Forests Policy (2011), the National Protected Areas Policy (2011) and the Upper Watersheds Management Plans; the National Environmental Act and The National Environmental Policy; the Waterworks and Water Conservation Act (2016)		
Soil contamination Leaks and spills of fuel from vehicles and machinery, misuse and spillage of hazardous substances such as paint and chlorine and improper management of waste can pollute soil during construction activities.	Low	Soil contamination can result in poor soil quality and could potentially contaminate shallow groundwater in construction areas and adjacent surface water sources	Negative	Reversible	Minor	Medium Term	General • Environmental conditions must be included in any construction contract, thereby making contractors accountable for preventing accidental spillages. • Effective implementation, monitoring and enforcement of the National Environmental	Environmental Health and Safety Management Plan Contractor Management Plan	Implementing Agency Contractor

RISKS	PROBABILITY OF IMPACT	POTENTIAL IMPACTS	DIRECTION OF IMPACT	PERMANENCE	MAGNITUDE OF IMPACT	IMPACT DURATION	PROPOSED MITIGATION MEASURES	MANAGEMENT PLANS REQUIRED	RESPONSIBLE PARTY
Soil contamination is likely to occur during the chemical treatment stage of well rehabilitation, which involves the use of chlorine and acid for disinfection, and during well drilling operations which utilise drilling additives.							Policy, and the National Pollution Rules by the Environmental Authority. Fuel Spills and Leaks • Conduct preventive maintenance for vehicles and machinery to ensure integrity and reliability and reduce/avoid leaks. • Conduct any on-site repairs on impervious surfaces. Chemicals and Hazardous Substances • Ensure proper handling, use and storage of all chemical and hazardous waste according to best practices. ○ Provide spill containment and clean-up equipment on site. ○ Personnel handling chemicals and hazardous substances must be trained in the use of spill prevention measures.		

RISKS	PROBABILITY OF IMPACT	POTENTIAL IMPACTS	DIRECTION OF IMPACT	PERMANENCE	MAGNITUDE OF IMPACT	IMPACT DURATION	PROPOSED MITIGATION MEASURES	MANAGEMENT PLANS REQUIRED	RESPONSIBLE PARTY
							○ Personnel handling chemicals and hazardous substances must be provided with and 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. ○ Store fuel, chemicals, and hazardous substances with secondary (spill) containment infrastructure. Use spill prevention		

RISKS	PROBABILITY OF IMPACT	POTENTIAL IMPACTS	DIRECTION OF IMPACT	PERMANENCE	MAGNITUDE OF IMPACT	IMPACT DURATION	PROPOSED MITIGATION MEASURES	MANAGEMENT PLANS REQUIRED	RESPONSIBLE PARTY
							measures such as drip trays during refuelling, bunds around storage tanks, etc. to capture spills and contain any leaks ○ 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 or stored in designated, lined and bunded areas. ○ Any spilling incidents must be reported as soon as possible.		
Land pollution The inert and hazardous solid waste	Medium	Land pollution can lead to soil contamination and water	Negative	Reversible	Minor	Short to Medium term	• Contain garbage and construction debris onsite until disposal at the	Environmental Health and Safety	Contractor Implementing Agency

RISKS	PROBABILITY OF IMPACT	POTENTIAL IMPACTS	DIRECTION OF IMPACT	PERMANENCE	MAGNITUDE OF IMPACT	IMPACT DURATION	PROPOSED MITIGATION MEASURES	MANAGEMENT PLANS REQUIRED	RESPONSIBLE PARTY
generated from construction activities and the poor housekeeping practices of construction staff is inappropriately disposed of and/ or accumulates on the construction site.		pollution. Additionally, land pollution can negatively impact the visual aesthetics at and near the construction site.					approved municipal disposal site. • Prohibit burning of solid waste on project sites. • Create green areas and/or plant trees around the perimeter of the site to act as a visual screen if possible. • Implement waste management sub-plan during the construction phase. • Effective implementation, monitoring and enforcement of National Environmental Policy, and the National Pollution Rules, action by the Environmental Authority	Management Plan Contractor Management Plan	
Water pollution Surface water contamination is associated with polluted or sediment-laden runoff entering surrounding watercourses. Groundwater contamination	Low/Medium	Water pollution can cause the deterioration of the quality of local water resources.	Negative	Reversible	Moderate	Short to Medium Term	General • Environmental conditions must be included in any construction contracts, thereby making contractors accountable for preventing accidental spillages • Effective implementation, monitoring and	Environmental Health and Safety Management Plan Grievance Mechanism Consultation Plan	Implementing Agency Contractor

RISKS	PROBABILITY OF IMPACT	POTENTIAL IMPACTS	DIRECTION OF IMPACT	PERMANENCE	MAGNITUDE OF IMPACT	IMPACT DURATION	PROPOSED MITIGATION MEASURES	MANAGEMENT PLANS REQUIRED	RESPONSIBLE PARTY
(particularly of unconfined aquifers) results from polluted surface runoff, inappropriate disposal of solid waste and sewage, and fuel or chemical leaks and residue contamination which can occur during the drilling and rehabilitation of wells scheduled during the construction phase of component 1.							enforcement of the Water Conservation Act, effective implementation, monitoring and enforcement of the Public Health Ordinance, enforcement of the National Pollution Rules Fuel Spills and Leaks • Conduct preventive maintenance for vehicles and machinery to ensure integrity and reliability and reduce/avoid leaks • Conduct any on-site repairs on impervious surfaces. • Where possible vehicles and equipment should be located more than 50 meters away from surface waters. If this is not possible, safety measures should be implemented to prevent water pollution, especially within the construction site.	Contractor Management Plan	

RISKS	PROBABILITY OF IMPACT	POTENTIAL IMPACTS	DIRECTION OF IMPACT	PERMANENCE	MAGNITUDE OF IMPACT	IMPACT DURATION	PROPOSED MITIGATION MEASURES	MANAGEMENT PLANS REQUIRED	RESPONSIBLE PARTY
							Chemicals and Hazardous Substances • Ensure proper handling, use and storage of all chemical and hazardous waste according to best practices: o Provide spill containment and clean-up equipment on site. o Personnel handling chemicals and hazardous substances must be trained in the use of spill prevention measures. o Personnel handling chemicals and hazardous substances must be provided with and trained in the correct use of the appropriate Personal Protective Equipment (PPE) o Utilise the proper dispensing equipment		

RISKS	PROBABILITY OF IMPACT	POTENTIAL IMPACTS	DIRECTION OF IMPACT	PERMANENCE	MAGNITUDE OF IMPACT	IMPACT DURATION	PROPOSED MITIGATION MEASURES	MANAGEMENT PLANS REQUIRED	RESPONSIBLE PARTY
							○ 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. ○ Store fuel, chemicals, and hazardous substances with secondary (spill) containment infrastructure. Use spill prevention measures such as drip trays during refuelling, bunds around storage tanks, etc. to capture spills and contain any leaks ○ Clean up any spills (including existing spills) immediately,		

RISKS	PROBABILITY OF IMPACT	POTENTIAL IMPACTS	DIRECTION OF IMPACT	PERMANENCE	MAGNITUDE OF IMPACT	IMPACT DURATION	PROPOSED MITIGATION MEASURES	MANAGEMENT PLANS REQUIRED	RESPONSIBLE PARTY
							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 or stored in designated, lined and bunded areas ○ Any spilling incidents must be reported as soon as possible • Instal roofing over potentially polluting sites if possible. • All potential pollutants should be removed immediately after the completion of works. • Wash down equipment in a wastewater containment area or a suitably designed and		

RISKS	PROBABILITY OF IMPACT	POTENTIAL IMPACTS	DIRECTION OF IMPACT	PERMANENCE	MAGNITUDE OF IMPACT	IMPACT DURATION	PROPOSED MITIGATION MEASURES	MANAGEMENT PLANS REQUIRED	RESPONSIBLE PARTY
							operated washdown facility to prevent residues, particularly from well drilling activities, from entering watercourses. Sewage • Implement the management of contaminated wastewater generated from construction camps Sediment Laden Runoff • If the site allows and discharge volumes are large, temporary lagoons and settling ponds can be constructed to contain wastewater and polluted groundwater. Settling ponds can be used to allow all suspended solids to settle before any liquid is released, provided there are no harmful substances in solution.		

RISKS	PROBABILITY OF IMPACT	POTENTIAL IMPACTS	DIRECTION OF IMPACT	PERMANENCE	MAGNITUDE OF IMPACT	IMPACT DURATION	PROPOSED MITIGATION MEASURES	MANAGEMENT PLANS REQUIRED	RESPONSIBLE PARTY
							• Utilise filtering devices such as sediment fences to remove suspended solids to reduce turbidity. • Perform equipment washdown inside a wastewater capture area or on a grassed area free from waterlogging or flooding. The capture area should be level and not be within 50m of the bank of any watercourse or naturally occurring sinkhole.		
Air pollution During component 1, construction activities, fugitive dust and emissions from increased vehicular traffic, heavy-duty equipment, piling of construction material and excavation may impact local air quality.	High	Air pollution can lead to negative health impacts for construction workers and local communities (i.e., respiratory conditions).	Negative	Reversible	Moderate	Short Term	General • Effective implementation, monitoring and enforcement of National Environmental Policy, and the National Pollution Rules, action by the Environmental Authority • Record complaints and relevant responses Fugitive dust • Cover haulage vehicles transporting aggregate, soil and cement	Environmental Health and Safety Management Plan Grievance mechanism Consultation Plan Contractor Management Plan	Contractor Implementing Agency

RISKS	PROBABILITY OF IMPACT	POTENTIAL IMPACTS	DIRECTION OF IMPACT	PERMANENCE	MAGNITUDE OF IMPACT	IMPACT DURATION	PROPOSED MITIGATION MEASURES	MANAGEMENT PLANS REQUIRED	RESPONSIBLE PARTY
							• 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 stockpiling/storage and disposal of solid waste • Wet cleared land areas regularly • Wet dust suppression methods on unsealed roads must be implemented to prevent the 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		

RISKS	PROBABILITY OF IMPACT	POTENTIAL IMPACTS	DIRECTION OF IMPACT	PERMANENCE	MAGNITUDE OF IMPACT	IMPACT DURATION	PROPOSED MITIGATION MEASURES	MANAGEMENT PLANS REQUIRED	RESPONSIBLE PARTY
							• Revegetate cleared areas immediately following construction to prevent loose soil from being blown away Emissions • Operate well-maintained vehicles and equipment • All earth-moving vehicles and equipment must be regularly maintained to ensure their integrity and reliability. • Construction vehicles and machinery shall not be left to idle when not in use. • Maintain all generators, vehicles, and other equipment in good working order to minimise exhaust fumes • Limit the use of roads in populated areas		
Noise and vibration pollution Noise and vibrations propagated from construction equipment and pre-	High	Noise and vibration pollution can be a nuisance and have negative health impacts (i.e., hearing	Negative	Reversible	Moderate	Short Term	• Provide workers with the necessary PPE e.g., hearing protection and ensure that they are worn • Sensitize residents in the area to the types of activities that will take	Environmental Health and Safety Management Plan	Contractor Implementing Agency

RISKS	PROBABILITY OF IMPACT	POTENTIAL IMPACTS	DIRECTION OF IMPACT	PERMANENCE	MAGNITUDE OF IMPACT	IMPACT DURATION	PROPOSED MITIGATION MEASURES	MANAGEMENT PLANS REQUIRED	RESPONSIBLE PARTY
construction and construction operations during component 1 may exceed background noise.		impairment, discomfort, etc.) on construction staff and the local population. Noise and vibration pollution can also affect fauna, especially birds, inhabiting areas adjacent to construction areas.					place ahead of the works and assign a liaison person with whom the residents can relate • Ensure project activities are scheduled during working hours of 8:00 a.m. to 8:00 p.m. • Maintain all equipment in proper working order to avoid excessive noise generation • As much as possible, use low vibration equipment, especially near old buildings and heritage sites • If complaints regarding noise are received from residents, consider installing partial screening around the noisiest activities and/or mufflers on noisy equipment • Limit implementation of simultaneous noisy works • Schedule works in front of hospitals, schools, places of worship and administrative buildings to occur quickly	Grievance Mechanism Consultation Plan Contractor Management Plan	

RISKS	PROBABILITY OF IMPACT	POTENTIAL IMPACTS	DIRECTION OF IMPACT	PERMANENCE	MAGNITUDE OF IMPACT	IMPACT DURATION	PROPOSED MITIGATION MEASURES	MANAGEMENT PLANS REQUIRED	RESPONSIBLE PARTY
							• Frequently change personnel that are employed for noisy works • In case of complaints, they should be recorded, and appropriate action should be taken. • Effective implementation, monitoring and enforcement of National Environmental Policy, and the National Pollution Rules, action by the Environmental Authority		
Flooding Soil stripping and the clearing of trees and vegetation during construction can make flooding more likely and more severe, especially in flood-prone areas.	Low	Flooding can damage houses, buildings and roads and lead to soil erosion, sedimentation, and surface water pollution. Flooding can also be the cause of landslides. Traffic could also be affected.	Negative	Irreversible	Major	Short Term	• Only clear topsoil from areas to be used. • Avoid steep cuts and where there are steep cuts, they must be shored. • Replant trees in affected areas of the project site or other areas. • Ensure an emergency preparedness and response plan is in place to cover man-made and natural hazards. Workers must be trained in the requirements of the	Environmental Health and Safety Management Plan	Contractor

RISKS	PROBABILITY OF IMPACT	POTENTIAL IMPACTS	DIRECTION OF IMPACT	PERMANENCE	MAGNITUDE OF IMPACT	IMPACT DURATION	PROPOSED MITIGATION MEASURES	MANAGEMENT PLANS REQUIRED	RESPONSIBLE PARTY
							emergency preparedness and response plan. • Proper implementation and/or enforcement of the National Physical Development Plan (1984) and the National Spatial development Strategy for T & T (2014); the National Forests Policy (2011), the National Protected Areas Policy (2011); the National Environmental Act and The National Environmental Policy; • Implement Construction Best Practices • As much as possible works should be undertaken in the dry season.		
Landslides Soil made unstable by soil stripping and the clearing of trees and vegetation during construction can increase the likelihood and/or severity of landslides.	Low	Landslides can lead to further soil erosion, sedimentation, water pollution and can damage property, houses, buildings and roads.	Negative	Irreversible	Major	Short term	• Only clear topsoil from areas to be used. • Avoid steep cuts and where there are steep cuts, they must be shored. • Replant trees in affected areas of the project site or other areas. • Ensure an emergency preparedness and	Environmental Health and Safety Management Plan	Contractor

RISKS	PROBABILITY OF IMPACT	POTENTIAL IMPACTS	DIRECTION OF IMPACT	PERMANENCE	MAGNITUDE OF IMPACT	IMPACT DURATION	PROPOSED MITIGATION MEASURES	MANAGEMENT PLANS REQUIRED	RESPONSIBLE PARTY
							response plan is in place to cover man-made and natural hazards. Train workers according to the requirements of the emergency preparedness and response plan. • Proper implementation and/or enforcement of the National Physical Development Plan (1984) and the National Spatial development Strategy for T & T (2014); the National Forests Policy (2011), the National Protected Areas Policy (2011) and the Upper Watersheds Management Plans; the National Environmental Act and The National Environmental Policy; • Implement Construction Best Practices. • As much as possible works should be undertaken in the dry season.		

RISKS	PROBABILITY OF IMPACT	POTENTIAL IMPACTS	DIRECTION OF IMPACT	PERMANENCE	MAGNITUDE OF IMPACT	IMPACT DURATION	PROPOSED MITIGATION MEASURES	MANAGEMENT PLANS REQUIRED	RESPONSIBLE PARTY
ECOLOGICAL ENVIRONMENT									
Disruption of/ damage to ecosystems Component 1 involves preparation and construction activities that can impact terrestrial and aquatic ecosystems, particularly activities that can result in soil disruption, soil erosion, soil and surface water contamination, and noise pollution. Also, if water resources are unmanaged and result in a reduction in environmental water this will result in the disruption/loss of ecologically sensitive systems sensitive flora and fauna in Rivers	Medium	Soil disruption, soil erosion, soil and surface water contamination, noise pollution and placement of structures can lead to a full or partial loss of habitat, habitat fragmentation, loss of functionality, loss of biodiversity and wildlife migration	Negative	Partially irreversible	Moderate	Long Term	General • Conduct an environmental assessment to identify project -specific risks and impacts and recommend additional mitigation measure to reduce risks identified. • Effective implementation, monitoring and enforcement of National Environmental Policy, and the National Pollution Rules, the National Biodiversity Policy, action by the Environmental Authority • Effective implementation, monitoring and enforcement of the Water Conservation Act, effective implementation, monitoring and enforcement of the Public Health Ordinance, enforcement of the National Protected Areas	Environmental Health and Safety Management Plan	Implementing Agency

RISKS	PROBABILITY OF IMPACT	POTENTIAL IMPACTS	DIRECTION OF IMPACT	PERMANENCE	MAGNITUDE OF IMPACT	IMPACT DURATION	PROPOSED MITIGATION MEASURES	MANAGEMENT PLANS REQUIRED	RESPONSIBLE PARTY
and Swamp ecosystems.							Policy. Soil disruption and erosion • Replant trees in the same area of the project site or other areas. Exotic vegetation managed and affected sites should be replanted or rehabilitated with indigenous grass species. • Avoid indiscriminate habitat destruction and localise the proposed development as much as possible (including support areas and services). • Control erosion through the utilization of silt traps, silt fencing, Gabions, etc. This is especially pertinent within areas of steeper gradients. Soil and surface water contamination • Ensure that proper handling, use and storage		

RISKS	PROBABILITY OF IMPACT	POTENTIAL IMPACTS	DIRECTION OF IMPACT	PERMANENCE	MAGNITUDE OF IMPACT	IMPACT DURATION	PROPOSED MITIGATION MEASURES	MANAGEMENT PLANS REQUIRED	RESPONSIBLE PARTY
							of all chemicals are done according to best practices. • Have spill containment and clean-up equipment on-site and dispose of waste per best practices. • Do not store fuel and chemicals near or at watercourses or water bodies. • Report and clean accidental spills immediately. • Contaminated soils must be removed and disposed of at a registered disposal site. • Properly maintain and service equipment • Refuelling should not be done within the riparian zones. Noise pollution • Limit animal disruptive activities to short time frames		

RISKS	PROBABILITY OF IMPACT	POTENTIAL IMPACTS	DIRECTION OF IMPACT	PERMANENCE	MAGNITUDE OF IMPACT	IMPACT DURATION	PROPOSED MITIGATION MEASURES	MANAGEMENT PLANS REQUIRED	RESPONSIBLE PARTY
SOCIO-ECONOMIC ENVIRONMENT									
Institutional conflict Conflicts arising from inadequate communication and coordination between implementing agency and the Municipal Corporation	Moderate	Scheduling clashes and poor working relationships between implementing agency and stakeholder agencies	Negative	Reversible	Moderate	Medium to Long Term	Establish a formal system to inform, coordinate and reduce conflicts that may arise in conducting project works and planned municipal activities.	Social Management Plan	Implementing agency Contractor
Under-representation of Women in the Project Workforce Women are less likely to actively seek employment or be hired to undertake project construction works because traditionally construction is perceived as 'men's work.' This is changing gradually with regard to professional jobs with more women graduating with civil engineering degrees. However, there is still	Moderate	Temporary local employment opportunities are only beneficial for men seeking employment in the unskilled and semi-skilled categories; Low employment opportunities for women.	Negative	Reversible	Minor	Short Term	As part of the Implementing 's agency contractual arrangements with the construction contractor, encourage the contractor to maximise local employment opportunities and to work with the local communities (and their leaders) in establishing a fair and transparent system for local worker recruitment. Inform the Division of Community Development, the Institute of Technology (MIC) – Multi-Sector Skills Training Programme (MuST), and the Regional Corporations of the types of job opportunities that will be available through the Project to	Social Management Plan Grievance Mechanism Consultation Plan	Implementing Agency Contractor

RISKS	PROBABILITY OF IMPACT	POTENTIAL IMPACTS	DIRECTION OF IMPACT	PERMANENCE	MAGNITUDE OF IMPACT	IMPACT DURATION	PROPOSED MITIGATION MEASURES	MANAGEMENT PLANS REQUIRED	RESPONSIBLE PARTY
low participation of women in semi-skilled and unskilled areas in the industry.							influence the types of semi-skilled training programmes offered in the Project area during pre-construction and construction phases. Emphasis should be placed on training women as well as men to improve their recruitment perspectives for semi-skilled positions. Take steps to ensure that qualified women are afforded equal access to job opportunities from the Project (linked to the first mitigation measure).		
Employment Generation Professional, skilled and unskilled personnel will be employed throughout the design and construction works in Components 1 and 3	High	This could lead to improved living conditions and quality of life for the residents in these communities.	Positive	Reversible	High	Short Term	Prioritize the hiring of local workers Avoid discrimination in employment through establishment of social policies and guidelines to which contractors responsible for hiring, will need to adhere. Provide training opportunities and jobs for young people.	Social Management Plan	Implementing Agency Contractor

RISKS	PROBABILITY OF IMPACT	POTENTIAL IMPACTS	DIRECTION OF IMPACT	PERMANENCE	MAGNITUDE OF IMPACT	IMPACT DURATION	PROPOSED MITIGATION MEASURES	MANAGEMENT PLANS REQUIRED	RESPONSIBLE PARTY
Noise pollution The construction works in Components 1 and 3 may result in generation of noise levels above acceptable ambient noise levels and sounds intensity due to the operation of construction vehicles and equipment.	High	This could have negative health related impacts. Exposure influences will be linked strongly to proximity to construction works, with the greatest effects likely to occur to project workers, and to households and sensitive receptors that are closest to the construction works. Sensitive receptors include persons who stay at home during construction hours, pregnant women, children, older adults (the elderly), and persons with pre-existing medical conditions (such as hypertension,	Negative	Reversible	Moderate	Short Term	Continuous monitoring will be necessary. Schedule the hours for construction work to minimise the impact on community. Collaborate with impacted communities and notify of the scheduling of construction activities at least one month in advance of start of construction works in their area.	Environmental Health and Safety Management Plan Grievance Mechanism (These are described in the ESMP)	Implementing Agency Contractor

RISKS	PROBABILITY OF IMPACT	POTENTIAL IMPACTS	DIRECTION OF IMPACT	PERMANENCE	MAGNITUDE OF IMPACT	IMPACT DURATION	PROPOSED MITIGATION MEASURES	MANAGEMENT PLANS REQUIRED	RESPONSIBLE PARTY
		heart conditions, mental disorders)							
Poor Air Quality The construction works in Components 1 and 3 may result in increased dust and exhaust emissions which may impact on local air quality.	High	This could have negative health impacts. Exposure influences will be linked strongly to proximity to construction works, with the greatest effects likely to occur to project workers, and to households and sensitive receptors that are closest to the construction works. Sensitive receptors include persons who stay at home during construction hours, pregnant women, children, and older adults (the elderly), persons with pre-	Negative	Reversible	Moderate	Short Term	Continuous monitoring will be necessary. The parameters to be monitored during construction include PM_{10} and $PM_{2.5}$, NO_2, SO_2, CO and O_3. Frequent wetting and other methods of dust suppression is recommended where digging is taking place. Roads that are used for transportation of materials should be watered to avoid dust emissions. Promote the use of the Grievance Mechanism	Environmental Health and Safety Management Plan Grievance Plan (These are described in the ESMP)	Implementing Agency Contractor

RISKS	PROBABILITY OF IMPACT	POTENTIAL IMPACTS	DIRECTION OF IMPACT	PERMANENCE	MAGNITUDE OF IMPACT	IMPACT DURATION	PROPOSED MITIGATION MEASURES	MANAGEMENT PLANS REQUIRED	RESPONSIBLE PARTY
		existing respiratory conditions.							
Disruption of Community Activities Disruption in normal activities within the affected communities because of Component 1 and 3 construction works	High	Unfavourable changes in traffic patterns, congestion and delays to drivers and commuters. Construction works may disrupt community events and the operation of local businesses by creating nuisance, traffic and restricting parking for and access to businesses. Public notice of construction activities may cause visitors to stay away from affected area, resulting in down	Negative	Reversible	Moderate	Short to Medium Term	Before the start of construction works, develop and distribute an initial project information packet to business owners and community groups/ association. Alert businesses about local construction works two weeks in advance (or a stipulated time frame as agreed between local businesses and the Contractor) and of any changes in the initial scheduling. Promote the use of the Grievance Mechanism	Social Management Plan Consultation Plan Grievance Mechanism Security Management Plan	Implementing Agency Contractor

RISKS	PROBABILITY OF IMPACT	POTENTIAL IMPACTS	DIRECTION OF IMPACT	PERMANENCE	MAGNITUDE OF IMPACT	IMPACT DURATION	PROPOSED MITIGATION MEASURES	MANAGEMENT PLANS REQUIRED	RESPONSIBLE PARTY
		time and the loss of business revenue to owners.							
Community road safety Construction works within communities my disrupt people's walking patterns and create unsafe and risky conditions for pedestrians.	Moderate	Additional traffic generated from construction activities may increase the number of road safety incidents and accidents. Sensitive receptors include children, persons with disabilities and the elderly.	Negative	Reversible	Moderate	Short Term	Implement the use of proper signage; construction vehicle speed limits; training of drivers; maintenance of construction vehicles, and use of traffic wardens. Establish procedures for the transport of equipment and heavy loads, a protocol for reporting vehicle accidents and a log for traffic related incidents. Establish a Project community road safety awareness for residents living close to the road and for workers and a monitoring mechanism to ensure effective implementation of the plan.	Environmental Health and Safety Management Plan Social Management Plan Grievance Mechanism Consultation Plan	Implementing Agency Contractor
Occupational health and safety	High	Minor and major worker injury and death may result from accidental falls, improper	Negative	Reversible	Moderate	Short to Medium term	Comply with national laws and regulations related to the provision of the following:	Environmental Health and Safety Management Plan	Implementing Agency Contractor

RISKS	PROBABILITY OF IMPACT	POTENTIAL IMPACTS	DIRECTION OF IMPACT	PERMANENCE	MAGNITUDE OF IMPACT	IMPACT DURATION	PROPOSED MITIGATION MEASURES	MANAGEMENT PLANS REQUIRED	RESPONSIBLE PARTY
		operation of construction hand-held tools, equipment, vehicular accidents and improper handling and storage of chemicals. Other injuries may result from workers operating equipment without proper care, inadequate training or due to a lack of personal protective equipment or from extended exposure to heat and dehydration from outdoor weather, dust, noise, and vibration.					- Fair compensation and treatment of workers for work done - Equitable and ethical terms and conditions of employment for workers - Safe and acceptable working conditions and standards, including those securing project worker health and safety. - Measures to protect the health and wellbeing all project workers in keeping with national and IDB guidelines to safeguard against the spread of COVID-19. - Measures to ensure gender equality on the project construction sites. Prepare and implement a health and safety plan prior to the start of construction works which takes the following into consideration: - All the necessary measures and maintain acceptable working conditions.	Social Management Plan Grievance Mechanism Consultation Plan	

RISKS	PROBABILITY OF IMPACT	POTENTIAL IMPACTS	DIRECTION OF IMPACT	PERMANENCE	MAGNITUDE OF IMPACT	IMPACT DURATION	PROPOSED MITIGATION MEASURES	MANAGEMENT PLANS REQUIRED	RESPONSIBLE PARTY
							- Informing the employees of the occupational risks and preventative measures that must be taken to address these risks. - Informing workers of their legal rights and obligations and provide them with the necessary training on Project occupational health and safety. - Ensuring all workers have the required personal protective equipment required of them to work on the Project and to regularly monitor to ensure compliance. - Routine checking of health and safety equipment to ensure that they proper functioning. Assigning an officer with responsibility for worker health and safety.		
Land Acquisition During the pre-construction and construction phases to make way for the	Moderate	Loss of employment and livelihoods in the affected communities.	Negative	Reversible	Major	Long term	Develop the site specific Land Acquisition and Compensation Plan in accordance with the Implementing Agency's Land Acquisition and Compensation Strategy	Land Acquisition and Compensation Plan	Implementing agency

RISKS	PROBABILITY OF IMPACT	POTENTIAL IMPACTS	DIRECTION OF IMPACT	PERMANENCE	MAGNITUDE OF IMPACT	IMPACT DURATION	PROPOSED MITIGATION MEASURES	MANAGEMENT PLANS REQUIRED	RESPONSIBLE PARTY
construction works associated with establishment of the water treatment plant or other infrastructure not owned by Water and Sewage Authority (WASA) for example with the drilling of wells in Freeport.								Consultation Plan Grievance Mechanism	
Temporary Economic displacement During the pre-construction and construction phases to make way for the construction works associated with establishment of the water treatment plant or other infrastructure not owned by Water and Sewage Authority (WASA)	Moderate	Loss of livelihoods in the affected communities.	Negative	Reversible	Moderate	Short term	Develop a Livelihood Restoration Plan (LRP) in line with national legislation, OP-710, and international best practice.	LRP	Implementing Agency
Disruption of Water Supply As a result of implementation of	Moderate	The disruption of public water supply to domestic, commercial and	Negative	Reversible	Moderate to Major	Medium Term	Notify impacted communities of the possible disruption of services starting two weeks in advance of construction works.	Social Management Plan	Implementing Agency and Implementing Agency Contractor

RISKS	PROBABILITY OF IMPACT	POTENTIAL IMPACTS	DIRECTION OF IMPACT	PERMANENCE	MAGNITUDE OF IMPACT	IMPACT DURATION	PROPOSED MITIGATION MEASURES	MANAGEMENT PLANS REQUIRED	RESPONSIBLE PARTY
Components 1 and 3 construction works		industrial customers may affect routine activities and events. Sensitive receptors will include schools, hospitals, health centres, day care facilities, elderly care facilities, etc.					Provision of truck-borne water supply to sensitive receptors, as needed	Grievance Mechanism Consultation Plan	
Health and Safety Hazards to Affected Communities	Moderate	Minor and major injury and possible death due to both accidental and natural hazards, especially in cases where structural elements or components of the project are accessible to affected community members or where failure could result in	Negative	Reversible	Moderate	Short Term	Use of proper signage and safeguards to protect the public in case of authorized and unauthorized entry on the site to the highest extent possible. Inform affected community of the potential hazards at or around a construction site, and measures in place to protect against these hazards Establish proper protocol for the reporting and handling of worksite accidents.	Environmental Health and Safety Management Plan Grievance Mechanism Consultation Plan	Implementing Agency Contractor

RISKS	PROBABILITY OF IMPACT	POTENTIAL IMPACTS	DIRECTION OF IMPACT	PERMANENCE	MAGNITUDE OF IMPACT	IMPACT DURATION	PROPOSED MITIGATION MEASURES	MANAGEMENT PLANS REQUIRED	RESPONSIBLE PARTY
		injury to the community.							
Damage to private property As a result of the conduct of Components 1 and 3 construction works	Moderate	There may be property loss and damage, asset loss and/or economic loss by private landowners, businesses, and leaseholders/ renters Disruption to other utility infrastructure and services due to damage	Negative	Reversible	Minor	Medium term	Provide compensation for loss of assets (property – land and structures) to private landowners (persons with legal rights to land or recognisable claims under Trinidad and Tobago law, such as letters of comfort) and persons occupying property Promote the use of the grievance mechanism plan to address project related complaints and issues Promptly repair any damage to vital infrastructure and services in consultation with, or by the service provider.	Social Management Plan Security Management Plan	Implementing Agency Contractor
Damage to or destruction of cultural and historical heritage resources As a result of the implementation of Components 1 and 3 construction works	Moderate	Loss of sites/ artifacts of cultural and historical value close to or within the boundaries of the project sites, for example, The Blue Basin River,	Negative	Irreversible	High	Long term	Design project activities taking care to avoid recorded site locations. In cases where it is suspected that resources may be in the project area of disturbance but are not specifically located, collaborate with the National	Environmental Health and Safety Management Plan	Implementing Agency and Implementing Agency's Contractor

RISKS	PROBABILITY OF IMPACT	POTENTIAL IMPACTS	DIRECTION OF IMPACT	PERMANENCE	MAGNITUDE OF IMPACT	IMPACT DURATION	PROPOSED MITIGATION MEASURES	MANAGEMENT PLANS REQUIRED	RESPONSIBLE PARTY
due to the on-site works and people and vehicle traffic.		particularly in cases of laying of new pipelines. Visual modification of landscapes.					Trust/Archaeological Committee in identifying their exact locations. In the case of the unearthing of unknown sites during construction, the following sequence of activities should be followed: • Suspend works in the vicinity of the discovery and allow for assessment of materials and location by the National Trust/Archaeological Committee before further construction activities can be taken. • Notify the Trust and collaborate with them in organizing the assessment materials and location and, if proven significant, in determining a plan of action for their preservation. • Include clauses in the contract document for contractors specifying actions and responsibilities if discoveries are made, including sensitising workers about		

RISKS	PROBABILITY OF IMPACT	POTENTIAL IMPACTS	DIRECTION OF IMPACT	PERMANENCE	MAGNITUDE OF IMPACT	IMPACT DURATION	PROPOSED MITIGATION MEASURES	MANAGEMENT PLANS REQUIRED	RESPONSIBLE PARTY
							these actions and against theft of any discovered materials.		

6.2

6.3 OPERATION PHASE

The following table presents the main impacts of the different components of the project and some possible mitigation measures. Further details including are included in the Environmental and Social Management Plan which is a separate deliverable.

Table 6-2: Impacts, Proposed Mitigation Measures, Management Plans and Responsible Party for the Operational Phase of the Activities in the First Operation

RISKS	PROBABILITY OF IMPACT	POTENTIAL IMPACTS	DIRECTION OF IMPACT	PERMANENCE	MAGNITUDE OF IMPACT	IMPACT DURATION	PROPOSED MITIGATION MEASURES	MANAGEMENT PLANS REQUIRED	RESPONSIBLE PARTY
PHYSICAL ENVIRONMENT									
Soil contamination Leaks and spills of fuel from vehicles and machinery; misuse and spillage of hazardous substances such as paint and chlorine; and improper management of waste can pollute soil during maintenance activities.	Low	Soil contamination can result in poor soil quality and could potentially contaminate shallow groundwater in areas adjacent to maintenance activities and adjacent surface waters.	Negative	Partially Reversible	Moderate	Short to Medium Term	Fuel Spills and Leaks • Conduct preventive maintenance for vehicles and machinery to ensure integrity and reliability and reduce/avoid leaks • Conduct any on-site repairs on impervious surfaces. Chemicals and Hazardous Substances • Ensure proper handling, use and storage of all chemical and hazardous waste according to best practices ○ Provide spill containment and cleanup equipment on site ○ Personnel handling chemicals and hazardous substances must be trained in the use of spill prevention measures ○ Personnel handling chemicals and hazardous substances must be trained in the correct use of the appropriate Personal Protective Equipment (PPE) ○ Utilise the proper dispensing equipment	Environmental Health and Safety Management Plan Contractor Management Plan	Water & Sewerage Authority

RISKS	PROBABILITY OF IMPACT	POTENTIAL IMPACTS	DIRECTION OF IMPACT	PERMANENCE	MAGNITUDE OF IMPACT	IMPACT DURATION	PROPOSED MITIGATION MEASURES	MANAGEMENT PLANS REQUIRED	RESPONSIBLE PARTY
							○ 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. ○ Store fuel, chemicals, and hazardous substances with secondary (spill) containment infrastructure. Use spill prevention measures such as drip trays during refuelling, bunds around storage tanks, etc. to capture spills and contain any leaks ○ 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 or stored in designated, lined and bunded areas		

RISKS	PROBABILITY OF IMPACT	POTENTIAL IMPACTS	DIRECTION OF IMPACT	PERMANENCE	MAGNITUDE OF IMPACT	IMPACT DURATION	PROPOSED MITIGATION MEASURES	MANAGEMENT PLANS REQUIRED	RESPONSIBLE PARTY
							• Any spilling incidents must be reported as soon as possible		
Water pollution Surface water and groundwater contamination can result from fuel or chemical leaks, particularly from the damage of equipment, and the entry of eroded sediment into surrounding watercourses during the maintenance phase. Over abstraction of surface water can lead to contaminated/ polluted	Low	Water pollution can cause the deterioration of the quality of local water resources.	Negative	Reversible	Moderate	Short to Medium Term	Fuel Spills and Leaks • Conduct preventive maintenance for vehicles and machinery to ensure integrity and reliability and reduce/avoid leaks • Conduct any on-site repairs on impervious surfaces. • Where possible vehicles and equipment should be located more than 50 meters away from surface waters. If this is not possible, permanent control and safety measures should be implemented to prevent water pollution Chemicals and Hazardous Substances • Ensure proper handling, use and storage of all chemical and hazardous waste according to best practices ○ Provide spill containment and clean-up equipment on site ○ Personnel handling chemicals and hazardous substances must be trained in the use of spill prevention measures	Environmental Health and Safety Management Plan	WASA

RISKS	PROBABILITY OF IMPACT	POTENTIAL IMPACTS	DIRECTION OF IMPACT	PERMANENCE	MAGNITUDE OF IMPACT	IMPACT DURATION	PROPOSED MITIGATION MEASURES	MANAGEMENT PLANS REQUIRED	RESPONSIBLE PARTY
surface water depending on the discharges to the surface source. Over-extraction of groundwater can also lead to a degradation of water quality stemming from a reduction in baseflow contributions. Over abstraction of groundwater in coastal aquifers can also lead to saltwater intrusion. Any associated land-use changes can lead to increased sediment-laden runoff and also results in a loss							○ Personnel handling chemicals and hazardous substances must be trained in the correct use of the appropriate Personal Protective Equipment (PPE) ○ Utilise the proper dispensing equipment ○ Storage areas must be well marked with appropriate signage. ○ 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. ○ Store fuel, chemicals, and hazardous substances with secondary (spill) containment infrastructure. Use spill prevention measures such as drip trays during refuelling, bunds around storage tanks, etc. to capture spills and contain any leaks ○ Clean up any spills (including existing spills) immediately, through containment and removal of product and		

RISKS	PROBABILITY OF IMPACT	POTENTIAL IMPACTS	DIRECTION OF IMPACT	PERMANENCE	MAGNITUDE OF IMPACT	IMPACT DURATION	PROPOSED MITIGATION MEASURES	MANAGEMENT PLANS REQUIRED	RESPONSIBLE PARTY
of valuable habitats and associated biodiversity which protects against erosion and sediment runoff.							appropriate rehabilitation or disposal of contaminated soils ○ All hazardous waste must be disposed of at a registered hazardous waste disposal facility or stored in designated, lined and bunded areas ○ Any spilling incidents must be reported as soon as possible • Wash down equipment in a wastewater containment area or a suitably designed and operated washdown facility to prevent residues from entering watercourses. Sediment-laden Runoff • Utilise filtering devices such as sediment fences to remove suspended solids to reduce turbidity.		
Noise and vibration pollution Noise and vibrations propagated	Low/Medium	Noise and vibration pollution can be a nuisance and have negative health impacts (i.e., hearing impairment, discomfort, etc.) on	Negative	Reversible	Moderate	Short term	• Provide workers with the necessary PPE e.g., hearing protection and ensure that they are worn • Sensitize residents in the area to the types of activities that will take place ahead of the maintenance	Environmental Health and Safety Management Plan Grievance mechanism	Water & Sewerage Authority

RISKS	PROBABILITY OF IMPACT	POTENTIAL IMPACTS	DIRECTION OF IMPACT	PERMANENCE	MAGNITUDE OF IMPACT	IMPACT DURATION	PROPOSED MITIGATION MEASURES	MANAGEMENT PLANS REQUIRED	RESPONSIBLE PARTY
from maintenance and repair operations may exceed background noise.		maintenance staff and the local population. Noise and vibration pollution can also affect fauna, especially birds, inhabiting areas.					works and assign a liaison person with whom the residents can relate. • Ensure maintenance activities are scheduled during working hours of 8:00 a.m. to 8:00 p.m. • Maintain all equipment in proper working order to avoid excessive noise generation • If complaints regarding noise are received from residents, consider installing partial screening around the noisiest activities and/or mufflers on noisy equipment • Limit implementation of noisy works simultaneously • Frequently change of personnel that are employed for noisy works • In case of complaints, they should be recorded, and appropriate action should be taken. • As much as possible, use low vibration equipment, especially near old buildings and heritage sites • Schedule for works in front of hospitals, schools, places of worship and administrative buildings to occur quickly		
Over Extraction of water	Low	Excessive extraction of groundwater can lead to saltwater intrusion	Negative	Irreversible	Major	Long Term	Abstraction should not be greater than the sustainable yield of the aquifer	Environmental Health and Safety Management Plan	Water Resources Agency- Water &

RISKS	PROBABILITY OF IMPACT	POTENTIAL IMPACTS	DIRECTION OF IMPACT	PERMANENCE	MAGNITUDE OF IMPACT	IMPACT DURATION	PROPOSED MITIGATION MEASURES	MANAGEMENT PLANS REQUIRED	RESPONSIBLE PARTY
resources Excessive pumping can reduce stream flow and mine the groundwater storage.		and possible aquifer mining, and potential depletion. Excessive groundwater extraction can also lead to a reduction in the baseflow in streams and therefore reduced availability of surface water. This can mean reduced surface water for water supply and more contaminated/ polluted water where there are discharges to the surface sources. This can also lead to perennial streams becoming intermittent and intermittent streams becoming more ephemeral; reduction in water available to support nearby water supply and ecology; and lead to increased sensitivity to the impacts of climate change. Over-extraction could also force competition between public water					Sustainable Yield Determinations for aquifers Sustainable Yield Determinations for surface water resources. This should consider the variation of stream based on dry and wet seasons and guide WASA on appropriate abstraction rates for surface water resources during dry and wet seasons.		Sewerage Authority

RISKS	PROBABILITY OF IMPACT	POTENTIAL IMPACTS	DIRECTION OF IMPACT	PERMANENCE	MAGNITUDE OF IMPACT	IMPACT DURATION	PROPOSED MITIGATION MEASURES	MANAGEMENT PLANS REQUIRED	RESPONSIBLE PARTY
		supply and water dependent ecology. Excessive extraction from surface water resources can negatively reduce volume water available for downstream users (domestic, commercial, recreational, cultural) and environmental flows, necessary for the sustenance of the river ecosystems							
Flooding Soil exposed during operation and maintenance activities can make flooding more likely and more severe, especially in flood-prone areas.	Low	Flooding can damage houses, buildings and roads and lead to soil erosion, sedimentation, and surface water pollution. Traffic could also be affected.	Negative	Partially irreversible	Moderate	Short to Medium term	• Ensure an emergency preparedness and response plan is in place to cover man-made and natural hazards. Workers must be trained in the requirements of the emergency preparedness and response plan. • Proper implementation and/or enforcement of the National Physical Development Plan (1984) and the National Spatial development Strategy for T & T (2014); the National Forests Policy (2011), the National Protected Areas Policy (2011) and the Upper Watersheds Management Plans; the National Environmental Act	Environmental Health and Safety Management Plan Consultation Plan Grievance Mechanism	Implementing Agency

RISKS	PROBABILITY OF IMPACT	POTENTIAL IMPACTS	DIRECTION OF IMPACT	PERMANENCE	MAGNITUDE OF IMPACT	IMPACT DURATION	PROPOSED MITIGATION MEASURES	MANAGEMENT PLANS REQUIRED	RESPONSIBLE PARTY
							and The National Environmental Policy • Conduct maintenance work during the dry season		
Landslides Soil exposed during operation and maintenance activities can make landslides more likely and more severe.	Low	Landslides can lead to further soil erosion, sedimentation, water pollution and can damage property, houses, buildings, and roads.	Negative	Partially Irreversible	Moderate	Short term	• Ensure an emergency preparedness and response plan is in place to cover man-made and natural hazards. Workers must be trained in the requirements of the emergency preparedness and response plan. • Proper implementation of the National Physical Development Plan (1984) and the National Spatial development Strategy for T & T (2014); the National Forests Policy (2011), the National Protected Areas Policy (2011) and the Upper Watersheds Management Plans; the National Environmental Act and the National Environmental Policy; • Conduct maintenance work during the dry season	Environmental Health and Safety Management Plan Contractor Management Plan	Water Resources Agency- Water & Sewerage Authority
Earthquakes Earthquakes can disrupt utilities and damage pipelines. They may also	Medium	Earthquakes can lead to rupture or leaking of pipelines. It may also disrupt electrical utilities which may disrupt water distribution networks and pumps.	Negative	Partially Irreversible	Moderate	Medium term	• Use of flexible pipe joints and penetrations into tanks to prevent breakage from earthquake movements. • All works should be done to local and international building codes and standards where possible.	Environmental Health and Safety Management Plan Contractor Management Plan	Water Resources Agency- Water & Sewerage Authority

RISKS	PROBABILITY OF IMPACT	POTENTIAL IMPACTS	DIRECTION OF IMPACT	PERMANENCE	MAGNITUDE OF IMPACT	IMPACT DURATION	PROPOSED MITIGATION MEASURES	MANAGEMENT PLANS REQUIRED	RESPONSIBLE PARTY
induce landslides.							• Ensure an emergency preparedness and response plan is in place to cover man-made and natural hazards. Workers must be trained in the requirements of the emergency.		
ECOLOGICAL ENVIRONMENT									
Alteration of habitat Soil disruption, soil erosion, soil and surface water contamination and noise pollution during maintenance activities can impact the terrestrial and marine ecosystems.	Low/medium	Soil disruption, soil erosion, soil and surface water contamination and noise pollution can lead to a full or partial loss of habitat, habitat fragmentation, loss of functionality, loss of biodiversity and migration of wildlife.	Negative	Partially irreversible	Moderate	Medium to long term	General • Implementation of the National Environmental Policy, and National Biodiversity Policy Soil disruption and erosion • Replant trees in the same area of the project site or other areas. Exotic vegetation managed and affected sites should be replanted or rehabilitated with indigenous grass species Soil and surface water contamination • Ensure that proper handling, use and storage of all chemicals are done according to best practices • Have spill containment and clean-up equipment on-site and dispose of waste per best practices • Do not store fuel or chemicals near or at watercourses or waterbodies	Environmental Health and Safety Management Plan	Implementing Agency - WASA Contractor

RISKS	PROBABILITY OF IMPACT	POTENTIAL IMPACTS	DIRECTION OF IMPACT	PERMANENCE	MAGNITUDE OF IMPACT	IMPACT DURATION	PROPOSED MITIGATION MEASURES	MANAGEMENT PLANS REQUIRED	RESPONSIBLE PARTY
							• Report and clean accidental spills immediately • Contaminated soils must be removed and disposed of at a registered disposal site. • Properly maintain and service equipment • Refuelling should not be done within the riparian zones Noise pollution • Limit animal disruptive activities to short time frames		
SOCIO-ECONOMIC ENVIRONMENT									
Over abstraction can impact downstream users (domestic, commercial and recreational users)	Moderate-High	Reduced availability and access to water	Negative	Reversible	Moderate-High	Medium to Long Term	Proper Monitoring location to of the stream flow to ensure that the environmental baseflow is sustained and downstream users will still have access.	Environmental Health and Safety Management Plan	Water Resources Agency- Water & Sewerage Authority
Minimisation of non-revenue water	High	Reduction in losses of non-revenue water Better assessment of demand due to metering customers	Positive	Reversible	Major	Long Term	N/A	N/A	N/A
Increased reliability of	High	More reliable water supply and improved	Positive	Reversible	Major	Long Term	N/A	N/A	N/A

RISKS	PROBABILITY OF IMPACT	POTENTIAL IMPACTS	DIRECTION OF IMPACT	PERMANENCE	MAGNITUDE OF IMPACT	IMPACT DURATION	PROPOSED MITIGATION MEASURES	MANAGEMENT PLANS REQUIRED	RESPONSIBLE PARTY
water supply and improved water quality to customers		water quality for the public and TT can meet the SDG goals.							
Improved institutional efficiency of WASA	High	Sustainability in managing the water resources in the project areas. Better customer relations and customer satisfaction	Positive	Reversible	Major	Long Term	N/A	N/A	N/A
Occupational Health and safety	High	Minor and major worker injuries and possible death may result from accidental falls, improper operation of construction hand-held tools, equipment, vehicular accidents and improper handling and storage of chemicals. Other injuries may result from workers operating equipment without proper care, inadequate training or due to a lack of personal protective equipment.	Negative	Reversible	Moderate	Long term	Comply with national laws and regulations related to the provision of the following: - Fair compensation and treatment of workers for work done - Equitable and ethical terms and conditions of employment for workers - Safe and acceptable working conditions, including securing worker health and safety. Prepare and implement a health and safety plan prior to the start of construction works which takes the following into consideration: - All the necessary measures and maintain acceptable working conditions.	Environmental Health and Safety Management Plan Grievance Mechanism	Implementing Agency

RISKS	PROBABILITY OF IMPACT	POTENTIAL IMPACTS	DIRECTION OF IMPACT	PERMANENCE	MAGNITUDE OF IMPACT	IMPACT DURATION	PROPOSED MITIGATION MEASURES	MANAGEMENT PLANS REQUIRED	RESPONSIBLE PARTY
		Minor or major injury to community members during maintenance					- Informing the employees of the occupational risks and preventative measures that must be taken to address these risks. - Informing workers of their legal rights and obligations and provide them with the necessary training on Project occupational health and safety. - Ensuring all workers have the required personal protective equipment required of them to work on the Project and to regularly monitor to ensure compliance. - Routine checking of health and safety equipment to ensure that they proper functioning. Assigning an officer with responsibility for worker health and safety. Use of proper signage and safeguards to protect the public in case of authorized and unauthorized entry on the site to the highest extent possible. Establish proper protocol for the reporting and handling of worksite accidents.		

6.4 CUMULATIVE IMPACTS

In Trinidad and Tobago's National Development Strategy 2016 – 2030 (Vision 2030), two of the five themes that focus and guide the country's transformational agenda to the year 2030 are 'improving productivity through quality infrastructure and transportation' and 'placing the environment at the centre of social and economic development'. The 2020 Roadmap to Recovery report identifies three pillars of development for the medium term that are consistent with the Vision 2030 goals and incorporates the development needs arising from the country's present circumstances. These pillars are transforming the economy, making food security a reality, and leaving no one behind. The 2020 Phase 2 Roadmap Report recommends projects and programmes that involve increasing domestic agricultural production, increasing the number of new homes and expanding and upgrading transport and drainage infrastructure. Indicative of these recovery priorities, the Ministry of Rural Development and Local Government (195) and The Ministry of Works and Transport (64), followed by the Ministry of Agriculture, Land and Fisheries (44), account for the majority of public sector projects for 2022.

When considering the total impact on a resource, ecosystem or human population, cumulative effects are the successive, incremental or combined impact from actions associated with the proposed project when added to other existing, planned or reasonably anticipated developments regardless of their nature or the entity. The Water Supply Improvement Program TT-L1055 in Trinidad and Tobago aims to improve the efficiency and quality of potable water and services in Trinidad and Tobago. Accordingly, component 1 of this program finances priority investments in works that stabilise and improve the water supply services in various areas in the nation. Component 3 attempts network optimisation through the reduction of commercial and physical losses, mainly in northwest Trinidad. Impacts from this proposed project are likely to add to or interact with effects from current and future development projects or activities. In this context, it should be noted that a reduction of water losses will actually allow additional water already treated to be provided for water supply and therefore reduce the non-revenue water.

There is potential for cumulative impacts on air quality, ambient noise and vibration levels, and water quality during the construction phase of this project. Simultaneous development projects in the vicinity of the project sites can potentially generate dust, exhaust emission, and hazardous chemicals and compound the proposed project's effects on air quality in the immediate project area. Any noise and vibration pollution within the immediate project areas likely exacerbates the health impact on the construction staff, local population, and wildlife. Additional greenhouse gases and short-lived climate pollutants generated from nearby vehicular traffic and other potential construction activities can increase the country's contribution to climate change, affecting the population and environment at every scale. The clearing of vegetation and potential loss of forest cover/deforestation from other development works can contribute to soil erosion and the associated water pollution experienced in the project areas, furthering the disruption and deterioration of local ecosystems that often lasts well past the construction phase. The resulting cumulative effects on the biological environment can accelerate biodiversity loss and wildlife migration from the project areas.

Estimations by the Water Resources Agency for 2025 put the country's domestic demand at 42.0 percent, while the industrial and agriculture sectors accounted for 26.5 and 2.0 percent, respectively. However, the increasing water demand associated with the anticipated increase in agricultural production, population growth and industrial development will increase demand on water resources and create competition among users and uses. Therefore, an appropriate Governance structure and proper

management of the country's water resources will be needed for effective water allocation among the competing sectors. In addition, land-use changes associated with housing and urban spaces will reduce soil infiltration and limit aquifer recharge as the prevalence of impervious surfaces increases and vegetation cover is removed. Reduced average annual rainfall resulting from climate change will decrease flows in surface water sources/rivers and recharge to aquifers. Furthermore, any current or future projects or activities in the immediate project areas that utilise water during its implementation or operation or interact with the surrounding biological environment are also likely to increase the demand on the water resources and probability of over-extraction. Over-extraction can lead to negatively impacting water quality or saltwater intrusion and possibly groundwater depletion/mining, reducing water availability for domestic consumption and ecological health.

Agriculture contributes to a number of environmental issues that cause environmental degradation including climate change, deforestation, biodiversity loss, irrigation problems, pollutants causing air pollution and water pollution, which can lead to health problems, soil degradation, and waste. The result is that agriculture globally exerts increasing pressure on land and water resources. In countries where agriculture is a major sector, this sector has the largest water demand and is a major source of pollution.

One of the 3 pillars of development transformation identified for Trinidad and Tobago is food security. This is clearly needed and important for the sustainable development of the country therefore, the environmental issues and impacts, which are cumulative with time, must be understood and properly managed to optimise the benefits.

For Tobago, tourism is particularly important for its sustainable development. Tourism also contributes to a number of issues that cause environmental degradation, which are also cumulative with time. These environmental issues include air pollution, water pollution, waste disposal, deforestation, loss of diversity, Global Warming, overpopulation, and ocean acidification. Like agriculture, the environmental issues stemming from tourism must also be understood and properly managed to optimise the benefits and support sustainable development.

7 CONCLUSION

In conclusion, based on the findings of the environmental and social assessment, it is the professional opinion of the Consultants that the project is not likely to result in significant negative environmental impacts. Where there are potential direct negative impacts, these are mostly short-term and reversible and can be mitigated. Once mitigated, the potentially negative physical and ecological impacts highlighted above are significantly minimised. However, it is recommended that a project specific environmental and social impact assessment be conducted for the construction of new water treatment plants/infrastructure particularly within proximity to cultural heritage sites and ecologically sensitive areas.

On the other hand, the project is expected to result in significant positive social impacts associated with the improvement in the supply of water to customers across the twin-island state. There are no anticipated direct negative impacts to any indigenous groups. With the proper implementation of all three components, it is anticipated that persons will be able to get water 24/7 as opposed to the current scheduled system. Additionally, significant improvements in the efficiency at which WASA operates and the ability of being able to properly assess demand with metering infrastructure this will result in improved long-term integrated water resources management, which in the face of climate change will result in the sustainable supply of water to the benefit of all.

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9 APPENDICES

9.1 Appendix 1 – Species List

Caroni Swamp – Species List - Fauna (Source: Meinke, 2018)

BIRDS

Common Name	Scientific Name	Family	Location
Great Blue Heron	*Ardea herodias*	Ardeidae	Caroni Swamp
Great Egret	*Ardea alba*	Ardeidae	Caroni Swamp
Little Egret	*Egretta garzetta*	Ardeidae	Caroni Swamp
Snowy Egret	*Egretta thul*	Ardeidae	Caroni Swamp
Little Blue Heron	*Egretta caerulea*	Ardeidae	Caroni Swamp
Tricolored Heron	*Egretta tricolor*	Ardeidae	Caroni Swamp
Scarlet Ibis	*Eudocimus ruber*	Threskiornithidae	Caroni Swamp
Cattle Egret	*Bubulcus ibis*	Ardeidae	Caroni Swamp
Striated Heron	*Butorides striata*	Ardeidae	Caroni Swamp
Black-crowned Night-Heron	*Nyctanassa nycticorax*	Ardeidae	Caroni Swamp
Boat-billed Heron	*Nycticorax nycticorax*	Cochleariidae	Caroni Swamp
Spoonbills	*Platalea*	Threskiornithidae	Caroni Swamp
Black Vulture	*Coragyps atratus*	Carthartidae	Caroni Swamp
Turkey Vulture	*Cathartes aura*	Carthartidae	Caroni Swamp
American Flamingo	*Phoenicopterus ruber*	Phoenicopteridae	Caroni Swamp
Pearl Kite	*Gampsonyx swainsonii*	Accipitridae	Caroni Swamp
Short-tailed Hawk	*Buteo brachyurus*	Accipitridae	Caroni Swamp
Semipalmated Plover	*Charadrius semipalmatus*	Charadriidae	Caroni Swamp
Black-necked Stilt	*Himantoppus mexicanus*	Recurvirostridae	Caroni Swamp
Greater Yellowlegs	*Tringa melanoleuca*	Scolopacidae	Caroni Swamp
Lesser Yellowlegs	*Tringa flavipes*	Scolopacidae	Caroni Swamp
Spotted Sandpiper	*Actitis macularius*	Scolopacidae	Caroni Swamp
Semipalmated Sandpiper	*Calidris pusilla*	Scolopacidae	Caroni Swamp
Pale-vented Pigeon	*Patagioenas cayennensis*	Columbidae	Caroni Swamp
Greater Ani	*Crotophaga major*	Cuculidae	Caroni Swamp
Green-throated Mango	*Anthracothorax viridgula*	Trochilidae	Caroni Swamp
Green Kingfisher	*Chloroceryle americana*	Alcedinidae	Caroni Swamp
American Pygmy Kingfisher	*Chloroceryle aenea*	Alcedinidae	Caroni Swamp
Straight-billed Woodcreeper	*Dendroplex picus*	Furnariidae	Caroni Swamp
Yellow Warbler	*Dendroica petechia*	Mimidae	Caroni Swamp
Northern Waterthrush	*Parkesia noveboracensis*	Mimidae	Caroni Swamp
Bicolored Conebill	*Conirostrum bicolor*	Thraupidae	Caroni Swamp

Common Name	Scientific Name	Family	Location
White-lined Tanager	*Tachyphonus rufus*	Thraupidae	Caroni Swamp
Blue-black Grassquit	*Volatinia jacarina*	Thraupidae	Caroni Swamp
Red-capped Cardinal	*Paroaria nigrogenis*	Thraupidae	Caroni Swamp
Red-breasted Meadowlark	*Sturnella militaris*	Icteridae	Caroni Swamp

MAMMALS

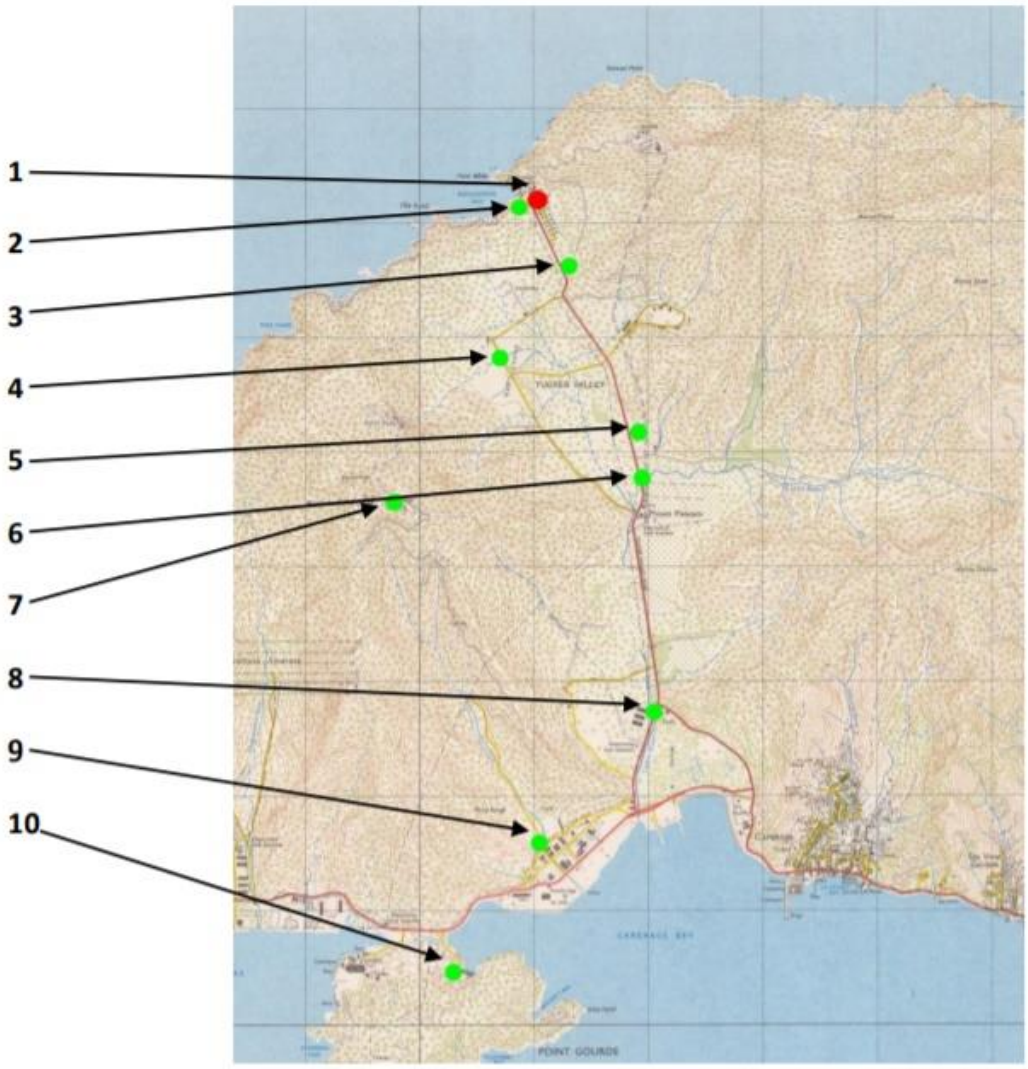
Common Name	Scientific Name	Family	Location
Silky Anteater	*Cyclopes didactylus*	Cyclopedidae	Caroni Swamp

REPTILES

Common Name	Scientific Name	Family	Location
Tropical House Gecko	*Hemidactylus mabouia*	Gekkonidae	Caroni Swamp
Turnip-tail Gecko	*Thecadactylus rapicauda*	Phyllodactylidae	Caroni Swamp

Tucker Valley, BioBlitz (2012) - Sample Locations

Site	Number	Decimal Latitude and Longitude
Basecamp – Macqueripe Bay car park	1	N 10.738447, W -61.617411
Macqueripe Bay to Golf Course Trail Head	2	N 10.738220, W -61.618409
Bamboo Cathedral to Tracking Station Trail Head	3	N 10.732897, W -61.615223
Edith Falls Trail Head	4	N 10.725813, W -61.620362
Samaan Park Trail Head	5	N 10.720353, W -61.609805
Cuesa River upstream site	6	N 10.714017, W -61.609225
End of Morne Catherine Road	7	N 10.714560, W -61.630855
Cuesa River downstream site	8	N 10.698246, W -61.608217
Start of Morne Catherine Road	9	N 10.687071, W -61.617208
Point Gourde Trail	10	N 10.676233, W -61.623816



Tucker Valley, BioBlitz (2012) – Bird Species

Common Name	Scientific Name	Family	Location
Broad-winged Hawk	*Buteo platypterus*	Accipitridae	Morne Catherine Road
Common Black Hawk	*Buteogallus anthracinus*	Accipitridae	Morne Catherine Road
Pearl Kite	*Gampsonyx swainsonii*	Accipitridae	Morne Catherine Road
Plumbeous Kite	*Ictinia plumbea*	Accipitridae	Bamboo Cathedral Road
Short-tailed Hawk	*Buteo brachyurus*	Accipitridae	Morne Catherine Road
White Hawk	*Pseudastur albicollis*	Accipitridae	Morne Catherine Road
Zone-tailed Hawk	*Buteo albonotatus*	Accipitridae	Morne Catherine Road
Short-tailed Swift	*Chaetura brachyura*	Apodidae	Morne Catherine Road
Limpkin	*Aramus guarauna*	Aramidae	Tucker Valley
Cattle Egret	*Bubulcus ibis*	Ardeidae	Macqueripe Bay
Yellow-crowned Night Heron	*Nyctanassa violacea*	Ardeidae	Cuesa River
Common Paraque	*Nyctidromus albicollis*	Caprimulgidae	Morne Catherine Road
White-tailed Nightjar	*Caprimulgus cayennensis*	Caprimulgidae	Cuesa River
Grayish Saltator	*Saltator coerulescens*	Cardinalidae	Tucker Valley
Black Vulture	*Coragyps atratus*	Cathartidae	Morne Catherine Road
Turkey Vulture	*Cathartes aura*	Cathartidae	Morne Catherine Road
Belted Kingfisher	*Ceryle alcyon*	Cerylidae	Tucker Valley
Southern Lapwing	*Vanellus chilensis*	Charadriidae	Morne Catherine Road
Bananaquit	*Coereba flaveola*	Coerebidae	Morne Catherine Road
Ruddy Ground Dove	*Columbina talpacoti*	Columbidae	Macqueripe Bay
Smooth-billed Ani	*Crotophaga ani*	Cuculidae	Macqueripe Bay
Squirrel Cuckoo	*Piaya cayana*	Cuculidae	Bamboo Cathedral Road
Yellow-headed Caracara	*Milvago chimachima*	Falconidae	Macqueripe Bay
Magnificent Frigatebird	*Fregata magnificens*	Fregatidae	Morne Catherine Road
Trinidad Euphonia	*Euphonia trinitatis*	Fringillidae	Morne Catherine Road
Violaceous Euphonia	*Euphonia violacea*	Fringillidae	Morne Catherine Road
Cocoa Woodcreeper	*Xiphorhynchus susurrans*	Furnariidae	Morne Catherine Road
Rufous-tailed Jacamar	*Galbula ruficauda*	Galbulidae	Morne Catherine Road
Gray-breasted Martin	*Progne chalybea*	Hirundinidae	Morne Catherine Road
Southern Rough-winged Swallow	*Stelgidopteryx ruficollis*	Hirundinidae	Macqueripe Bay
White-winged Swallow	*Tachycineta albiventer*	Hirundinidae	Morne Catherine Road
Carib Grackle	*Quiscalus lugubris*	Icteridae	Macqueripe Bay
Crested Oropendola	*Psarocolius decumanus*	Icteridae	Morne Catherine Road
Yellow Oriole	*Icterus nigrogularis*	Icteridae	Macqueripe Bay
Tropical Mockingbird	*Mimus gilvus*	Mimidae	Macqueripe Bay
Trinidad Mot-Mot	*Momotus bahamensis*	Momotidae	Morne Catherine Road
Osprey	*Pandion haliaetus*	Pandionidae	Morne Catherine Road
American redstart	*Setophaga ruticilla*	Parulidae	Morne Catherine Road
Golden-crowned Warbler	*Basileuterus culicivorus*	Parulidae	Morne Catherine Road

Northern Waterthrush	*Parkesia noveboracensis*	Parulidae	Morne Catherine Road
Tropical Parula	*Setophaga pitiayumi*	Parulidae	Morne Catherine Road
Brown Pelican	*Pelecanus occidentalis*	Pelecanidae	Macqueripe Bay
Crimson-crested woodpecker	*Campephilus melanoleucos*	Picidae	Tucker Valley
Lineated Woodpecker	*Dryocopus lineatus*	Picidae	Morne Catherine Road
Golden-headed Manakin	*Pipra erythrocephala*	Pipridae	Morne Catherine Road
White-bearded Manakin	*Manacus manacus*	Pipridae	Bamboo Cathedral Road
Long-billed Gnatwren	*Ramphocaenus melanurus*	Polioptilidae	Morne Catherine Road
Lilac-tailed Parrotlet	*Touit batavicus*	Psittacidae	Morne Catherine Road
Orange-winged Amazon	*Amazona amazonica*	Psittacidae	Morne Catherine Road
Channel-billed Toucan	*Ramphastos vitellinus*	Ramphastidae	Morne Catherine Road
Ferruginous Pygmy-owl	*Glaucidium brasilianum*	Strigidae	Morne Catherine Road
Mottled Owl	*Ciccaba virgata*	Strigidae	Morne Catherine Road
Spectacled Owl	*Pulsatrix perspicillata*	Strigidae	Morne Catherine Road
Barred Antshrike	*Thamnophilus doliatus*	Thamnophilidae	Morne Catherine Road
Black-crested Antshrike	*Sakesphorus canadensis*	Thamnophilidae	Tucker Valley
Great Antshrike	*Taraba major*	Thamnophilidae	Tucker Valley
White-bellied Antbird	*Myrmeciza longipes*	Thamnophilidae	Morne Catherine Road
White-flanked Antwren	*Myrmotherula axillaris*	Thamnophilidae	Morne Catherine Road
Bay-headed tanager	*Tangara gyrola*	Thraupidae	Morne Catherine Road
Blue Dacnis	*Dacnis cayana*	Thraupidae	Morne Catherine Road
Blue-black Grassquit	*Volatinia jacarina*	Thraupidae	Tucker Valley
Blue-gray Tanager	*Thraupis episcopus*	Thraupidae	Morne Catherine Road
Green Honeycreeper	*Chlorophanes spiza*	Thraupidae	Morne Catherine Road
Palm Tanager	*Thraupis palmarum*	Thraupidae	Morne Catherine Road
Purple Honeycreeper	*Cyanerpes caeruleus*	Thraupidae	Morne Catherine Road
Silver-beaked Tanager	*Ramphocelus carbo*	Thraupidae	Macqueripe Bay
Turquiose Tanager	*Tangara mexicana*	Thraupidae	Morne Catherine Road
White-lined Tanager	*Tachyphonus rufus*	Thraupidae	Bamboo Cathedral Road
Little Tinamou	*Crypturellus soui*	Tinamidae	Morne Catherine Road
Black-tailed Tityra	*Tityra cayana*	Tityridae	Macqueripe Bay
Blue-chinned Sapphire	*Chlorestes notatus*	Trochilidae	Morne Catherine Road
Copper-rumped Hummingbird	*Amazilia tobaci*	Trochilidae	Morne Catherine Road
Green Hermit	*Phaethornis guy*	Trochilidae	Morne Catherine Road
Long-billed Starthroat	*Heliomaster longirostris*	Trochilidae	Morne Catherine Road
Rufous-breasted Hermit	*Glaucis hirsutus*	Trochilidae	Morne Catherine Road
Tufted Coquette	*Lophornis ornatus*	Trochilidae	Morne Catherine Road
White-chested Emerald	*Amazilia brevirostris*	Trochilidae	Morne Catherine Road
House Wren	*Troglodytes aedon*	Troglodytidae	Morne Catherine Road
Rufous-breasted Wren	*Pheugopedius rutilus*	Troglodytidae	Morne Catherine Road
Violaceous Trogon	*Trogon violaceus*	Trogonidae	Tucker Valley
White-tailed Trogon	*Trogon chionurus*	Trogonidae	Bamboo Cathedral Road
Cocoa Thrush	*Turdus fumigatus*	Turdidae	Bamboo Cathedral Road
Spectacled Thrush	*Turdus nudigenis*	Turdidae	Macqueripe Bay
White-necked Thrush	*Turdus albicollis*	Turdidae	Bamboo Cathedral Road

Boat-billed Flycatcher	*Megarynchus pitangua*	Tyrannidae	Morne Catherine Road
Bright-rumped Attila	*Attila spadiceus*	Tyrannidae	Morne Catherine Road
Euler's Flycatcher	*Lathrotriccus euleri*	Tyrannidae	Morne Catherine Road
Forest Elaenia	*Myiopagis gaimardii*	Tyrannidae	Morne Catherine Road
Great Kiskadee	*Pitangus sulphuratus*	Tyrannidae	Macqueripe Bay
Southern Beardless-Tyrannulet	*Camptostoma obsoletum*	Tyrannidae	Morne Catherine Road
Streaked Flycatcher	*Myiodynastes maculatus*	Tyrannidae	Morne Catherine Road
Tropical Kingbird	*Tyrannus melancholicus*	Tyrannidae	Morne Catherine Road
Tropical Peewee	*Contopus cinereus*	Tyrannidae	Morne Catherine Road
Yellow-bellied Elaenia	*Elaenia flavogaster*	Tyrannidae	Macqueripe Bay
Yellow-breasted Flycatcher	*Tolmomyias flaviventris*	Tyrannidae	Bamboo Cathedral Road
Barn Owl	*Tyto alba*	Tytonidae	Tucker Valley Golf Course
Golden-fronted Greenlet	*Hylophilus aurantiifrons*	Vireonidae	Morne Catherine Road
Rufous-browed Peppershrike	*Cyclarhis gujanensis*	Vireonidae	Morne Catherine Road

Tucker Valley, BioBlitz (2012) – Mammals Species

Common Name	Scientific Name	Family	Location
Red Howler Monkey	*Alouatta macconnelli*	Atelidae	Golf Course trail
Tufted Capuchin	*Cebus apella*	Cebidae	Bamboo Cathedral
Nine-banded Armadillo	*Dasypus novemcinctus*	Dasypodidae	Golf Course trail
Red-rumped Agouti	*Dasyprocta leporina*	Dasyproctidae	Tucker Valley
Robinson's Mouse Oppossum	*Marmosa robinsoni*	Didelphidae	Golf Course trail
Sac-winged Bat	*Saccopteryx* sp. A	Emballonuridae	Bunker Trail
Sac-winged Bat	*Saccopteryx bilineata*	Emballonuridae	Bunker Trail
Free-tailed Bat	*Molossus* sp.	Molossidae	Bunker Trail
Seba's Short-tailed Bat	*Carollia perspicillata*	Phyllostomidae	Bamboo Cathedral
Fruit Bat	*Artibeus* sp.	Phyllostomidae	Bunker Trail
Red-tailed Squirrel	*Sciurus granatensis*	Sciuridae	Tucker Valley

Tucker Valley, BioBlitz (2012) – Reptiles Species

Common Name	Scientific Name	Family	Location
Spectacled Caiman	*Caiman crocodilus*	Alligatoridae	Cuesa River
Green Turtle	*Chelonia mydas*	Cheloniidae	Macqueripe Bay
Tropical Racer	*Mastigodryas boddaerti*	Colubridae	Tucker Valley
Horsewhip Snake	*Oxybelis aeneus*	Colubridae	Tucker Valley
Lora	*Leptophis* sp.	Colubridae	Tucker Valley
Tigre	*Spilotes pullatus*	Colubridae	Bamboo Cathedral
Cat-eyed Snake	*Leptodeira annulata ashmedi*	Dipsadidae	Tucker Valley
Slug-eating Snake	*Sibon nebulata*	Dipsadidae	Tucker Valley
Beh Belle Chemin	*Liophis melanotus*	Dipsadidae	Tucker Valley
African woodslave	*Hemidactylus mabouia*	Gekkonidae	Tucker Valley

Green Iguana	*Iguana iguana*	Iguanidae	Tucker Valley
Jungle Anole	*Anolis planiceps*	Polychrotidae	Tucker Valley
Chameleon	*Polychrus marmoratus*	Polychrotidae	Tucker Valley
Skink	*Copeoglossum aurae or Marisora aurulae?*	Scincidae	Tucker Valley
Spot-nose Gecko	*Gonatodes humeralis*	Sphaerodactylidae	Tucker Valley
White-banded Gecko	*Gonatodes vittatus*	Sphaerodactylidae	Tucker Valley
Zandolie	*Ameiva atrigularis*	Teiidae	Tucker Valley
Spiny Tree Lizard	*Plica plica*	Tropiduridae	Tucker Valley
Bushmaster	*Lachesis muta*	Viperidae	Morne Catherine Road

Tucker Valley, BioBlitz (2012) – Mulluscs Species

Common Name	**Scientific Name**	**Family**	**Location**
Freshwater Snail	*Pomacea glaucus*	Ampullaridae	Tucker Valley
Freshwater Snail	*Marisa cornuarietis*	Ampullaridae	Tucker Valley
Land Snail	*Plekocheilus glaber*	Bulimulidae	Pointe Gourde
Land Snail	*Drymaeus vincentinus*	Bulimulidae	Pointe Gourde
Land Snail	*Bulimulus diaphanus*	Bulimulidae	Pointe Gourde
Stocky Cerith	*Cerithium litteratum*	Cerithiidae	Macqueripe Bay
Land Snail	*Habroconus cassiquiensis*	Euconulidae	Samaan Park Trail
Land Snail	*Ovachlamys fulgens*	Helicarionidae	Tucker Valley
Land Snail	*Helicina dysoni*	Helicinidae	Pointe Gourde
Rough Fileclam	*Ctenoides scabra*	Limidae	Macqueripe Bay
Land Snail	*Megalobulimus oblongus*	Megalobulimidae	Macqueripe
Land Snail	*Cyclohidalgoa translucidum trinitense*	Neocyclotidae	Tucker Valley
Freshwater Snail	*Nerite* sp.	Neritidae	Tucker Valley
Caribbean Reef Octopus	*Octopus briareus*	Octopodidae	Macqueripe Bay
Land Snail	*Orthalicus undatus*	Orthalicidae	Macqueripe
Land Snail	*Simpulopsis corrugatus*	Peltellidae	Pointe Gourde
Slug	*Pallifera* sp.	Philomycidae	Pointe Gourde
Atlantic Wing Oyster	*Pteria colymbus*	Pteriidae	Macqueripe Bay
Flat Tree Oyster	*Isognomon alatus*	Pteriidae	Macqueripe Bay
Land Snail	*Streptaxis glaber*	Streptaxidae	Pointe Gourde
Land Snail	*Beckianum beckianum*	Subulinidae	Pointe Gourde
Land Snail	*Subulina octona*	Subulinidae	Pointe Gourde
Land Snail	*Obeliscus plicatellum*	Subulinidae	Pointe Gourde
Land Snail	*Leptinaria unilamellata*	Subulinidae	Tucker Valley

Land Snail	*Happiella* cf. *decolorata*	Systrophidae	Tucker Valley
Freshwater Snail	*Melanoides tuberculata*	Thiaridae	Tucker Valley
Land Snail	*Brachypodella trinitatis*	Urocoptidae	Pointe Gourde
Slug	*Sarasinula plebia*	Veronicellidae	Samaan Park Trail
Land Snail	*Trichodiscina coactiliata*	Xanthonychidae	Pointe Gourde

Tucker Valley, BioBlitz (2012) – Insects Species

Common name	Scientific Name	Family	Location
Earwig	*Carcinophora sp.*	Anisolabididae	Tucker Valley
Bee	*Partamona nigrior*	Apidae	Macqueripe
Bee	*Lestrimelitta spinosa?*	Apidae	Macqueripe
Robber Fly	Sp. A	Asilidae	Tucker Valley
Giant Water Bug	Sp. A	Belostomatidae	Cuesa River
Butterfly	*Catoblepia berecynthia*	Brassolidae	Morne Catherine Road
Damselfly	*Hetaerina occisa*	Calopterygidae	Cuesa River
Harlequin beetle	*Acrocinus longimanus*	Cerambycidae	Tucker Valley
Longhorn beetle	Sp. A	Cerambycidae	Tucker Valley
Bloodworms	Sp. A	Chironomidae	Cuesa River
Leafhopper	*Tettigoniella sp.*	Cicadellidae	Tucker Valley
Large Cicada	Sp. A	Cicadidae	Tucker Valley
Small Cicada	Sp. B	Cicadidae	Tucker Valley
Ladybird A	Sp. A	Coccinellidae	Tucker Valley
Ladybird B	Sp. B	Coccinellidae	Tucker Valley
Damselfly	*Argia sp.*	Coenagrionidae	Cuesa River
Damselfly	*Ischnura sp.*	Coenagrionidae	Tucker Valley
Leaf-footed Bug	Sp. A	Coreidae	Tucker Valley
Leaf-footed Bug	Sp. A	Coreidae	Tucker Valley
Mosquito A	Sp. A	Culicidae	Tucker Valley
Mosquito B	Sp. B	Culicidae	Tucker Valley
Weevil A	Sp. A	Curculionidae	Tucker Valley

Weevil B	Sp. B	Curculionidae	Tucker Valley
Stick Insect	*Caribbiopheromera trinitatis*	Diapheromeridae	Tucker Valley
Stick Insect	*Ocnophiloidea regularis*	Diapheromeridae	Tucker Valley
Click beetle	Sp. A	Elateridae	Tucker Valley
Ant	*Ectatoma ruidum*	Formicidae	Macqueripe
Ant	*Pseudomyrmax* sp. A	Formicidae	Macqueripe
Ant	*Pseudomyrmax* sp. B	Formicidae	Macqueripe
Ant	*Azteca* sp.	Formicidae	Macqueripe
Ant	*Odontomachus* sp.	Formicidae	Macqueripe
Ant	*Atta cephalotes*	Formicidae	Macqueripe
Water Strider	Sp. A	Gerridae	Cuesa River
Cricket A	Sp. A	Gryllidae	Tucker Valley
Cricket B	Sp. B	Gryllidae	Tucker Valley
Cricket C	Sp. C	Gryllidae	Tucker Valley
Caddisfly larvae	Sp. A	Hydropsychidae	Cuesa River
Firefly	*Aspidosoma sp.*	Lampyridae	Tucker Valley
Mayfly larvae	Sp. A	Leptophlebiidae	Cuesa River
Dragonfly	*Micrathyria sp.*	Libellulidae	Cuesa River
Dragonfly	*Perithemis sp.*	Libellulidae	Cuesa River
Dragonfly	*Orthemis sp.*	Libellulidae	Tucker Valley
Butterfly	*Ocaria thales*	Lycaenidae	Morne Catherine Road
Butterfly	*Ziegleria hesperitis*	Lycaenidae	Morne Catherine Road
Pointed Sister	*Adelpha iphiclus*	Nymphalidae	Morne Catherine Road
Coolie	*Anartia amathea amathea*	Nymphalidae	Morne Catherine Road
Biscuit	*Anartia jatrophae jatrophae*	Nymphalidae	Morne Catherine Road
Astarte 88	*Callicore astarte antillena*	Nymphalidae	Morne Catherine Road
BD butterfly	*Diaethria astala antillena*	Nymphalidae	Tucker Valley
Queen	*Danaus gilippus*	Nymphalidae	Tucker Valley
Monarch	*Danaus plexippus*	Nymphalidae	Morne Catherine Road
Flambeau	*Dryas iulia*	Nymphalidae	Morne Catherine Road
Juliette	*Eueides aliphera*	Nymphalidae	Morne Catherine Road
Ringlet no. 1	*Euptychia* sp. A	Nymphalidae	Tucker Valley
Ringlet no. 2	*Euptychia* sp. B	Nymphalidae	Tucker Valley

Gray Cracker	*Hamadryas februa ferentina*	Nymphalidae	Morne Catherine Road
Variable Cracker	*Hamadryas feronia farinulenta*	Nymphalidae	Morne Catherine Road
Ethilia Longwing	*Heliconius ethilla*	Nymphalidae	Morne Catherine Road
Ricini Longwing	*Heliconius ricini*	Nymphalidae	Morne Catherine Road
Postman Butterfly	*Heliconus erato*	Nymphalidae	Tucker Valley
Hermes Satyr	*Hermeuptychia hermes*	Nymphalidae	Morne Catherine Road
Orange Mapwing	*Hypanartia lethe*	Nymphalidae	Morne Catherine Road
Small Sweet	*Hypothyris euclea*	Nymphalidae	Tucker Valley
Blue Glasswing	*Ithomia pellucida pellucida*	Nymphalidae	Tucker Valley
Mangrove Buckeye	*Junonia genoveva genoveva*	Nymphalidae	Morne Catherine Road
Satyrid Butterfly	*Magneuptychia libye*	Nymphalidae	Morne Catherine Road
Jamaican Mestra	*Mestra dorcas hersilia*	Nymphalidae	Morne Catherine Road
Donkeys Eye	*Precis lavinia*	Nymphalidae	Tucker Valley
Purple King Shoemaker	*Prepona laertes*	Nymphalidae	Tucker Valley
Banded Banner	*Pyrrhogyra neaerea neaerea*	Nymphalidae	Morne Catherine Road
Night Nymph	*Taygetis sp.*	Nymphalidae	Tucker Valley
King Swallowtail	*Papilio thoas thoas*	Papilionidae	Morne Catherine Road
Cattleheart	*Parides anchises cymocles*	Papilionidae	Morne Catherine Road
Cattleheart	*Parides neophilus*	Papilionidae	Morne Catherine Road
Bessbug	Sp. A	Passalidae	Tucker Valley
Shield Bug	Sp. A	Pentatomidae	Tucker Valley
Little yellowie	*Eurema venusta*	Pieridae	Tucker Valley
Cowman Yellow	*Phoebis sennae*	Pieridae	Tucker Valley
Water Penny	Sp. A	Psephenidae	Cuesa River
Assassin Bug	Sp. A	Reduviidae	Tucker Valley
Underleaf	*Lymnas iarbas*	Riodinidae	Tucker Valley
Gray Theope	*Theope lycaenina*	Riodinidae	Morne Catherine Road
Giant Grasshopper	*Tropidacris dux*	Romaleidae	Tucker Valley
Scarab A	Sp. A	Scarabaeidae	Tucker Valley
Scarab B	Sp. B	Scarabaeidae	Tucker Valley
Dung beetle A	Sp. C	Scarabaeidae	Tucker Valley
Dung beetle B	Sp. D	Scarabaeidae	Tucker Valley
Wasp	*Trypoxylon albipes*	Sphecidae	Macqueripe
Wasp	*Trypoxylon maidli*	Sphecidae	Macqueripe

Wasp	*Trypoxylon maidli*	Sphecidae	Macqueripe
Wasp	*Sceliphron fistularium*	Sphecidae	Macqueripe
Termite	*Neocapritermes angusticeps*	Termitidae	Tucker Valley
Termite	*Microcerotermes arboreus*	Termitidae	Tucker Valley
Termite	*Nasutitermes corniger*	Termitidae	Tucker Valley
Termite	*Nasutitermes ephratae*	Termitidae	Tucker Valley
Katydid A	Sp. A	Tettigoniidae	Tucker Valley
Katydid B	Sp. B	Tettigoniidae	Tucker Valley
Katydid C	Sp. C	Tettigoniidae	Tucker Valley
Small Water Strider	Sp. A	Veliidae	Cuesa River
Wasp	*Brachygastra bilineolata*	Vespidae	Macqueripe
Wasp	*Polybia occidentalis*	Vespidae	Macqueripe
Wasp	*Polybia rejecta*	Vespidae	Macqueripe
Wasp	*Synoeca surinama*	Vespidae	Macqueripe
Wasp	*Mischocyttarus labiatus*	Vespidae	Macqueripe
Wasp	*Polistes versicolor*	Vespidae	Macqueripe
Wasp	*Metapolybia cingulata*	Vespidae	Macqueripe
Wasp	*Mischocyttarus fitzgeraldi ?*	Vespidae	Macqueripe
Wasp	*Zeta argillaceaum*	Vespidae	Macqueripe