



GRENADA



NATIONAL WATER AND SEWERAGE AUTHORITY

CLIMATE-RESILIENT WATER SECTOR IN GRENADA (G-CREWS) PROJECT

Consultancy Service for Design of Seven Sisters Transmission Line

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

30 OCTOBER 2024

FINAL



In cooperation with Roberts Caribbean Ltd.
Environment and Development
Consulting Division





NATIONAL WATER AND SEWERAGE
AUTHORITY

Consultancy Service for
Design of Seven Sisters Transmission Line
For G-CREWS PROJECT- COMPONENT 3

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSEMENT

Final report

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List of abbreviations and acronyms

BMUV	German Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection
CANARI	Caribbean Natural Resources Institute
CAPEX	Capital Expenditure Projects
C-ESMP	Construction - Environmental and Social Management Plan
COVID	Corona Virus
CSO	Central Statistics Office
DBH	Diameter at Breast Height
EIA	Environmental Impact Assessment
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
GBV	Gender-based Violence
GCF	Green Climate Fund
G-CREWS	Climate-Resilient Water Sector in Grenada
GDP	Gross Domestic Product
GEPAP	Gender Equality Policy and Action Plan
GHG	Greenhouse Gas Emissions
GIZ	German Development Corporation
GPD	Gallons per day
GRENLEC	Grenada Electricity Services
GRC	Grievance Redressal Committee
GRM	Grievance Redressal Mechanism
HDD	Horizontal Directional Drilling
HOI	Human Opportunity Index
IDB	Inter-American Development Bank
ILO	International Labour Organization
IPCC	Inter-governmental Panel on Climate Change
IUCN	International Union for the Conservation of Nature

LA & PE	Les Avocats and the Petite Etang
LIDAR	Light Detection and Ranging
NAWASA	National Water and Sewerage Authority
NGO	Non-governmental Organization
NIS	National Insurance Scheme
OSHA	Occupational Health and Safety Administration
PDA	Planning and Development Authority
PURC	Public Utilities Regulatory Commission
PWD	Persons With a Disability
RGPF	Royal Grenada Police Force
RWH	Rainwater Harvesting
SEAH	Sexual Exploitation, Abuse and Harassment
SIDS	Small Island Developing States
SSP	Shared Socioeconomic Pathway
TNC	The Nature Conservancy
UNDP	United Nations Development Programme
UNICEF	United Children Fund
WHO	World Health Organization
WRMU	Water Resource Management Unit

EXECUTIVE SUMMARY

The Government of Grenada through the National Water and Sewerage Authority (NAWASA) in partnership with the German Development Corporation (GIZ) proposes to build a water transfer line from the Great River in St. Andrew's to the Les Avocats Water Treatment Plant located in St. David's to address the future water challenges in the southeastern part of the island. This intervention is funded under the Climate-Resilient Water Sector in Grenada (G-CREWS) Project. G-CREWS is an initiative of the Government of Grenada in partnership with the German Development Corporation (GIZ). The intervention is jointly financed by the Green Climate Fund (GCF), the German Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV) under its International Climate Initiative, and the Government of Grenada.

The National Water and Sewerage Authority has identified the Seven Sister Transmission Line project to increase the production of raw water which will contribute to the programme's objective to improve a climate-resilient water supply system.



The statement contained in this document, prepared by Kocks Consult in cooperation with Roberts Caribbean Limited, represents the final draft Environmental and Social Impact Assessment for the proposed project. The Assessment is compliant with Section 22 of the Grenada Physical Planning and Development Control Act 2016, applicable national policies and legislation, and the GCF Interim Environmental and Social Safeguards.

Nature of the Problem: The rationale for the proposed Seven Sisters Water Transfer Project is directly related to the present and future capacity of the Les Avocats and the Petite Etang (LA & PE) water supply system to meet the water needs of its service area situated within southeast Grenada. A hydrological study and reservoir simulation of the LA & PE system undertaken in 2023 by the GIZ found that in the dry season, the reservoirs are insufficient to guarantee one hundred percent supply to its service area. Moreover, during the dry season, a deficit between the demand and safe yield of the LA&PE reservoirs exists equivalent to $Q_{\text{deficit}} = 1,125\text{m}^3/\text{d}$ (247,388 GPD). Developing and implementing suitable sustainable measures to fulfil the water deficit in the southeastern block is therefore necessary.

Project Location and Study Area

The proposed project site is situated on mainland Grenada, within the parishes of St. Andrew and St. David. The site encompasses parts of the Great River and the Chaussee watersheds located towards the central and the southeastern end of mainland Grenada and the western periphery of the Beausejour watershed. It extends from a point in the Great River, downstream the Seven Sisters Waterfall up through an allowed road within the Adelphi community and unto the Grand Etang Main Road (see Figure 1).

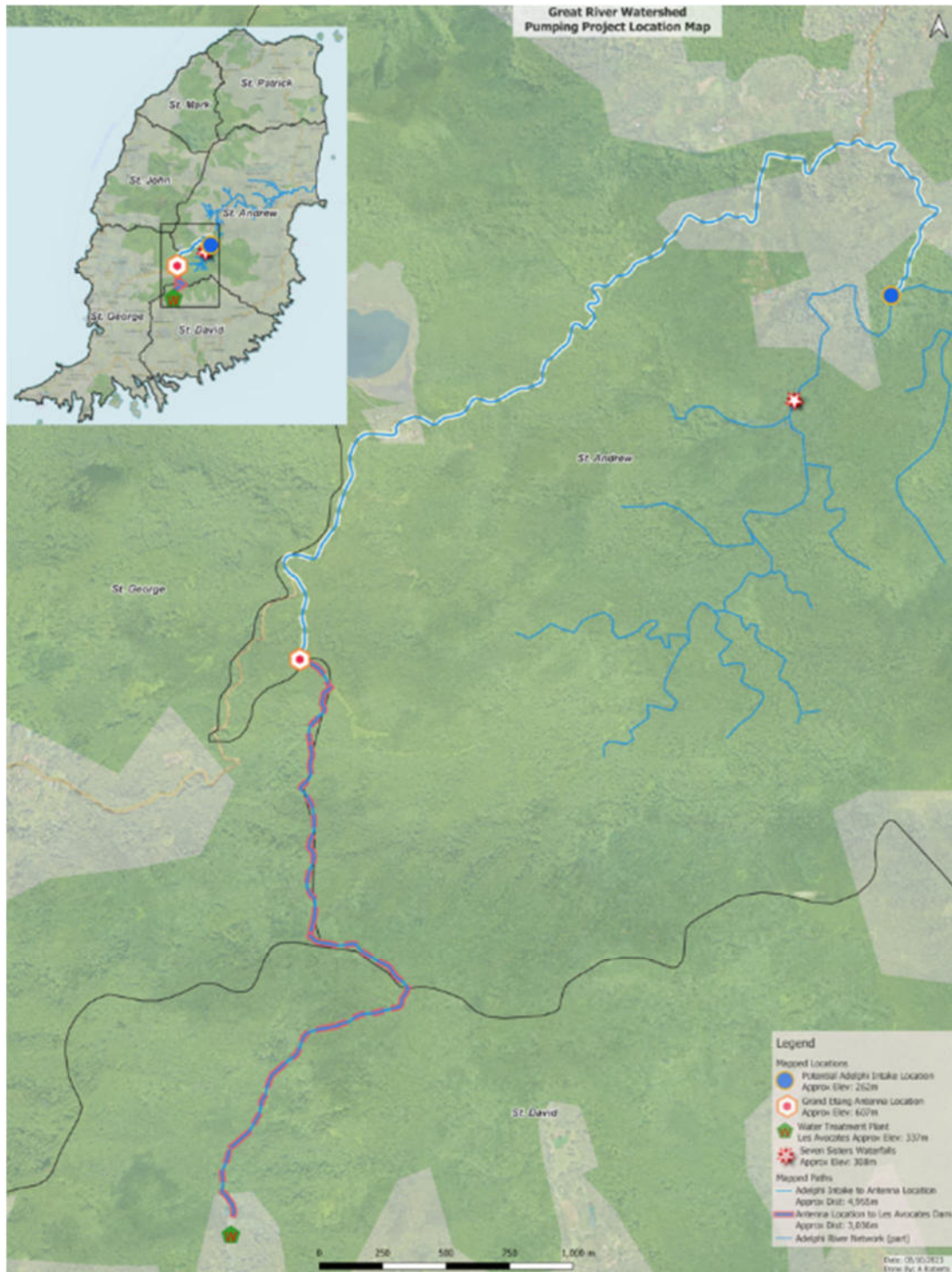


Figure 1: Project location

The entire roadside from the Grand Etang Main Road up to 1910 where the utility antennas are erected is part of the project site. The site extends southward through the Grand Etang Forest Reserve along an existing recreational trail up to the elevated points at Mt. Sinai and Mt. Lebanon, and then unto the Les Avocats Water Treatment Plant and Reservoir.

The ecological study area for the proposed project comprises the Great River around the point of abstraction to include the adjacent riparian, the roadway along the proposed pipe route and locations where the pumps are to be installed, and parts of the Grand Etang Forest Reserve where the transmission pipes are likely to be placed. The Grand Etang Lake and adjacent

wetland ecosystem and the Adelphi/Gangadee Waterfall are excluded from the ecological study area since they are not influenced and/or affected by the intervention.

The wider social study area of the proposed project incorporates the communities upstream and downstream of the point of abstraction, and the resource users and businesses that are dependent on the river. Micro and small businesses that operate within and/or utilize the services provided by the Grand Etang Forest Reserve and beneficiaries located within the southeastern communities are considered paramount to the social study area.

Methodology

The ESIA was designed primarily to determine the minimum ecological flow required at the Great River downstream the intake and the impact of the pipeline route. The methodology employed complied with the approach required for the ESIA process and comprised the following key elements:

- Initial scoping to identify the priority issues of concern to be incorporated in the ESIA.
- Policy, legal, and institutional review.
- Characterization of the baseline terrestrial and riverine ecology at locations near areas of planned works, and the socio-economic and cultural conditions within the project site and Study Area. Description of the baseline geophysical conditions such as soil, geology, land use, topography, and noise levels were also central to understanding the baseline setting.
- Analysis of hazards and risks, including climate projections applicable to the water sector.
- Stakeholder analysis and engagement, which included assessment of attitudes towards the proposed intervention throughout the report preparation process.
- Prediction of impacts and determination of significance.
- Recommendation of mitigation measures, and key parameters to be monitored throughout the project's cycle.

Project Description and Improvement Measures

The proposed solution to address the dry season deficit in the LA & PE water supply system entails the construction of a transfer line from the Great River to the Water Treatment Plant or Reservoir at Les Avocats. A total of 16 l/s or 300,000 gallons per day (1,362 m³/d) is the proposed abstraction volume. Water would be pumped only when there is a supply deficit in the Les Avocats/Petite Etang system, which is determined to be approximately 80 to 100 days a year.

The transfer infrastructure would be designed to pump water from the intake first towards the Grand Etang main road then unto Hurricane Edge at 1910. From this point, water would be gravity fed to the Les Avocats Reservoir or directly to the Les Avocats Water Treatment Plant.

The proposed project comprises three (3) key elements components.

1. An intake downstream the Seven Sisters Waterfall.
2. A pumping station after the intake.
3. Routing of the pipeline from the intake across three sections: From intake to Grand Etang Main Road (Section 1), from Grand Etang Main Road to Antenna 1910 (Section 2); and from Antenna 1910 to Les Avocats (Section 3).

Moreover, three options have been analysed during the feasibility stage, proposed for routing the pipe down to Les Avocats

Option 1: Routing the pipe directly across the mountain via the shortest route ([preferred route](#))

Option 2: Routing the pipe along the mountain ridge guided by an existing recreational trail for a considerable part of the route. The pipe would be laid underground as much as possible (but its more challenging due to the configuration and the narrowness of the ridge).

Option 3: Running the pipe along the ridge using a technique called Horizontal Directional Drilling (HDD). This is a trenchless method of installing the underground pipe by passing about 40% of the steep terrain. The remaining of the route will follow option 2. After a deeper investigation of the requirements for HDD, the site conditions, and discussions with suppliers, the engineering team has opted to disregard this as a viable option. The maximum drilling length and the necessity to be able to access both sides of the drilling area with machinery do not allow the implementation of this technical alternative.

Project Alternatives

Various options to address the water supply problem within the southeastern communities were discussed and reviewed by the NAWASA/GIZ technical team. A summary of these solutions considered are summarized below.

- The two dams that were initially planned (i.e., the Les Avocats extension and the new Petit Etang construction) were deemed too expensive and not sufficiently effective. Other possible sites for constructing a dam in the neighbouring catchments were investigated. Mt. Williams Dam would have been an alternative. However, this would require the construction of a relatively high dam to guarantee the desired outcome in the dry season. The construction of the dam at Mt. William was therefore cancelled due to the scale of the intervention and the budgetary and time constraints to operationalize this solution.
- A more cost-effective solution with much less impact on nature was the preferred idea to transfer water from the neighbouring Great River catchment area to the existing Les Avocats system. No huge dam construction is required under this alternative option. Rather, transfers are only necessary during the dry season, when there is not enough water available.
- Various options and routes were investigated to transfer the water from the Great River. However, after much review and evaluation, the team favoured the currently planned route, from the Great River, through the Grand Etang Forest Reserve and then unto Les Avocats.

Synergistic Projects and Programmes

Various complementary interventions are planned or are ongoing with positive implications for the proposed project. These interventions designed to strengthen the resilience of the water sector in Grenada are planned and/or implemented by the G-CREWS Project, the government of Grenada, and other entities.

1. NAWASA is presently building a new water treatment plant with a capacity of 600,000 gal/day at Laura Lands, St. David's. This forms part of NAWASA's capital expenditure (CAPEX) Projects. The intervention has already started and is projected to be completed in 2024.
2. Construction of a new glass-fused steel tank for treated water at the Petite Etang Water Treatment Plant. This new facility will provide an additional 1,364 m³ (299,944 GPD) of storage capacity.
3. Promotion and training in the setting up and maintenance of rainwater harvesting systems targeting various groups across the country. This initiative is implemented through the G-CREWS Project and the Ministry of Agriculture, particularly through its Extension and Land Use Divisions.
4. Prioritization of demand reduction strategies.

5. Implementation of remote monitoring and control systems and sediment proofing of intakes to address the concerns of increased turbidity in the water stream after heavy rainfall. Funding for a pilot initiative is planned under the G-CREWS project.
6. Setting up of the Water Resource Management Unit (WRMU) consistent with Component 1 of the G-CREWS project, "Climate-Resilient Water Governance." The WRMU will be responsible for managing Grenada's water resources as provided for in the National Water Policy, the Water Resources Management and Regulations Action 2021, and related instruments.

Policy, Legal and Institutional Context

The Government of Grenada has in place policies, strategic plans, and standards that provide the framework for sustainable environmental development within the tri-island state. These instruments promote the protection and conservation of biodiversity and other natural and cultural resources, sustainable livelihoods, community resilience, and human health and welfare. Various pieces of legislation are also important to the proposed project. Highlights include the Physical Planning and Development Control Act 23 of 2016, Grand Etang Forest Reserve Act, CAP 124, 1906, Forest, Soil and Water Conservation Act, Cap 116, Birds and other Wildlife (Protection) Act, CAP 34, 1964, National Parks and Protected Areas Act 42 of 1990, Waste Management Act, 2001, and the Noise Control Act No. 7 of 2006, CAP 211A.

Baseline Ecological setting

Based on the vegetative transects conducted along the proposed terrestrial route, an estimated 49 families of plants were observed, comprising 37 families of trees, herbs, shrubs, and vines, and 12 families of pteridophytes and lycopodiophytes. Two observed Pteridophytes and Lycopodiophytes were identified as Lesser Antillean endemics.

A total of 8 different taxonomic groups were identified and recorded at the family level within the areas sampled around the proposed intake. Three (3) freshwater fish species were observed namely the migratory Suck-stone (Sirajo goby), Mountain Mullet (*Agonostomus monicola*), and the River Goby (*Awaous* sp.). Water quality parameters around the intake were within acceptable range except for alkalinity and phosphate levels. Since these were snapshot readings, more long-term analysis of water quality around the intake required before any generalization of the water quality can be ascertained.

Baseline Socioeconomic and Cultural Setting

Beneficiary communities: Generally, most communities served by the Les Avocats/Petite Etang system do not receive a 24-hour water supply year-round. Inconsistencies in supply are most pronounced during the dry season from January to June. However, throughout periods of reduced precipitation in the wet season, in particular September, reliability decreases substantially. Reliability for some communities decreases as low as about 40% or less due to daily disruptions and the operation of a valve regulation system. Unsatisfactory water quality arising from moderate to high turbidity levels in the water stream after rains was also a concern raised by representatives from the southeastern area.

Livelihoods Provided by the Grand Etang Forest Reserve: The natural resources inherent in the Grand Etang Forest Reserve support important livelihoods for key segments of the national populace. The Reserve represents a central component of the national tourism product and promotion of the Pure Grenada brand. It constitutes one of the nation's flagship ecotourism experiences for soft to moderate recreational ventures. The trail system within the Reserve provides excellent hiking and nature tour opportunities. From an economic perspective, several individuals, as well as micro, small, and medium enterprises, all locally owned generate a livelihood from the tourism and recreational activities that occur within the Reserve.

Livelihoods Provided by the Downstream Part of the Great River: The river downstream the proposed intake supports and sustains four (4) main livelihood activities.

1. River Tubing and Related Adventures
2. Bamboo Rafting
3. Farming
4. Subsistence aquatic/riverine Fisheries.

Other uses of the Great River downstream the intake includes recreation (e.g., swimming and picnicking), and a site for the National Learn to Swim program.

Land tenure: More than 90% of the lands likely to be directly impacted by the project are owned by the State. Private lands are found almost exclusively along the roadside in the community of Adelphi from the intake to the Grand Etang Main Road. Based on plans for the proposed project, one pump will be placed on part of a 6-acre plus lot situated directly adjacent to the intake. The NAWASA has already commenced discussion with the property owner, who has agreed in principle to the installation of the pump on the property. Involuntary Resettlement is not foreseen as part of this project.

Stakeholder Analysis and Perspectives

The main project benefits identified by stakeholders include reduced absenteeism from work due to less disruptions in water supply. Other valuable benefits identified included improved human health due to increased reliability in water supply, better hygiene and sanitation, and reduced incidence of waterborne infectious diseases. Augmentation of select parts of the access road leading to the intake was also identified as a likely benefit.

Generally, most stakeholders, in particular community people raised various concerns about the proposed project, especially its adverse impacts on the downstream cultural and livelihood-dependent uses within the Great River. Concerns were raised by select government representatives, NGOs, affected communities and beneficiary groups, river tubing companies, owners of land along the intake, and local businesses.

Impact Prediction

Impact prediction and significance determination for this study are guided by an adapted methodology from the IUCN and other entities. The proposed project has important benefits for providing safe drinking water to the target communities which is a core existential need for human development. It is also associated with positive impacts on employment, livelihoods, and the national economy.

The most prominent adverse impacts and risks associated with the project are routing the pipe pipeline from 1910 to Les Avocats and the proposed abstraction on river-dependent livelihoods. Impacts on vegetation, soil, and to a lesser extent wildlife habitats were also identified to be significant. Risks and likely impacts on workers' health and safety during the proposed pipelaying from 1910 to Les Avocats would also require astute management to limit the resultant magnitude of all adverse outcomes. Natural disasters, and unplanned leaks and ruptures within the pipeline infrastructure present critical risks during the operational phase of the project. These must be managed effectively to preserve and protect valuable forest resources.

The recommended mitigation measures for the construction and operational phase comply with the GCF environmental and social performance standards for the following key areas.

- Labour and Working Conditions
- Resource Efficiency and Pollution Prevention
- Community Health, Safety, and Security
- Land Acquisition and Involuntary Resettlement

- Biodiversity Conservation and Sustainable Management of Living Natural Resources
- Protection and Preservation of Cultural Heritage

In addition, other mitigation measures are also presented for consideration by the design team to enhance the sustainability of the project at the design phase.

Monitoring and Evaluation

Parameters to monitor during the construction and operation phase are:

- Complaints and/or levels of satisfaction from downstream river users.
- Vegetation regrowth at the project site and areas targeted for reforestation.
- Occurrence of soil movement activity along the pipe alignment route, particularly from 1910 to Les Avocats.
- Aquatic biodiversity around the intake.
- Water quality around the intake.
- Reliability of customers' water supply.

Conclusion

Based on the impact assessment process, and informed by the best available information, **Option 1** is perceived to be the most suitable of all options. Design and implementation of all relevant mitigation measures to prevent and reduce risks and impacts during the construction and operational phases are imperative.

Although the proposed quantity of water to be abstracted is within acceptable limits, to ensure greater compliance with the Brisbane Declaration for environmental flows, and to prevent and reduce adverse impacts to downstream livelihoods, particularly the river tubing industry during the operational phase, the timing of water withdrawals is critical. Moreover, to ensure that the project does good, further discussions with the Client and relevant stakeholders concerning the three options that integrate the aspect of timing into the proposed water withdrawal plan are required. This is necessary to maximize the overall sustainability of the proposed development intervention, while fulfilling the potable water needs of the southeastern communities.

1 INTRODUCTION

1.1 Project Background

The Government of Grenada through the National Water and Sewerage Authority (NAWASA) in partnership with the German Development Corporation (GIZ) proposes to build a water transfer line from the Great River in St. Andrew's to the Les Avocats Water Treatment Plant located in St. David's to address the future water challenges in the southeastern part of the island. This intervention is funded by the Climate-Resilient Water Sector in Grenada (G-CREWS) project.

The Climate-Resilient Water Sector in Grenada project is an initiative of the Government of Grenada in partnership with the German Development Corporation (GIZ). The intervention is jointly financed by the Green Climate Fund (GCF), the German Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV) under its International Climate Initiative, and the Government of Grenada. The main objective of the G-CREWS project is to increase systemic climate change resilience in Grenada's water sector. This development intervention is a 6-year project implemented by the Government of Grenada, the Grenada Development Bank, and the NAWASA in partnership with the GIZ. The project's holistic approach addresses two main climate risks and vulnerabilities of Grenada: freshwater availability and disaster preparedness.

G-CREWS supports the water sector's comprehensive transformation on multiple levels, representative of a national 'paradigm shift' for Grenada's overall resilience. It targets citizens and businesses as water users, the public sector as the provider of potable water and infrastructure, and behavioural changes triggered through appropriate governance, regulation, economic incentives, and awareness raising. Five major components are pursued as part of the G-CREWS project.

1. Climate-resilient water governance
2. Climate-resilient water users
3. Climate-resilient water supply system
4. Additional contributions of the water sector to Grenada's NDC
5. Regional learning and replication.

The proposed Seven Sisters water transfer project will contribute to the achievement of Component 3, building Climate-Resilient Water Supply Systems. This will be achieved through an increase in water resource yield for the southeastern part of mainland Grenada.

Although the proposed water transfer project was evaluated at the initial conceptualization stage as a Category "C"¹ development, assessment of the project's potential negative and positive impacts and identification of measures to prevent, mitigate, and/or compensate for adverse impacts were recommended by the Client (GIZ and NAWASA). This is consistent with national legislation, the GCF's Environmental and Social Performance Standards and recommended international practice.

The statement contained in this document, prepared by Roberts Caribbean Limited, represents the Environmental and Social Impact Assessment (ESIA) for the proposed project. The Assessment is compliant with the stipulations set out in Section 22 of the Grenada Physical Planning and Development Control Act 2016, and applicable national policies and legislation (see Section 3). It also embraces the principles, policies, and standards of the GCF to manage

¹ Category C projects are low risk with minimal or no adverse environmental and social risks and/or impacts

environmentally and socially sustainable interventions. Specifically, the ESIA is compatible with the GCF Environmental and Social Performance Standard #1 – Assessment and Management of Environmental and Social Risks and Impacts.

1.2 Objectives and Scope of Impact Assessment

The primary aim of this consultancy is to carry out an ESIA of the proposed Seven Sisters Water Transmission Line Project. Further, the intent is to generate a sound environmental and social impact evaluation process for the proposed project that is focused on the construction of the Transfer System and associated temporary or permanent civil works that will be implemented. The focus of the assignment would be the determination of the minimum ecological flow at the Great River and the impact of the pipeline route. A full and comprehensive public participation process is envisaged as part of the assessment activity.

Recommendation of risk mitigation measures to facilitate the integration of the necessary social, and environmental safeguards into the design is a key focus of the ESIA. The development of a standalone Environmental and Social Management Plan (ESMP) is also a key deliverable of this consultancy. This instrument is structured to mitigate any adverse impacts of the proposed project, and optimize its social and environmental responsibility, within the context of a responsible governance framework.

1.3 Overview of Methodology and Constraints

The Environmental and Social Impact Assessment was prepared by a team of consultants, with competencies applicable to the needs of the proposed project (see Appendix 1). The team utilized a multidimensional strategy that included secondary literature review and analysis, primary field-based research, and consultation with key stakeholders. This methodology was in alignment with the general steps² required for the ESIA process. While the methodology is presented as a linear process, varying levels of iteration inform the development of the final deliverables.

- Preliminary meeting with the Client to better understand the scope of work and the existing resources that are available on the project site and study area.
- Review of existing secondary literature to understand the rationale for the proposed project, identify available baseline data and information, and preliminary recommendations that can inform the current work. Key initial documents examined included the Hydrological Study and Reservoir Simulation report (Theisen, 2023, Eds.), the Pre-feasibility Study of a Small Dam for NAWASA Near Petite Etang (Geotechnical Investigations Services, 2016), and the ESIA and ESMP for the G-CREWS project (Schuttelaar, 2017; Ramessar, 2021).
- Preliminary field visits of the proposed project site and the preferred route for the water transmission line. This was carried out on two occasions by representatives of the ESIA team due to inclement weather conditions and the relatively large area that the project site covers. This was led by a representative from the NAWASA in collaboration with GIZ and the Department of Forestry, cognizant of the high interests of the latter entities.
- Conduct of a policy, legal, and institutional review. National environmental, social, gender, and macroeconomic policies and laws applicable to the intervention were examined. This aimed at identifying priority issues and best practices for optimizing

² Standard ESIA steps involves screening (conducted by the funding agency), scoping, baseline studies, impact assessment, review of alternatives, elaboration of mitigation measures, preparation of the Environmental Impact Statement & ESMP, review of the ESIA, monitoring and compliance (IISD, n.d.; UNEP, n.d.).

- ecosystem integrity and sustainable social development within the project’s life cycle. Complementary projects and related governance mechanisms are also documented.
- Conduct of the baseline primary site assessments that incorporated the following:
 - Determination of the baseline terrestrial and riverine ecology within the Study Area, at locations in close proximity to areas of planned works.
 - Analysis of water quality results at the intake carried out by NAWASA in early 2023.
 - Characterization of the socio-cultural and economic setting of the Study Area. Determination of the cultural and livelihood uses of the Great River downstream the point of abstraction was deemed important. Similarly, beneficiaries’ perspectives of the baseline water supply received were also ascertained.
 - Implementation of a comprehensive stakeholder analysis and engagement process was also carried out. This aimed to better understand stakeholder knowledge about the project site and study area and their attitudes towards the proposed intervention, through the employment of qualitative research methodologies.
 - Description of the geophysical conditions such as soil, geology, land use, and topography, guided by maps from the Grenada Land Information System, Land Use Division. In addition, information about the road network, traffic and pedestrian use, and baseline noise levels at sensitive sites were also evaluated.
 - Prediction of impacts and recommendation of mitigation measures, inclusive of a Monitoring and Evaluation Plan during the construction and operational phases were articulated.
 - Review of the Draft ESIA by the Client and the GCF, and subsequently by key stakeholder groups. The resultant feedback along with comments from the Client were used to prepare a final Draft version of the ESIA and related outputs. This version would then be submitted to the Planning and Development Authority (PDA) for review and approval, consistent with the national permitting process.

While every effort was made to utilize the most suitable approaches to conduct primary and secondary research to inform the impact prediction process, the study was nonetheless constrained by an inability to monitor the impact of the proposed water abstraction on downstream socioeconomic and ecological parameters during the dry season during the report preparation period. This would be addressed as part of the monitoring and evaluation of the project during the operational phase. In spite of this, the employment of an integrated approach, built on the pillars of multi-disciplinarity, validation through expert and community input, and use of credible secondary and scholarly literature, facilitated the development of an ESIA of high quality and integrity.

1.4 Report layout

The ESIA comprises six main chapters as outlined below:

Chapter 1	Introduction
Chapter 2	Legal and institutional framework
Chapter 3	Presentation of project area and the preferred option
Chapter 4	Impact prediction and determination of significance
Chapter 5	Environmental and social management plan

Chapter 6	Stakeholder analysis and engagement
Annexes	Details of surveys, analysis and consultations

2 Legal and institutional framework

2.1 International performance requirements

The elaboration of the ESIA is aligned with international performance standards and guideline, mainly:

1. International Finance Corporation (IFC) Performance Standards: These standards are crucial for managing environmental and social risks. They include requirements for assessing and managing impacts on communities, biodiversity, and natural resources, while promoting sustainable practices. Key performance standards relevant to this project include:
 - a. Performance Standard 1: Assessment and Management of Environmental and Social Risks and Impacts.
 - b. Performance Standard 5: Land Acquisition and Involuntary Resettlement.
 - c. Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources.
2. World Bank Safeguard Policies: These policies aim to minimize the adverse impacts of projects on the environment and affected people. The relevant policies include:
 - a. Operational Policy (OP) 4.01: Environmental Assessment, which requires the assessment of potential environmental risks.
 - b. OP 4.12: Involuntary Resettlement, which addresses the need for fair treatment of individuals affected by project activities.
3. United Nations Environmental Programme (UNEP) Guidelines: These guidelines promote best practices in environmental management, encouraging comprehensive stakeholder engagement and the inclusion of traditional ecological knowledge.

The IFC Performance Standards are a cornerstone for environmental and social risk management in projects funded by international financial institutions. They emphasize a proactive approach to identifying and mitigating potential impacts. Here's a deeper look at the relevant standards for the water supply transmission line project:

Performance Standard 1: Assessment and Management of Environmental and Social Risks and Impacts: This standard requires the project proponent to conduct a comprehensive environmental and social assessment to identify risks and impacts associated with the project. Key elements include:

- Stakeholder Engagement: Early and ongoing consultation with affected communities and stakeholders to gather input and address concerns.
- Risk Management Framework: Development of a plan that outlines mitigation strategies, monitoring requirements, and adaptive management practices to address identified risks.

Performance Standard 2: Labor and Working Conditions. This standard addresses the working conditions and treatment of project workers, ensuring their rights are upheld. It includes provisions for:

- Fair Labor Practices: Compliance with national labor laws and international labor standards, including non-discrimination, health and safety, and freedom of association.
- Community Health and Safety: Measures to prevent risks to local communities resulting from project activities, including management of worker interactions with local populations.

Performance Standard 5: Land Acquisition and Involuntary Resettlement. This standard emphasizes the need for a fair and transparent process when land acquisition is necessary. Key components include:

- **Minimizing Displacement:** Strategies to avoid or minimize physical and economic displacement.
- **Resettlement Planning:** Development of a resettlement action plan that provides for compensation, livelihood restoration, and support for affected individuals.

Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources. This standard focuses on the protection of biodiversity and sustainable use of natural resources. Important aspects include:

- **Impact Assessment:** Evaluating the potential impacts on biodiversity and ecosystems and developing strategies to mitigate adverse effects.
- **Conservation Measures:** Implementing conservation initiatives to protect critical habitats and promote sustainable resource use.

2. World Bank Safeguard Policies

The World Bank's safeguard policies are designed to prevent adverse impacts on the environment and affected populations. They provide a framework for responsible project planning and execution. The following policies are particularly relevant:

Operational Policy (OP) 4.01: Environmental Assessment

This policy mandates that all projects undergo an environmental assessment process to evaluate their potential environmental impacts. Key elements include:

- **Categorization:** Projects are categorized based on their potential environmental impacts (e.g., Category A, B, or C) to determine the depth of assessment required.
- **Public Consultation:** Active engagement with affected communities to gather input and inform decision-making processes.

OP 4.12: Involuntary Resettlement

This policy is crucial for projects that may result in land acquisition or displacement. It emphasizes:

- **Compensation and Support:** Affected individuals must receive compensation that is adequate, fair, and timely. This includes both monetary compensation and support for livelihood restoration.
- **Participation:** Ensuring that affected populations are involved in the planning and implementation of resettlement strategies, enhancing transparency and community trust.

OP 4.04: Natural Habitats

This policy aims to protect critical natural habitats and biodiversity. It includes:

- **Avoidance of Critical Habitats:** Projects should avoid causing significant conversion or degradation of critical natural habitats unless there are no feasible alternatives.
- **Mitigation Strategies:** If impacts on natural habitats are unavoidable, appropriate mitigation measures must be implemented to minimize harm.

2.2 International conventions

The State of Grenada is a party to a diversity of conventions on environmental management, community resilience, social development and occupational health and safety. Compliance of

the proposed project with the guiding principles and applicable elements are strongly recommended. Principal instruments applicable to the proposed project are listed below.

- 2030 Agenda for Sustainable Development (as an integral framework for the issues presented in the proposed project).
- St. George’s Principles of Environmental Sustainability.
- The United Nations Convention to Combat Desertification, and the National Action Programme for implementation of the Convention and Voluntary Targets for Land Degradation Neutrality.
- The Convention on Biological Diversity.
- United Nations Framework Convention on Climate Change and related instruments.
- The Paris Agreement (2015).
- S.A.M.O.A Pathway (as central to Small Island Developing States – SIDS).
- The Sendai Framework for Disaster Risk Reduction.
- ILO Convention 155³ – Occupational Safety and Health Convention (Ratified in 2012).
- Convention on the Rights of the Child (ratified 1990).
- Convention on the Elimination of All Forms of Discrimination Against Women (ratified 1990).
- The Beijing Declaration and Platform for Action (1995); and the Commonwealth Plan of Action for Gender Equality (2005-2015).
- International Covenant on Economic, Social and Cultural Rights (ratified 1991).
- Inter-American Convention on the Prevention, Punishment and Eradication of Violence Against Women (‘Convention of Balem de Para’) ratified 2000.
- Nairobi Forward Looking Strategies for the Advancement of Women (1985).
- Caribbean Joint Statement on Gender Equality and the Post 2015 and SIDS Agenda.
- The Convention on the Rights of Persons with Disabilities.

2.3 Regulatory Planning Approval for the Proposed Development

Regulatory approval for the ESIA is the responsibility of the Planning and Development Authority as stipulated by the Planning and Development Control Act 23 of 2016 (Refer to Section 2.5). Section 17 (1) of the Act identifies operations on or uses of land that are not covered under the Act. Within the context of water supply projects, this relates to works carried out by or on behalf of the Government or any statutory body relating to the inspection, repair, or renewal of sewers, water mains, pipes, cables, or other apparatus, including breaking open any road or land for that purpose. The scope of the proposed project, however, is beyond that addressed in this section of the Act.

Section 22 (1) of the Act specifies that “the Authority may require an Environmental Impact Assessment (EIA) to be carried out in respect of any application for permission to develop land, including an application for approval in principle if the proposed development could significantly affect the environment.” The Act continues that “unless the Authority for good cause otherwise determines, an EIA shall be carried out in respect of any application for development of a kind mentioned in the Third Schedule.” While the Third Schedule did not specify water transmission projects, it referenced water purification plants, dams, and reservoirs as developments that are applicable under the Act.

Note: A legal assessment was conducted by the legal department of NAWASA (see annex 12 of this ESIA, concluding that that there is no need to get the ESIA officially approved by PDA, however PDAs involvement and recommendations are highly welcomed in this project.

³ International Labour Organization (ILO).

A consultative approach was used to prepare the ESIA although the procedure for public participation is not yet established through national regulations. However, this Final Draft ESIA would be submitted to the Planning and Development Authority for information and enrichment.

2.4 Environmental and Risk Management Frameworks and Strategic Planning Frameworks

The Government of Grenada has in place policies, strategic plans, and standards that provide the framework for sustainable environmental development within the tri-island state. These instruments promote the protection and conservation of natural and cultural resources, sustainable livelihoods, community resilience, and human health and welfare. The undermentioned sections summarize the main environmental and development instruments with implications for the proposed Project. The proposed project must comply with the vision, goals, and focus of the national agenda as part of its stewardship for social and environmental sustainability.

2.4.1 National Environmental Management Policy and Strategy

The National Environmental Policy and Management Strategy (NEP/MS) recognizes that the environment plays a central role in social and economic development. It presents a framework to foster environmental sustainability while optimizing the contribution of natural resources to economic, social and cultural development (Government of Grenada⁴, 2005).

The current NEP/MS although planned to be updated in 2023/2024 is guided by seven principles and values, all of which are directly relevant to the proposed project. These are adoption of a precautionary approach, equitable distribution of benefits, accountability and transparency, public participation, compliance with the rule of law, and public awareness and education. Moreover, seven objectives are outlined to achieve the goal of sustainable environmental management, all of which should underpin the proposed water transfer project cognizant of its location within Grand Etang Forest Reserve.

- Biodiversity conservation;
- Optimize the contribution of the environment to the production and trade of economic goods and services;
- Prevent and mitigate the negative impacts of environmental change and natural disasters, with a clear focus on building resilience in these systems;
- Maintain and enhance the contribution of the environment to human health; and
- Fulfil regional and international responsibilities.

2.4.2 National Water Policy

The sound management of water resources plays a central role in the development of the economy. The increasing impacts of environmental degradation, climate change, and the rising demands for water among key economic sectors, among other issues were identified as major constraints to development within the State (GoG, 2019). The Policy envisages optimal and sustainable use of the country's water resources to maximize the welfare of the nation. Access to water of sufficient quantity and quality is viewed as a basic human right. Furthermore, the Policy is built on the principles of intergenerational equity, participatory decision making, integrated water resource management, conservation of ecological integrity, and adoption of

⁴ Hereinafter referred to as the GoG.

the precautionary principle. Mainstreaming these principles in the design and implementation phases of the proposed project is of paramount importance.

Water Safety Plan

The Water Safety Plan (WSP) was developed on the premise that a potable water supply is critical for a healthy nation, in particular controlling the spread of water borne diseases. It emphasizes preventive risk management, aimed at avoiding and/or limiting the negative impacts of contaminants entering the water supply system. The Plan is designed to provide NAWASA with a roadmap to sustain the delivery of safe water for human consumption (Pivott et al, 2013). The proposed project is therefore expected to align its designs with the intent of the WSP.

Grenada Dry Season and Drought Management Plan

Considering the vulnerability of Grenada to drought conditions, the Dry Season and Drought Management Plan aims to achieve the greatest public benefit for domestic water use and sanitation in an efficient and equitable manner during severe dry periods, to facilitate sustainable development. The NAWASA, the main public water supplier is a core governance entity of the Plan. The main objective of the Plan is to prepare for and mitigate against future drought events in Grenada, which is consistent with the aims of the proposed water transfer project. Within the context of the Plan, the NAWASA is required to ensure the provision of a consistent supply of water to the public, while adapting strategies to offset the impacts of climate change.

2.4.3 National Climate Change Policy for Grenada, Carriacou and Petite Martinique

The National Climate Change Policy 2017-2021 envisions an empowered Grenadian population capable of managing risks from climate change. The Policy emphasizes pursuit of a low carbon development pathway and strengthened resilience at the individual, community and national levels (GoG, 2017). The Policy is structured around seven objectives, two of which are particularly relevant to the proposed development.

- Build climate resilience in the water supply and sewage systems;
- Facilitate climate smart infrastructure and sustainable land management (SLM).

It is imperative that the design, construction, and operational phases of the proposed project integrate the necessary climate change considerations to ensure congruence with the intent of the policy.

National Climate Change Adaptation Plan for Grenada, Carriacou and Petite Martinique (NAP)

The NAP is a flagship instrument for building adaptive capacity within key sectors, including water. It envisions a resilient nation that continually adapts to climate change, by reducing its vulnerability through comprehensive adaptation strategies. Although the NAP is currently being reviewed, strengthening climate resilience in the water sector will continue to be a pivotal pillar in the updated NAP. Considerations for long-term climate resilience in the proposed project are strongly encouraged.

2.4.4 Revised Forest Policy for Grenada, Carriacou and Petite Martinique

The Revised National Forest Policy (GoG, 2018) recognizes the tremendous importance of forest resources in the attainment of environmentally sound social and economic development. It promulgates that sustainable management of forest resources remains critical to the protection of the quantity and quality of the country's water supply particularly under drier climatic conditions. The policy's strategic focus on biodiversity conservation and forest

management to support climate adaptation and mitigation, and forest-based livelihoods is central to the Seven Sisters Water Transfer project. Integrating measures in the design, construction, and operational phases of the project that respect the integrity of the Grand Etang Forest Reserve and related resources is of paramount importance.

2.4.5 National Land Policy

Recognized as a long awaited intervention, the National Land Policy aims to establish the necessary framework for the sustainable, productive and equitable development, management and use of land and natural resources⁵ to compliment socio-economic development initiatives in the country (GoG, 2018b). It is imperative that the necessary sustainable land management practices are adopted during the pipe laying process to safeguard land resources along the sites of major works. This is also in harmony with the allied instruments – the Land and Marine Management Strategy and Grenada’s Aligned National Action Programme for the United Nations Convention to Combat Desertification.

2.4.6 National Physical Development Plan

The National Physical Development Plan 2003-2021 establishes an integrated instrument to guide development activity in Grenada, Carriacou and Petite Martinique in a sustainable manner. It provides a rational approach for informing strategic land use and investment decisions through sustainable management of the physical environment (PPU – Ministry of Finance, 2003). Four of the development objectives relating to growth management, economic infrastructure and development and environmental management are directly relevant to the proposed intervention planned by NAWASA. Adoption of best practices to ensure harmony between the built infrastructure and the Forest Reserve is highly recommended.

2.4.7 National Biodiversity Strategy and Action Plan

The updated and revised National Biodiversity Strategy and Action Plan (NBSAP) 2016-2021 is pursuant to Grenada’s obligations under the Convention on Biological Diversity. The Plan envisions biodiversity proactively conserved for enhanced national resilience, human well-being, and livelihoods. The objective of the Strategy is to provide a holistic and practical framework for action on conservation and sustainable use of national biodiversity, for enhanced human wellbeing and livelihoods. It presents two (2) main strategic priorities:

1. Enhanced national capacity for biodiversity conservation and sustainable use.
2. Key national ecosystems are restored and sustainably managed.

Determination of the minimum ecological flow at the intake point and integrating measures that limit soil movement and vegetative removal along the proposed route is consistent with the strategic priorities of the NBSAP.

2.4.8 Annandale and Grand Etang Forest Reserves Management Plan

The Annandale and Grand Etang Forest Reserves Management Plan was principally established to support watershed protection with the overarching aim of maintaining an optimal water supply for Grenada. Secondary and compatible uses of the Reserve consistent with the Management Plan are associated with recreation, tourism, education, biodiversity conservation, and the production of timber and non-timber forest products in an effort to support sustainable livelihoods and the socio-economic development of Grenada (Turner,

⁵ Including coastal resources.

2007). The proposed use of the forest as a major route for the water transmission line must be carried out in a manner that respects resident biodiversity and advances the objectives of soil and water conservation, recreation and sustainable livelihoods.

2.4.9 Second Nationally Determined Contributions

Grenada Second Nationally Determined Contribution pursuant to the Paris Agreement prioritizes forestry as one of four sectors to achieve the ambitious goal of limiting global average temperatures well below 2oC or less (GoG, 2020). Maintaining ecosystem integrity within the Grand Etang Forest along the proposed areas of major works must be a central principle underpinning the design, construction, and operation of the Seven Sisters Water Transfer project.

2.4.10 National Hazard Mitigation and Grenada Comprehensive Disaster Management Policy and Strategy

The National Hazard Mitigation Policy seeks to mainstream hazard risk reduction into national development planning and augment capacities for disaster risk reduction, with a particular focus on minimizing vulnerabilities among marginalized groups. Similarly, Grenada Comprehensive Disaster Management (CDM) Policy and Strategy prepared 10 years after the passage of Hurricane Ivan recognizes the imperative of proactive multi-hazard disaster risk management. Considering the vulnerability of soils in certain parts of the Grand Etang Forest Reserve to erosion and related events, investment in disaster risk reduction and climate adaptation measures is strongly recommended throughout the project cycle. Moreover, implementing appropriate preparedness and response mechanisms to limit the impact of any unforeseen occurrences in the operational phase is in harmony with the intent of the Hazard Mitigation and CDM Policy and Strategy.

2.4.11 National Energy Policy for Grenada




The National Energy Policy of Grenada communicates the Government’s vision to ensure access to affordable, accessible, equitable, and reliable energy sources and services for national development and improved quality of life for its citizens (GoG, 2011). It is intended that the Policy delivers a sustainable low carbon approach to development, transforming Grenada as a model Small Island Developing State. The Policy’s goals and objectives relevant to the integration of renewable sources of energy in the national energy mix and maximizing opportunities for energy efficiency and conservation in all sectors should be embraced by the proposed project as much as possible. The existing 2011 Energy Policy is currently being updated together with the preparation of an Energy Efficiency Act to advance the Government’s renewable energy and energy efficiency thrusts. The solar PV system proposed as part of the Seven Sisters project aligns well with this new Act.

2.5 Social and Economic Development Policy and Strategic Planning Framework

2.5.1 National Sustainable Development Plan 2020-2035

The National Sustainable Development Plan is the anchor for Grenada’s development agenda for the period 2020-2035. It envisions Grenada as a “resilient and prosperous nation, with a conscious and caring citizenry, promoting human dignity and realizing its full potential through sustainable economic, social and environmental progress for all” (National Plan Secretariat,

2019). The project’s focus on enhancing water supply to the southeastern communities supports the attainment of Goals 1 and 2 as shown below.

	<p>Goal 1: High human and social development: Putting people at the center of sustainable development and transformation;</p>
	<p>Goal 2: Vibrant, dynamic, competitive economy, with supporting climate and disaster resilient infrastructure;</p>
	<p>Goal 3: Environmental sustainability and security (National Plan Secretariat, 2019).</p>

2.5.2 Gender Equality Policy and Action Plan

The Gender Equality Policy and Action Plan (GEPAP) was developed on the premise of Government’s commitment to building a nation based on the principles of gender equality, human rights and fundamental freedoms. It envisions:

“A nation that values every boy, girl, man and woman as equal citizens and participants in the political, economic, environmental, social and cultural life of the country, with equal rights, benefits, privileges and responsibilities without regard to sex, colour, creed, opinion or other distinction” (pg. 109).

The Policy aims to promote gender equality, equity, social justice, and sustainable development in Grenada. While all 10 policy statements have some indirect implications for the project, four are of particular importance: Gender, labour and employment; Gender, economic growth and poverty reduction; Gender, climate change, natural disasters, and natural resource management; and gender, agriculture and tourism. Embracing the principles and practices of gender equality and human rights is central to the effective design and implementation of the proposed development venture.

National Strategic Plan to Reduce Gender-Based Violence

The 2013-2018 Strategic Plan envisions a society in which all persons, from all social and economic background and communities, have equal opportunities to enjoy lives free from all forms of gender-based violence (GBV). Creating an environment of zero-tolerance to GBV at the institutional, community and personal level is central to the strategic approach for addressing GBV. Strengthening the family and empowerment of women is also central to this approach (GoG, 2013). Integrating appropriate mitigation measures to comply with the intent of this instrument is a top priority for project planners and implementers.

Table 1: Laws and regulations relevant to the proposed project

<p>Physical Planning and Development Control Act 23 of 2016 Responsible Agency: Ministry with Responsibility for Planning and Development</p>
<p>The Physical Planning and Development Control Act represents the leading instrument governing physical development in Grenada. It makes provision for the orderly and progressive development of land and the preservation and improvement of related amenities. Section 22 provides for the conduct of EIAs for any proposed land development that could significantly affect the environment. Schedule III identifies development in conservation and environmental protection areas or other sensitive environments as matters for which an EIA is required. While the Act makes provision for the development of EIA regulations as outlined in Section 22 (4), these are currently not yet developed or enforced.</p>

<p>Implementation of the necessary safeguards to ensure compliance with applicable prescribed conditions for the Grand Etang Forest Reserve is of utmost importance.</p>
<p>Land Development Regulations, Section 27, Cap. 160 Responsible Agency: Ministry with Responsibility for Planning and Development</p>
<p>Physical development in Grenada is regulated by the Land Development Control Regulations, part of its predecessor instrument, the Land Development Control Act. It specifies the requirements for different types of buildings or developments, including for industrial and other purposes. With respect to developments by Government Departments and Statutory Boards, Section 8 notes that where permission is not specifically granted elsewhere in the Regulations, no works shall be carried out without the approval of the Authority. All standard conditions specified in Sections, 2, 3, 4, 8, 10 and 11 also apply.</p>
<p>Grand Etang Forest Reserve Act, CAP 124, 1906</p>
<p>This Act establishes the forest around Grand Etang as a forest reserve for the benefit of Grenada. The primary objective of the Act was to preserve and maintain the forest reserve as an important natural resource central to the promotion of rainfall and water supply for the island. The lands within the reserve's boundary should be in perpetuity part of Government land and should be strictly reserved for the public purposes of forest conservation.</p>
<p>Forest, Soil and Water Conservation Act, Cap 116 Responsible Agency: Ministry with Responsibility for Forestry and Agriculture</p>
<p>The above Ordinance establishes the Forestry Department and makes provision for the conservation of forest, soil and water, and other natural resources in Grenada. Section 7 makes provision for the protection of forest on private lands for among other reasons soil erosion, landslide risk reduction and maintenance of water supplies in springs, rivers and reservoirs. The Act also allows for the voluntary conservation of natural resources by private landowners (Section 12) and makes felling of certain trees unlawful without a permit (Section 19). The Act however, is outdated and lacks the relevant regulations for full enforcement. It is currently being reviewed to address its inherent weaknesses.</p>
<p>Birds and other Wildlife (Protection) Act, CAP 34, 1964 (amended 1980 & 1990)</p>
<p>This Act protects wild birds and other wildlife including fish, turtle, lobsters and oysters. It makes provision for the absolute protection of select wild birds as specified in the First Schedule. The Act makes exporting, killing, wounding, taking any wild bird, their eggs or nest an offence. Guilty offenders shall be liable to a fine of EC\$ 1000 and to imprisonment for six months. Close season for birds protected under the Act is from March 1 to August 31st of each year, unless the Minister appoints other times as set out in the Gazette.</p>
<p>National Parks and Protected Areas Act 42 of 1990 [CAP 206] (Amended 2009)</p>
<p>An Act to provide for the designation and maintenance of national parks and protected areas, and for connected purposes. It speaks to Government's authority to create, administer, and maintain national parks and protected areas and identifies restrictions on land in such areas.</p> <p>Regarding public utility works within a national parks system owned by the State, the Governor General or the Ministry may enter into an agreement with an authority responsible for a public utility. This agreement will be designed for the purpose of that authority constructing some new works or undertaking or extending any existing work or undertaking on or under the surface of land within the national parks system. The authority may carry out such construction or extension subject to the terms and conditions of the agreement. The Act notes that the Governor General in respect of Government lands within the national parks system (NPS) may make regulations for the following including preservation of flora and fauna, preservation and maintenance for water supplies and water catchment area, prevention of soil erosion, landslip, the entry and control of movement of persons and animals, the construction, maintenance, operation and administration of roads, ways, public works and utility services, the regulation and control of transportation within the NPS, and the regulation and control of development, construction and building within the NPS.</p> <p>With respect to offences and penalties, Section 17 (2) states that anyone without lawful authority hunts, traps or kills any wild animal/bird or picks or digs up any wildflower, shrub or plant in a national park or removes or defaces any historical or archeological artefact in a national park shall be guilty of an offence and liable to a fine of EC\$ 1000 and imprisonment for six months.</p>

Wild Animal and Bird Sanctuary Act, 1928 (CAP 339) (Amended 1963)

This piece of legislation established the Grand Etang Forest Reserve as a sanctuary for wild animals and birds. It focused primarily on the offences and penalties associated with the instrument. It makes killing, wounding, taking or attempting to kill, wound or take any wild animal or bird; setting any snare or trap for the capture of any wild animal or bird; or the carrying of any firearm an offence. Such offenders if found guilty shall be fined EC\$500.00; in case of a second or subsequent offence, the offender once found guilty will be fine and imprisoned for three months. The firearm can also be forfeited. Best practices to prevent any intentional or unintentional destruction or damage to wild animals and birds within the Reserve should be key during any construction activities within the Reserve.

Waste Management Act, 2001 Responsible Agency: Ministry Responsible for Health

An Act to provide for the management of waste in conformity with best environmental practices. It specifies the appropriate disposal of waste, contrary to which an offence is committed that can attract fines of EC\$ 20,000 and imprisonment of three months. Section 33 notes that the unauthorized disposal of waste in or on any national park or protected area...marine waters, river or river bank without lawful authority commits an offence, liable to a fine of EC\$ 50,000 and imprisonment for 6 months (Part V). Best practices for waste management generated by industrial and institutional facilities are presented in Section 38. Lack of regulations and enforcement capability hinders effectiveness. While a permit or license is not required under this Act, compliance with the best practices for waste management set out in the Act and promoted by the Grenada Solid Waste Management Authority is key.

Noise Control Act No. 7 of 2006, CAP 211A | Responsible Agency: Ministry of Health

An Act to provide for the regulation and control of noise. Section 9 sets out the mechanism for prior consent for works on construction sites. Any person who knowingly carries out works or permits the work to be carried out in contravention of any condition attached to a consent under this section is guilty of an offence. Control of noise is addressed in Section 10. The Minister has the power to serve a notice to anyone that contravenes the Act. Lack of regulations for this instrument however, also limits the effectiveness of the Act. Notwithstanding this, compliance is expected.

Employment Act Cap 89 of Responsible Agency: Ministry of Labour

Part IV of the Act addresses fundamental principles which prohibits discrimination on the grounds of race, colour, national extraction, social origin, religion, political opinion, sex, marital status, family responsibilities, age or disability, in respect of recruitment, training, promotion, terms and conditions of employment, termination of employment or other matters arising out of the employment relationship. The Act states that "every employer shall pay male and female employees equal remuneration for work of equal value." The law makes provision that an individual claiming an infringement of his or her rights can seek redress through the Court if that infringement cannot be redressed by way of the industrial relations framework. Unfortunately, not all workers in all sectors are members of trade unions or staff associations. For those workers, workers on fixed-term contracts, and those in unregulated work environments, there are questions about the level to which these fundamental principles are implemented, practiced, monitored and upheld. However, this section of the law has the potential to increase the voice of the disenfranchised within the labour market.

National Insurance Act 1983, Amended 2011

An Act to establish a national insurance through the collection of contributions and other income for the payment of sickness, invalidity, maternity, survivors', aged, funeral and other benefits and matters. Section IV of the Act makes provision for categories of insured persons and of insurable employment. Within the context of the Act, employers/contractors are expected to pay the requisite monthly contributions for each insurable employee in a timely manner. Any change in the employment status of the employee should be brought to the attention of the Scheme. Section V of the Act speaks to the kinds of benefits that are available under the Act, which includes sickness and invalidity. Offences and penalties are also discussed. Contractors and other employees engaged via the project are expected to comply with the requirements of the Act to avoid any unnecessary consequences.

Aspects of this Act are endorsed by the Social Security (O.E.C.S. Convention) Act, Chapter 307 C, 2000.

Domestic Violence Act, Act 19 of 2010

An Act to provide greater protection for victims of domestic violence, and to make provision for the granting of protection orders and for related matters. The Act speaks to among other matters, protection orders, police powers of entry and arrest. Compliance by the project contractors, consultants and related human resource is strongly encouraged.⁶

2.6 Institutional arrangements

Matters pertaining to the provision of a safe supply of potable water, management of natural resources, including forest reserves, social development, and implementation of infrastructural projects are shared by several public sector agencies. Their responsibilities and possible areas where additional capacity is needed are outlined below:

- National Water and Sewerage Authority (NAWASA) – The principal agency responsible for providing potable water to the populace. All national development issues pertaining to water supply including infrastructure development are led by NAWASA, with support from other institutions. Augmentation of the existing human resources within NAWASA is necessary to support stakeholder engagement and the environmental and social monitoring of the proposed project during the construction and operational phases. It is therefore highly recommended that Environmental, Social and Gender Specialists be engaged, as part of human resource strategy to foster compliance with the relevant safeguards as outlined in the ESMP. Consideration for additional staff to implement the Stakeholder Engagement Plan is also key.
- Water Resource Management Unit – Although not yet commissioned, this entity is expected to play a key role in the management of the state’s water resources. This includes granting of licenses for all agencies/individuals planning to abstract water in the nation’s rivers.
- Ministry of Infrastructure and Physical Development, Public Utilities, Civil Aviation & Transportation.
 - Play a lead coordinating and technical role in supporting the design and implementation of public infrastructure across the state.
 - The Planning and Development Authority is responsible for planning and development control at the national level. Review and approval of all ESIA are under the direct responsibility of the PDA (refer to Section 2.3).
 - Tourism – This department is responsible for the management of all tourism-related infrastructure within the national parks system, which includes the recreational zone in the Grand Etang Forest Reserve. Although Tourism does not have a direct responsibility in the implementation of the proposed project, their advice on mitigation measures to limit any adverse effects on the tourist activities in the Grand Etang area during the construction phase is deemed important.
- The Department of Forestry within the Ministry of Agriculture, Lands and Cooperatives – Provides leadership for the management of resources within the Grand Etang Forest Reserve. It is expected that this department will play a lead role in providing technical advice and endorsement of any final plans for routing the transmission line in the proposed project. Moreover, providing a monitoring role during project implementation would be critical. However, due to the staff limitations within the department,

⁶ Include applicable aspects under Grenada Criminal Code, Act No. 76 of 1958 as amended by Criminal Code Amendment Act, No. 29 of 2012 (S.234).

employment of the necessary Environmental and Social Safeguards Specialist will be pivotal during the construction phase.

- Ministry of Health - The Division of Environmental Health within this Ministry plays a key role in regulating potable water quality to ensure consistency with applicable guidelines for human health. Importantly in collaboration with the Ministry of Labour they are also interested in ensuring that best occupational practices are adopted during construction to limit all adverse health conditions.
- Ministry of Labour – Promotes appropriate measures for ensuring equity in the workplace and best practices for occupational health and safety.
- Ministry of Social & Community Development, Housing and Gender Affairs – Leads in all matters pertaining to social development within the ambit of the Gender Policy and Action Plan. However, all Ministries have a responsibility to foster social inclusion and mainstream gender equality at the policy and programmatic levels. This Ministry can be an excellent partner during the implementation of the Stakeholder Engagement Plan as elucidated in the ESMP.
- Other entities such as the Ministry with responsibility for Finance and Central Statistics Office are supporting enabling institutions.

3 Presentation of project area

3.1 Catchment area

The proposed project site is situated on mainland Grenada, part of a tri-island state comprising two other islands - Carriacou and Petite Martinique. Grenada the largest of the three islands is the southernmost windward island in the Eastern Caribbean, situated approximately 100 miles north of Venezuela and 90 miles southwest of Barbados. It is located between Latitude 11°59' and 12°20' North and Longitude 61°36' and 61°48' West. The island stretches 18 km wide and 34 km long, with a coastline of approximately 121 km. Altogether mainland Grenada comprises 71 water catchments, of which the Great River Watershed is the largest with significant importance for sustainable water production. Administratively, the island is divided into seven parishes, namely Saint Andrew, Saint Patrick, Saint David, Saint George, Saint John and Saint Mark. Considered a middle-income country, the human development index of the state was 0.795 points in 2021, comparing well with the world's average based on an assessment of 184 countries (The Global Economy, n.d.).

The proposed project site for the water transfer project is located within two parishes - St. Andrew and St. David. The site encompasses parts of the Great River and the Chaussee watersheds located towards the central and the southeastern end of mainland Grenada respectively. It also borders the Beausejour watershed to the west (see Figure 2).



Figure 2: Project site within key watersheds

Moreover, the project site extends from a point in the Great River, downstream of the Seven Sisters Waterfall through a 10 feet allowed road within a local area call “Gangadee” (part of the Adelphi community), to the Grand Etang Main Road. The entire roadside from the Grand Etang Main Road up to 1910 where the utility antennas are erected is part of the project site. There are 5 antennas at the site, three owned by FLOW with support services provided to Digicel. The project site extends southward through the Grand Etang Forest Reserve along an existing recreational trail down to the valley and up to the elevated points at Mt. Sinai and Mt. Lebanon.

At a critical juncture along the trail, the site diverts southeasterly unto the Les Avocats Treatment Plant and Reservoir (see Figure 3).

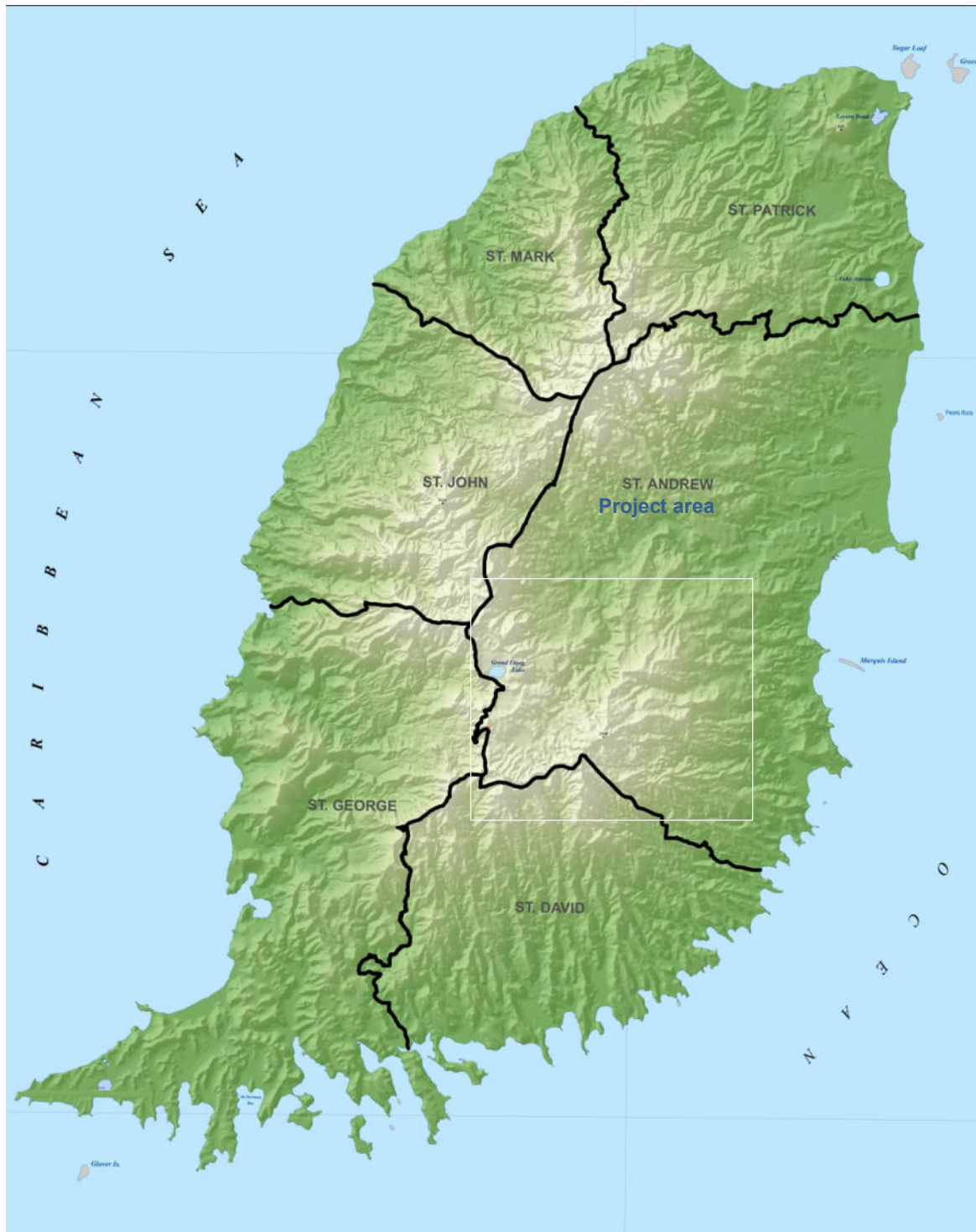


Figure 3: Project location

The ecological study area for the proposed project comprises the Great River around the point of abstraction to include the adjacent riparian, the roadway along the proposed pipe route, parts of the Grand Etang Forest Reserve where the transmission pipes are likely to be placed, and locations where pumps are proposed to be installed. A few critical ecosystems and natural resources although located within the Great River watershed are excluded from the ecological study area since they are not influenced and/or affected by the intervention. These are the:

- Grand Etang Lake and adjacent wetland ecosystem – located upstream of the intake.
- Adelphi or “Gangadee” Waterfall – although this natural site is located downstream the intake, it is fed by a different tributary, and as such would not be affected by the proposed abstraction (see Figure 4)

The wider social study area of the proposed project incorporates the communities upstream and downstream of the point of abstraction, and resource users and businesses that utilize the river (e.g., river tubing companies and farmers). Micro and small businesses that operate within and/or utilize the services provided by the Grand Etang Forest Reserve and beneficiaries located within the southeastern communities are considered paramount to the study area.

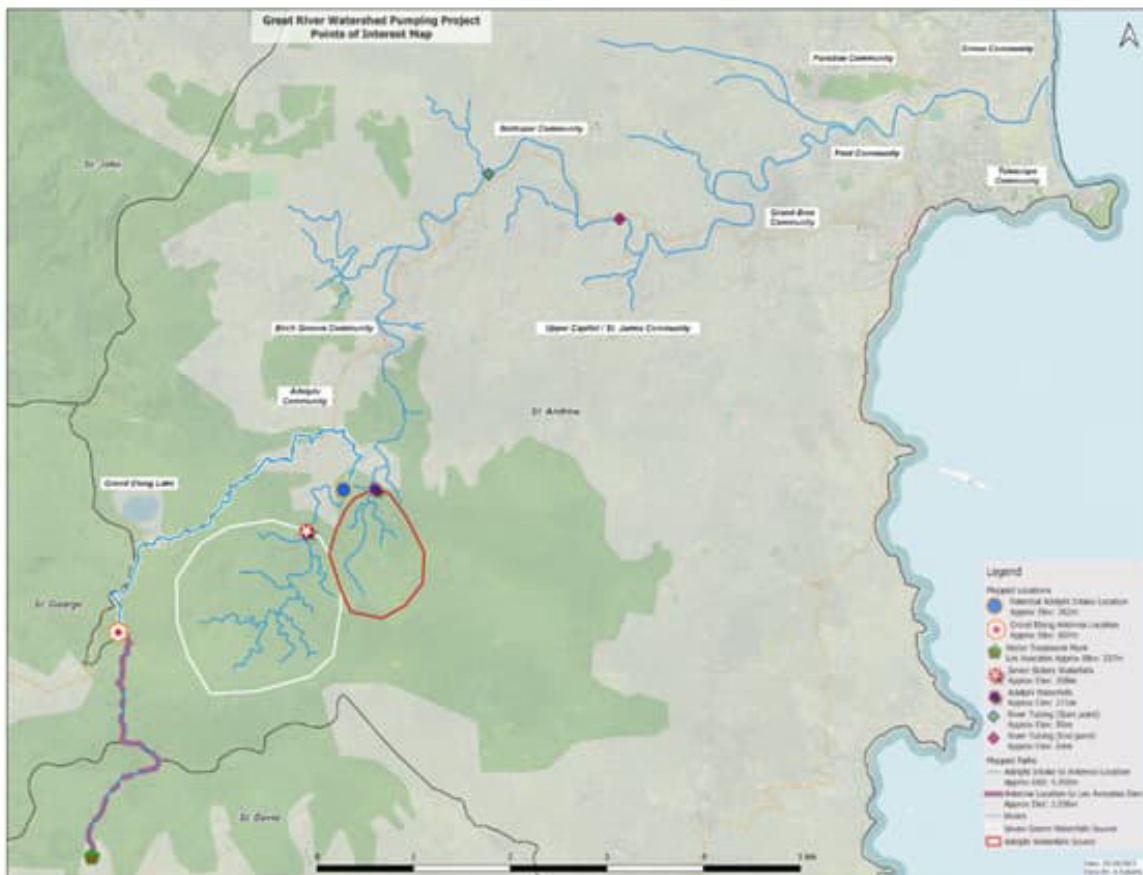


Figure 4: Map showing the ecological and social study areas and excluded elements

3.2 Water Resources and Supply Context

3.2.1 National Setting

Grenada’s overall water risk rating is characterized as high according to the World Resources Institute (i.e., quantity – high, physical risk quality – extremely high, regulatory, and reputational – extremely high). This is linked to various challenges facing the water sector which includes:

- Annual and seasonal variations in supply
- Damage from floods and extreme rainfall events
- High dependence on treatment plants to improve quality
- The fragility of the freshwater ecosystem and
- High reputational risks.

Inadequate national water storage and distribution infrastructure to meet current and future demand in response to developments in the urban and rural areas compound these issues.

The effects have social and economic ramifications, negatively impacting households, in particular women and water dependent businesses.

The state’s water sector is also highly vulnerable to the effects of climate change on the hydrological cycle and is ranked the most vulnerable of the Organization of Eastern Caribbean States (OECS). An assessment of the economic impact of climate change on Grenada’s water sector in 2011 identified integrated watershed management, research on the water potential of key ecosystems, rainwater harvesting, infrastructure maintenance and improvement, protected areas conservation, efficient use, and water information management as the highest priority adaptation actions to build resilience to climate change in the sector (ECLAC, 2011). Key metrics that define the baseline national water supply system on mainland Grenada are summarized in Figure 5








	Surface water is the predominant source
	NAWASA operates 29 water supply facilities.
	23 surface and 6 ground water potable supply sources
	Maximum yield in rainy season (July to November) = 54,600m ³ /day
	Maximum yield in dry season (December to May) = 31,800m ³ /day.
	Maximum water demand in rainy & dry season = 45,500m ³ /day & 54,600m ³ /day.
	High risk of insufficient water supply during the dry season & periods of drought.

Figure 5: Key metrics of mainland Grenada water supply system (Source NAWASA)

3.2.2 Water Supply System Serving the Southeastern Communities

The Les Avocats and Petite Etang Water Supply System is the principal source of water for the targeted southeastern communities. Combined, both systems serve a supply area of 11,400 persons and 6040 connections (see Table 2).

The Les Avocats (LA) dam is located in the south of the island, approximately 1.8 km north of Barrows in the parish of St. David. The catchment is quite steep with an area of 1.2 km² and extends north to the summit of Mt. Sinai at an elevation of +768 m. The treatment plant is designed with a production capacity 2,200 m³/day and is fed by the Baillies Bacolet River along with four smaller streams. Post-hurricane recovery of the catchment ensures effective infiltration and a reliable daily minimum baseflow during the dry season, ranging from 1,200 to 1,400 m³/d. During the wet season, baseflow and interflow are very high and provide the average source required for the reservoir’s functioning. The average annual rainfall ranges from 2,100 to 2,700 mm/yr. Minimal precipitation between January and April, however, reduces the contribution of surface water runoff, resulting in a seasonal deficit in water availability and the reservoir related water supply system. The reservoir at LA needs infrastructural upgrades due to the deterioration of the dam over time. This upgrade, however, is not considered part of the proposed project and is excluded from further discussion in this document.



Figure 6: System layout for the LA and PE Water supply system

Table 2: Details of the LA & PE water supply system

Characteristic	Les Avocats	Petite Etang
Year of construction	1957	After 1965
Design capacity of treatment plant	3,300 m ³ /day 725,670 GPD	1,146 m ³ /d 252,000 GPD
Number of connections	5,190	850
Number of persons served	9,100	2,300
Water storage capability	71,630-gallon tank at Les Avocats & 80,000-gallon tank at Richmond Hill	81,000-gallon tank at Petite Etang & 200,000-gallon tank at La Pastora

The Petit Etang (PE) system is located in the south-central part of the island, east of Les Avocats. The three catchments of Petit Etang, Coco Dee, and Blin-eff supply raw water to the PE treatment plant via three intake points (intakes) fed by gravity. The design capacity of the plant is 1,146 m³/d (252,000 GPD) (Bornemann, 2015). Recognizing the limitations of this system, a planned expansion of the treatment plant is expected to increase the daily production capacity to 2460 m³/d (650,000 gallons/d), coupled with the construction of a glass-fused steel tank for an additional 1,364 m³ of storage. Similarly, to the LA system, these improvement measures are not included as part of the proposed project and are therefore not considered in the description, rather as future complementary interventions.

3.2.3 Nature of the Problem – Why the Seven Sisters Water Transfer Project?

The rationale for the proposed Seven Sisters Water Transfer Project is directly related to the present and future capacity of the Les Avocats and the Petite Etang (LA & PE) water supply system to meet the water needs of its service area. This integrated water supply system consists of four small reservoirs: Les Avocats, Petite Etang, Cocoa Dee, and Blin-eff. It is a major source of water for the semi-urban areas in the southwestern part of mainland Grenada,

spanning Petite Esperance in the east to Morne Jaloux in the southeast (see Figure 2.2.2-1). Moderate annual population growth of 0.5% in the southeastern communities is predicted coupled with an increase in the number of new tourism developments in St. David’s. In addition, the impact of climate change is also a major stressor on freshwater resources, cognizant of the predicted air temperature and decreasing precipitation, likely to intensify future drought events.

A hydrological study and reservoir simulation of the LA & PE system was undertaken in 2023 by the GlZ. The study was based on rainfall data for the last six years. The analysis also considered the effects of some dry years with a recurrence of one in 10 to 15 years based on rainfall data for the last 50 years (Theisen, 2023). Based on the hydrological study, during the rainy season, there is enough water produced by the LA & PE water treatment plants to supply the connected areas. In the dry season, however, the reservoirs are not sufficient to guarantee one hundred percent supply. Specifically, the safe yield of the existing reservoir at LA & PE in dry periods was calculated at Q safe yield: 1,975 m³/d (434,302 GPD). Future water demand in the supply area during the dry season was calculated and determined to be Q demand: 3,100 m³/d or 681,690 GPD. Within the LA & PE system, a deficit between the Demand and Safe Yield exists in the dry period equivalent to Q deficit: 1,125 m³/d (247,388 GPD) (see Table 3). Developing and implementing suitable sustainable measures to fulfil the water deficit in the southeastern block is therefore necessary. This points to the need to utilize additional local and regional water resources to meet the future water needs of the affected communities.

Table 3: Key findings hydrological analysis – LA & PE watersheds (Theisen, 2023)

Location	Latitude	Longitude	Elevation (m)	Catchment Area (m ²)	Volume [m ³]	Safe yield rainfall period of last 5 years [m ³ /d]
Old Les Avocats	12.06600	-61.701000	345	1,200	3,300	1,180
Petit Etang Dam (Catchment 1)	12.065778	-61.688635	415	524	325	450
Blin-eff Dam (Catchment 2)	12.069161	-61.682735	450	327	30	110
Cocoa Dee Dam (Catchment 3)	12.068927	-61.682137	426	614	150	230
Total current situation [m ³ /d]						1,975
Total demand [m ³ /d]						3,100
Deficit current situation [m ³ /d]						1,125

3.2.4 The Proposed Solution/Improvement Measures

The proposed solution to address the dry season deficit in the LA & PE water supply system is the construction of a transfer line from a select point in the Great River to the Water Treatment Plant or Reservoir at Les Avocats. The amount of water to be pumped would be equivalent to 16 l/s or 300,000 gallons per day (1,362 m³/d). This is expected to fill the gap between the safe yield of the existing dam system (1,975 m³/d) and the future demand (3,100 m³/d). The proposed volume of water would ensure one hundred percent supply for the connected southeastern population even in extremely dry years similar to the 2009/2010 drought period. Water would be pumped only when there is a supply deficit in the Les Avocats/Petite Etang system which is determined to be approximately 80 to 100 days a year (~21.9% to 27.4% of the time each year). Based on the hydrological study and reservoir simulation referred to in

Section 3.2.2, even with abstraction of the Q_a : 1,360 m³/d in the worst case during a 6-year period the minimum discharge is not less than Q_{min} : 2,277 m³/d which corresponds to 1.75 times or 175% the volume of abstracted water. The WTP is already reaching its capacity and is overloaded by 20%. NAWASA is considering the construction of a new plant. The design of the new plant, however, is not part of the proposed project. The proposed project should consider options for dealing with the overloading that is already occurring.

The transfer infrastructure would pump water which is collected in a water intake below the Seven Sisters waterfalls in the Great River catchment, first towards the main road at Grand Etang. There, the water is proposed to be pumped to the Antenna 1910 where the utility antennas are located. From this point, water would be gravity-fed to the Les Avocat Reservoir. Details of the proposed routes considered are provided below.

The proposed project comprises three (3) key elements as described below.

Element 1 & 2 : Water Intake and pump station

The water intake is located below the seven sisters' waterfalls. Coordinates:

12°05'55.12" N

61°40'36.84" W

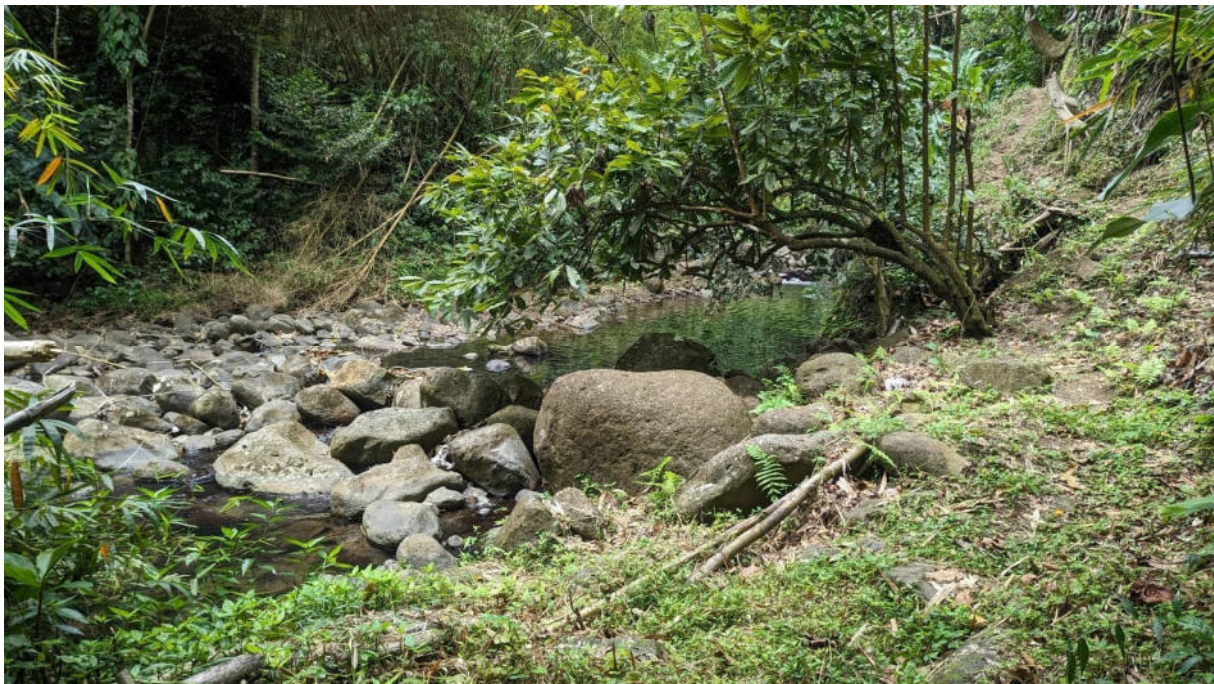


Figure 7: Picture from the intake location

Site Environment

The area is located downhill of and at the northeast of the 7 Sisters waterfalls next to the creek bed. The site is unused and is surrounded by intense vegetation.

Site ownership

The site at the intake belongs to a private person who runs a farm near the site. The area of the intake and pumping station including the immediate surrounding is 380 m².

The intake is located at a creek which has its source at the seven sister's waterfall. The creek bed has a width varying between 12-20 m. The bottom is constituted of a conglomerate of rocks and stones. Main water level in the creek is estimated to be 0.4 m. The creek is bordered by an extensive vegetation. The terrain is partially flat and partially with some steep elevations.

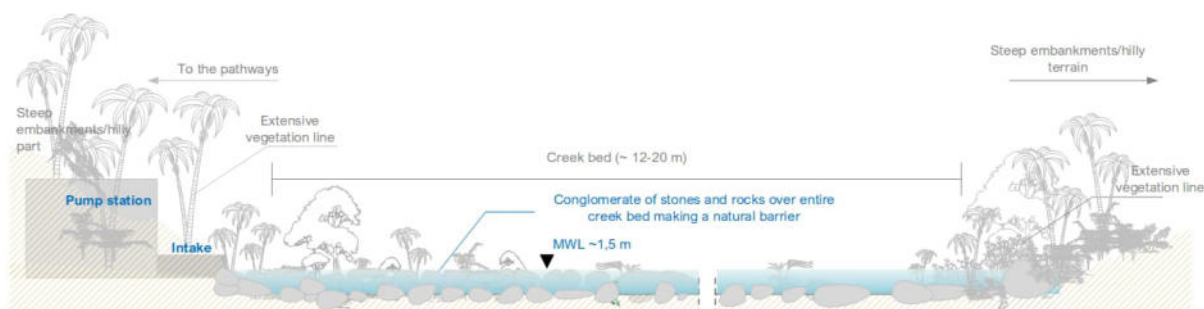


Figure 8: Cross section at intake location

Geological conditions

The Southeast Mountain, part of which is located within the Grand Etang Forest Reserve was active during the Miocene period. The area is composed of ande-site domes, lava and pyroclastic flow deposits that radiate from the Southeast Mountain. Generally, the Great Riverbeds is the main geological base for the Great River. Another important geological base within the proposed project site are the Mount Granby Volcanics and the Southeast Mountain Volcanics located along the route from 1910 to Les Avocats. Based on the Ministry of Agriculture's soil classification system, capitol clay loam is the principal soil type dominating the project site and wider study area. capitol clay loam is a fine textured moderately well to well-drained soil of variable depth. Such soils are suited for forested areas in shallow steep areas with high rainfall as found in the Grand Etang Forest Reserve.

Hydrogeological conditions

The groundwater potential on mainland Grenada is not yet fully developed. The main groundwater aquifers can be found at Bailles Bacolet, The Great River, Duquesne, Beausejour, Chemin Valley and Pearls-Paradise. The current exploited groundwater is approximately 1890 m³/day, with a potential capacity of approximately 3,973 m³/day. The ground water resource in the Hillsborough watershed has the highest potential capacity of 90-97m³/day with the highest existing number of dug wells.

Distances to protected areas

The intake location is not in a protected area. The transmission line is bordering the main road which crosses the Grand Etang National Park and the Annandale Forest reserve. A particular attention needs to be paid during the construction of this portion of the transmission line (approx. 4,6 km).

Accessibility

The intake is accessible through a small unpaved road with a various street course which needs to be improved as part of the project. The length of the road is approx. 960 m long, mainly driveable with a 4 x 4 car. The last part of 300 m to the intake is steep and covered with intense vegetation and only accessible by walking.

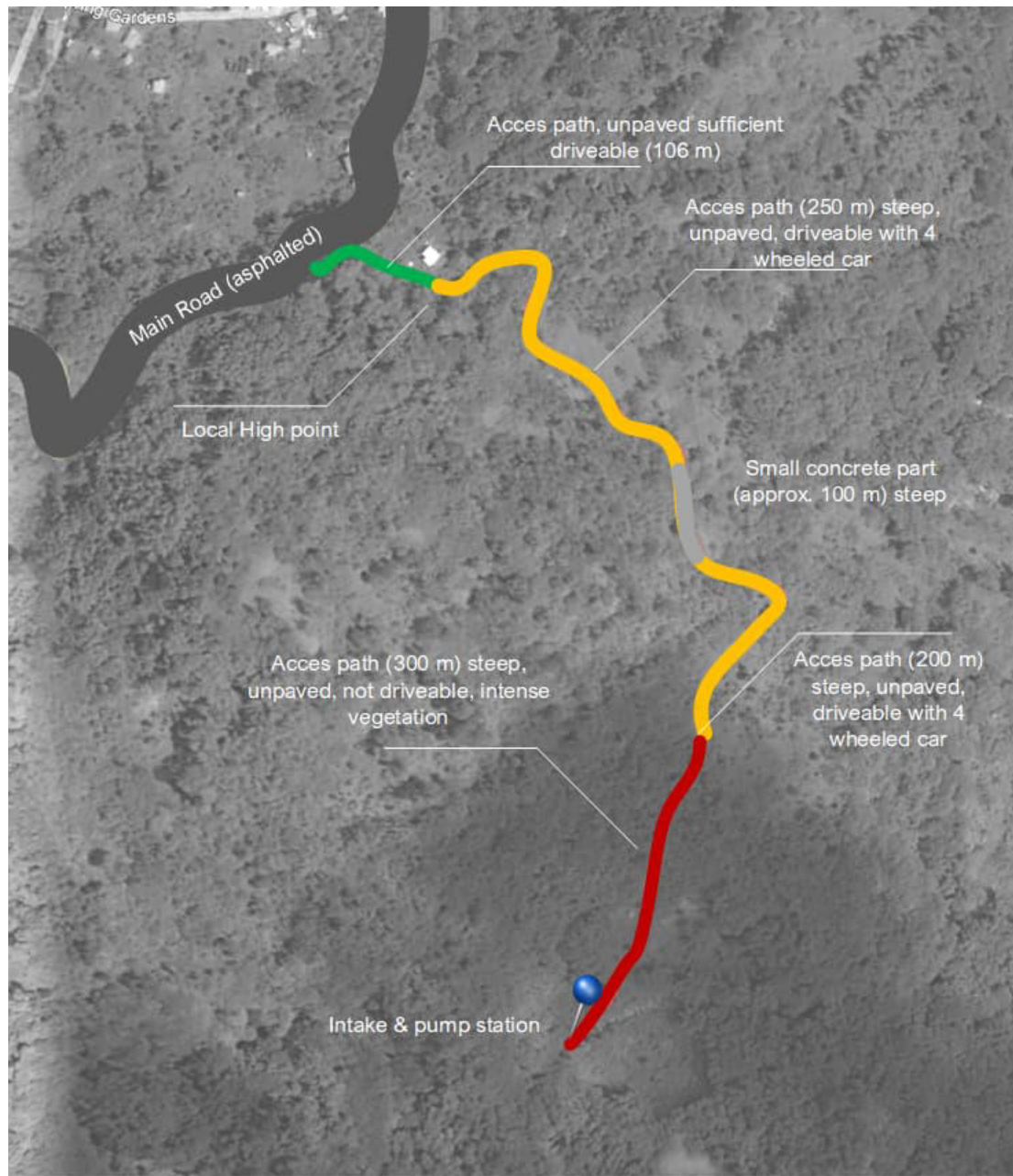


Figure 9: Access Road to intake

Utilities

There are no existing utilities in the direct vicinity of the site.



An electrical power line (400 V line/3 phase)⁷ located alongside the main street will be extended by the national electricity company and a transformer (90 KW) will be installed at the intake location (Compensation via a Solar PV system under the project are planned and an agreement between PURC, GRENLEC and NAWASA on the compensation for the solar PV system has already been negotiated in 2023). The works Contractor shall be responsible for connection to the intake structure. A provisional sum of 120,000 ECD has been allocated for this purpose.

⁷ General note : Grenada's electricity supply is primarily generated by the Grenada Electricity Services Limited (Grenlec), which operates the national power grid. Historically, the island's energy production has relied heavily on imported diesel fuel to generate electricity, leading to high greenhouse gas (GHG) emissions and significant fuel import costs. Diesel generators remain a major source of power generation in Grenada

Site visits with the national electricity company and NAWASA was also held at the end of May 2024.

Main Data Intake and pumping station	
Intake system	<p>One main intake (16 l/s) channel with a baffle wall, a bar screen, one overflow side channel and a sand trap including sluice gate valves</p> <p>Main intake length: 28,65 m, including a sand trap between inflow and overflow with a length of 3,80 m</p> <p>Side channel/overflow/backwash: 9,80 m</p>
Pump station structure	<p>Monolithic concrete structure</p> <p>Dimensions</p> <p>Outside: 7,80 x 5,50 x 3,8 m</p> <p>Inside:</p> <p>Water chamber: 1,70 x 4,90 x 3,1 m</p> <p>Pump room: 5,20 x 4,90 x 3,1 m</p>
Pumps	<p>Design flow Q: 16 l/s</p> <p>Number of pumps (1 active-1 standby)</p> <p>Capacity of each pump: 16 l/s</p> <p>Static Head: app. 344</p> <p>Head loss: app 20 m</p> <p>Total Head: app 364 m</p> <p>Power adsorbed: 79 kW</p>

The location of the intake and the pump station was chosen to guarantee the minimum intake flow. There is a natural rock boulder dam which ensure an impoundment height of approximately 1.3 m in the middle of the creek and approximately 0.5 m at the intake. Small arrangements need probably to be made to protect the pump station from the backlog and potential flooding.

	
Surrounding location of the PS: more downstream, on a flat rooted out area close to the creek bed	Surrounding location of the PS more upstream, close to the creek bed

	
<p>Surrounding location close to the creek bed on a higher level, close to the creek bed</p>	<p>Location of the PS</p>

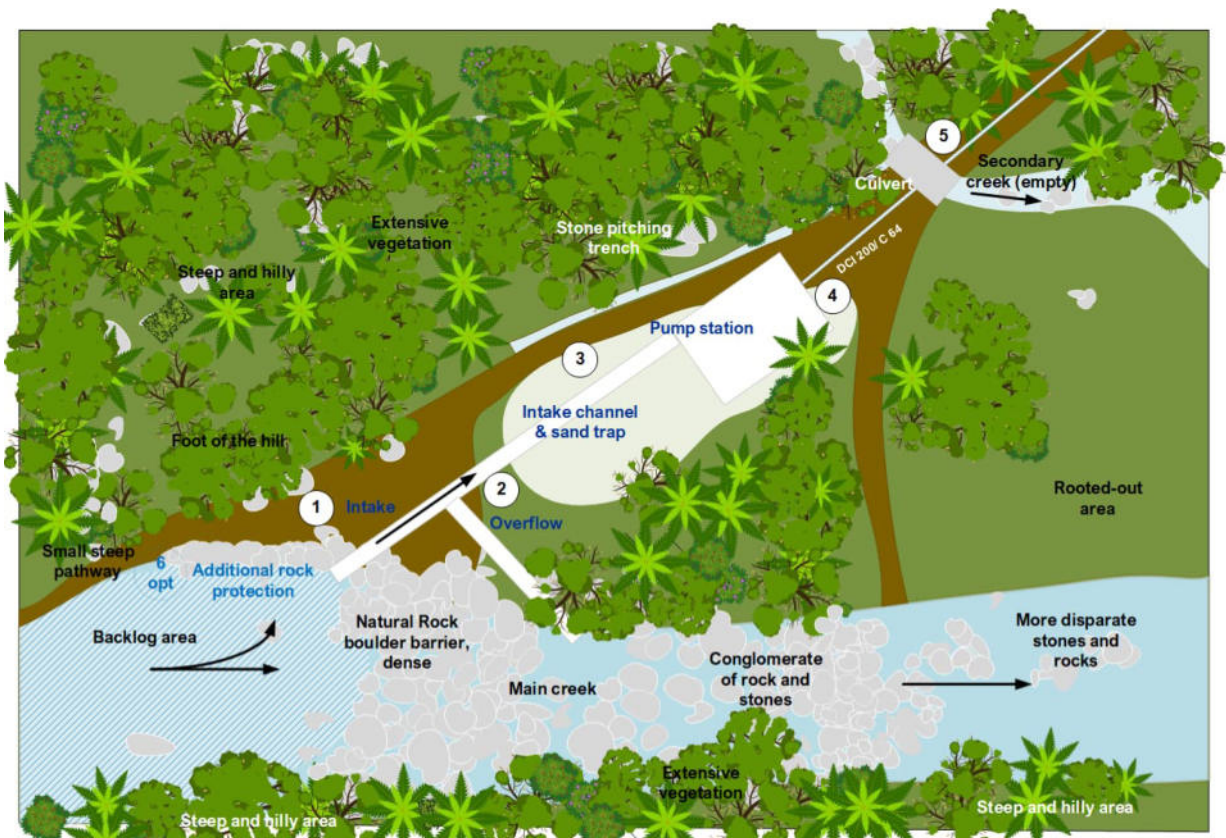


Figure 10: Intake area and backlog area

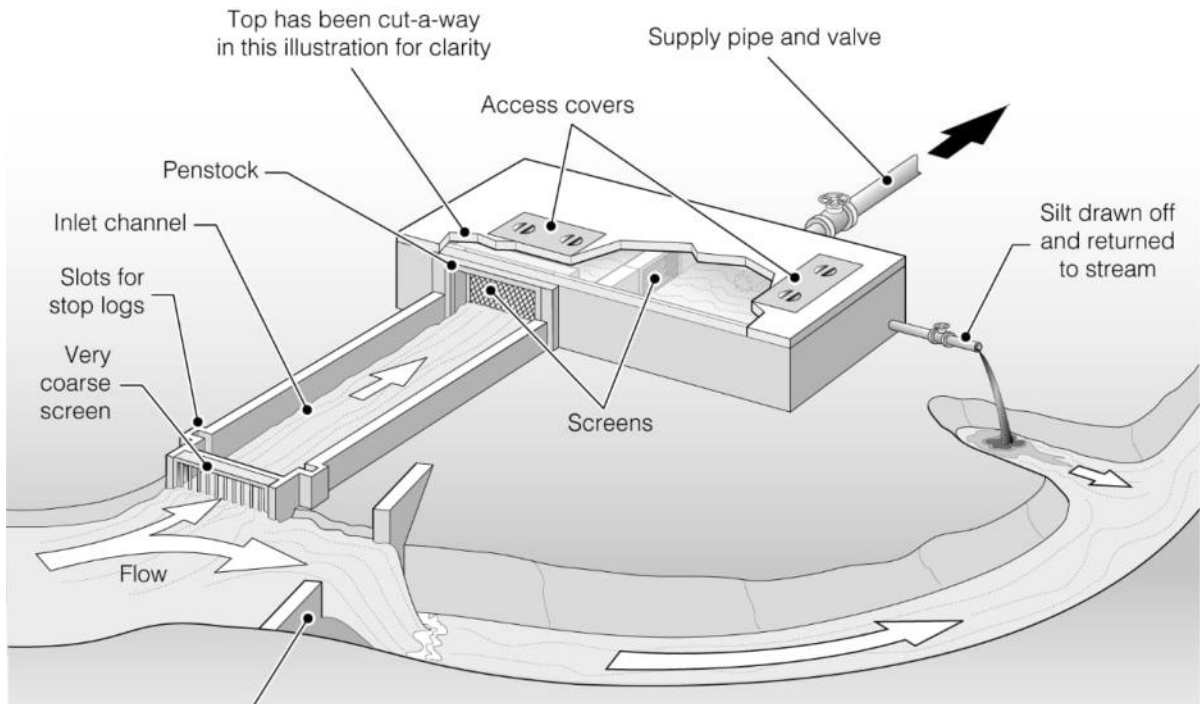


Figure 11: Principle scheme of the system (intake & pump station)

	Lattitude	Longitude	Height over N.N
Start Intake Road	12°6'14.90	61°40'38.78	Approx 330



Figure 12: Road junction from the main road to the intake

The roads lead after 60 m to a local high point, from which the roads leads constantly to the intake location after approximately 900 m

	Lattitude	Longitude	Height over N.N
Local high point	12°6'15.73	61°40'40.95	Approx 390

Element 3: Pipeline Alignment from the Intake to Les Avocats

Intake to Antenna (DCI pipe)

The transmission line from the intake to Antenna will be established with DCI pipes (DN 200/C64 and C40) and can be split in 3 distinctive sections:

Section 1: Intake to main road (0⁺⁰⁰⁰+0⁺⁹⁵⁸):

Accessibility. The works in this section consist mainly of:

- Clearing the vegetation
- Excavating the trench in natural ground in sequences
- Preparation of the pipe bed (laying of adequate material)
- Laying the pipes (with all fittings, bends, etc.): DCI DN 200/C64 (PN 40)
- Backfilling, compacting and closing the sub-sections
- Construction and junction of 1 washout (concrete chamber) at station 0⁺²⁰⁵
- Construction and junction of 1 air valve (concrete chamber) at station 0⁺⁸⁴⁸
- Construction of a culvert at the intersection drainage trench at eastern side of the intake and the pump station (approx. at Station 0⁺⁰²⁵)
- Upgrading the entire access road (except the small concrete part of about 100 m) with compacted excavation and gravel material over a length of 550 m and 300 m approaching steep road to the intake with concrete.

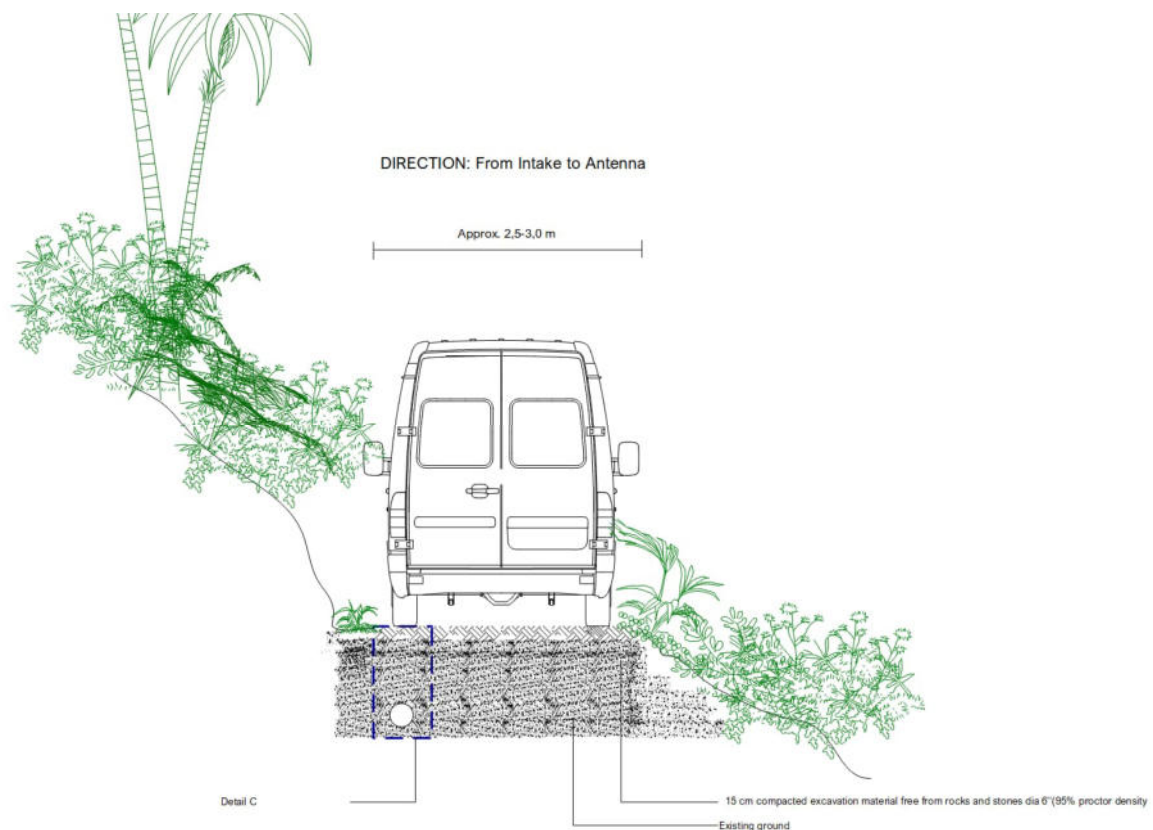


Figure 13: Typical cross section of the road from intake to main road after works

Section 2: Main Road to Access Antenna (0⁺⁹⁵⁸-4⁺⁵⁹³)

This part follows the main asphalted road and had various characteristics:

- a) The road is bordered by a rainwater channel



Figure 14: Picture of road type A

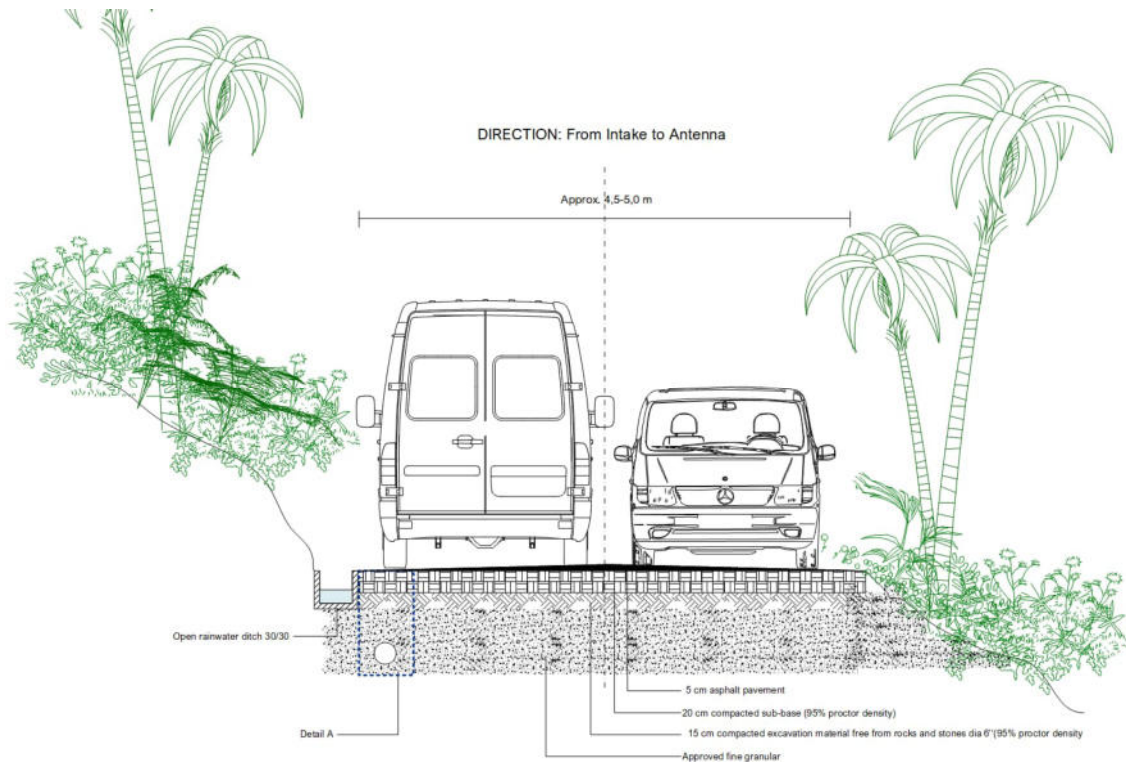


Figure 15: Typical cross section of the road type a after works

- b) The road is bordered by a banket with vegetation



Figure 16 : Picture of road type B

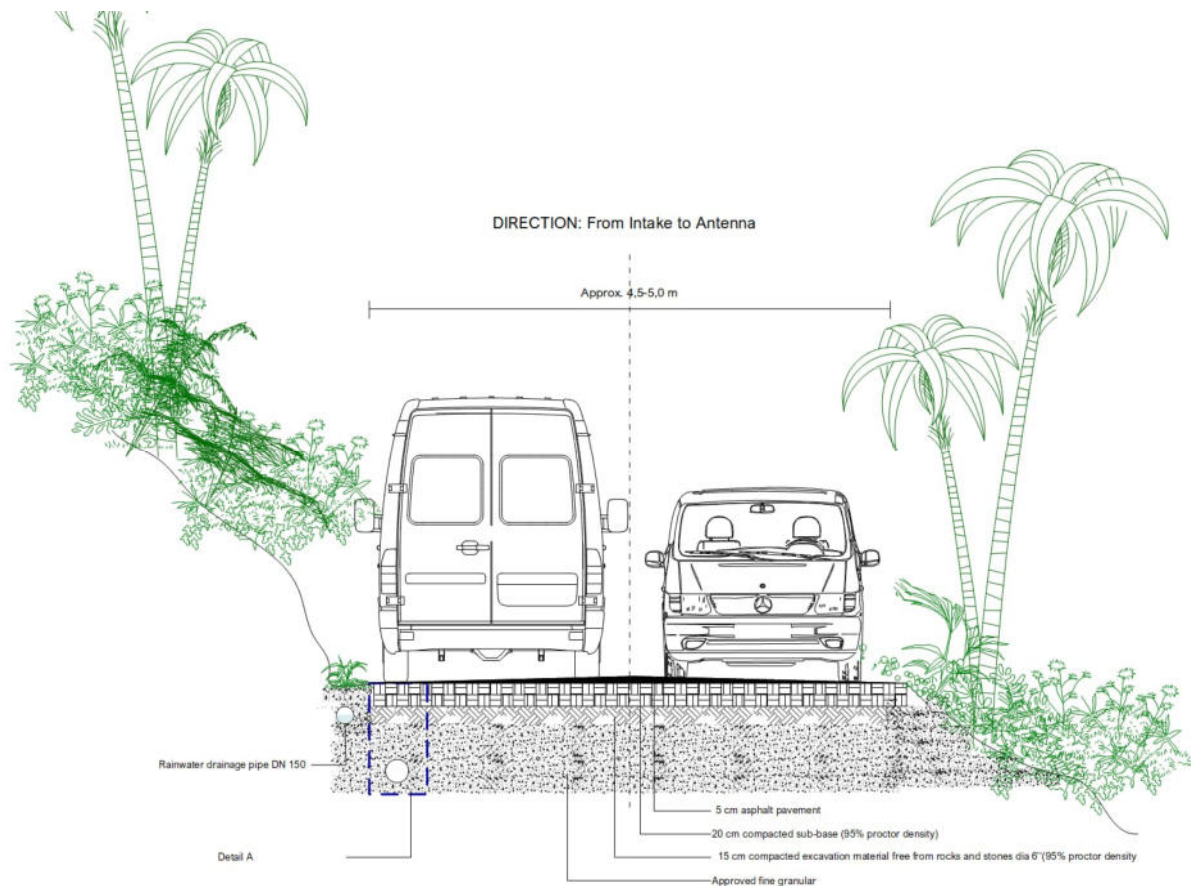


Figure 17: Typical cross section of road type B

- c) The road is crossing a river/creek bed over a bridge (with a culvert)



Figure 18 : Picture of road type C

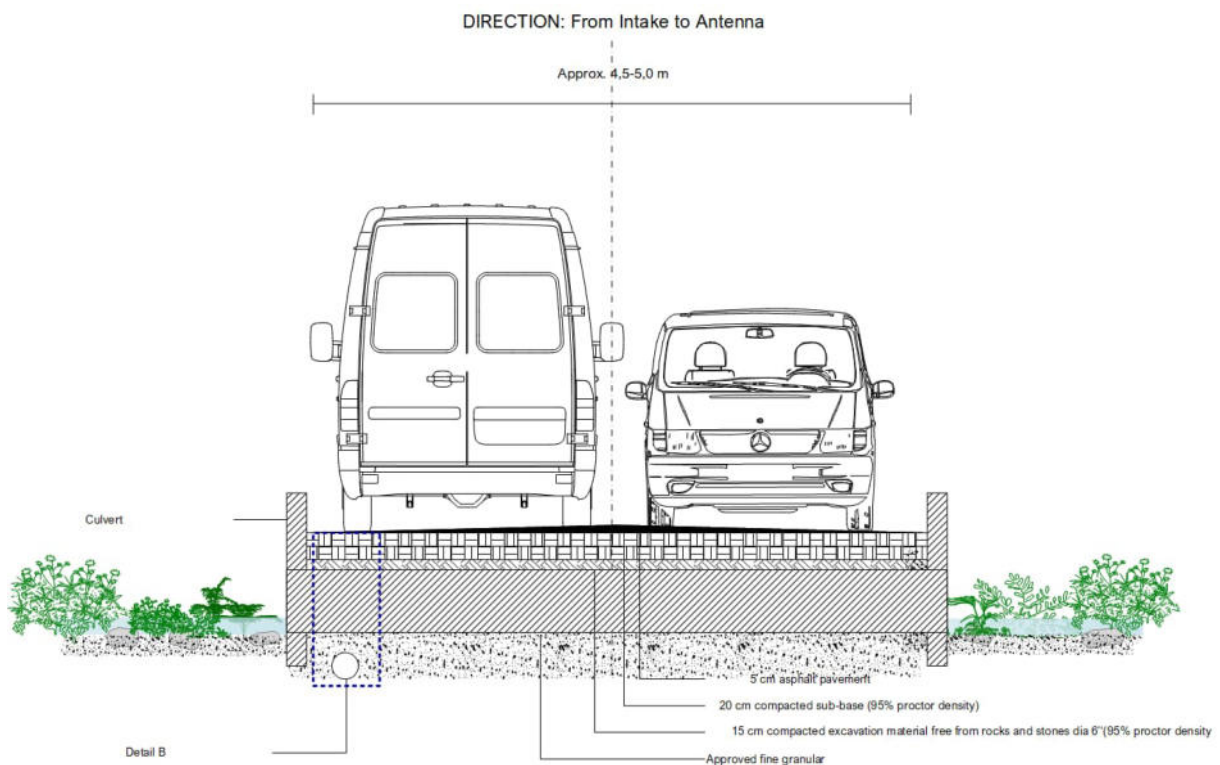


Figure 19: Typical cross section of road type C

For this section the works consist mainly of:

- Cutting existing asphalt road layers over a width of approx. 1 m
- Excavating the trench in natural ground in sequences
- Preparation of the pipe bed (laying the pipe bed with adequate material)
- Laying the pipe (with all fittings, bends, etc.)
 - From chainage 0⁺⁹⁵⁸ to chainage 2⁺⁰⁰⁰ : DCI Pipe DN 200/C64 (PN 40)

- From chainage 2⁺⁰⁰⁰ to chainage 4⁺⁵⁹³ : DCI Pipe DN 200/C40 (PN 25) including the construction of thrust blocks
- Backfilling, compacting and closing the sub-sections
- Construction and junction of 5 washouts (concrete chamber) along the road (detailed location provided in the drawings)
- Construction and junction of 4 air valves (concrete chamber) along the road (detailed location provided in the drawings)
- Construction of a derivation chamber to the Grand Etang and a pipeline section (DN 200/C40) of 30 m to a connection point
- Construction of 10 crossings at the intersection with the culverts (detailed location provided in the drawings)
- Road reinstatement

Section 3: Access road to Antenna (4⁺⁵⁹³-4⁺⁹⁵²). The last section leads up to the high point located at the Antenna 1910. The road is a one-way unpaved road, driveable with a 4x 4 wheeled car with steeps till 10-12° bordered by intense vegetation.



Figure 20: Access Road to Antenna

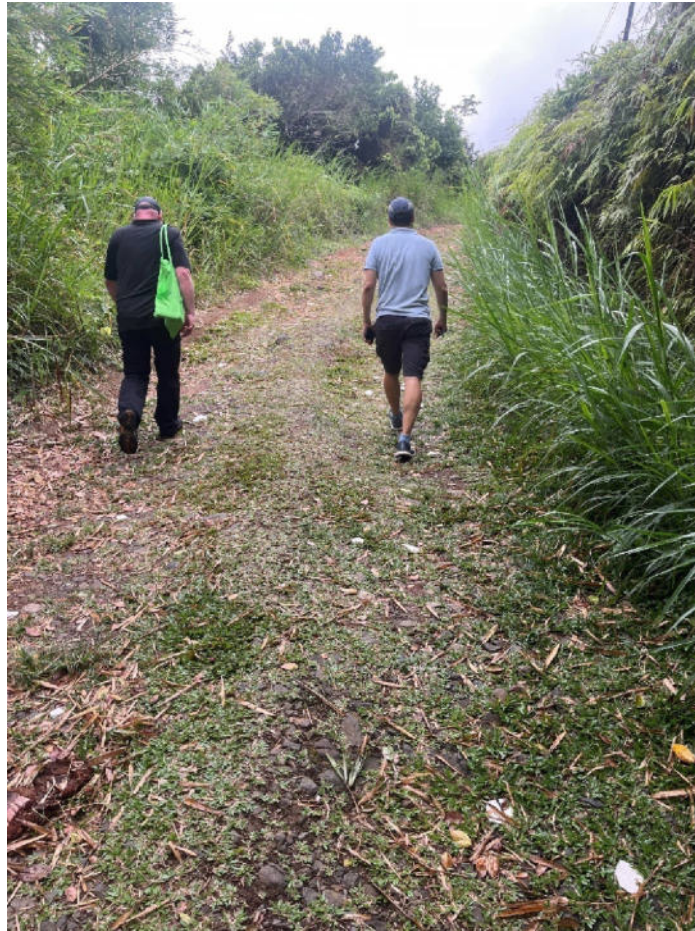
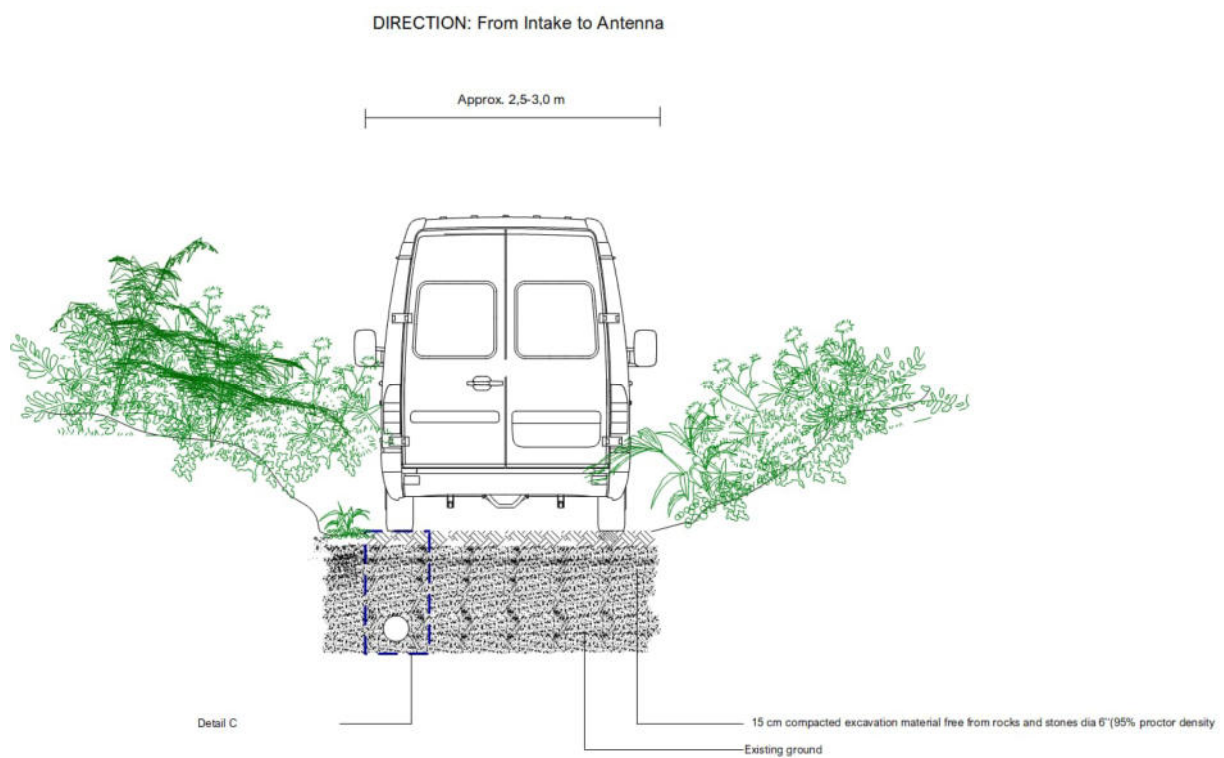


Figure 21: Access Road to Antenna



The works in this section consist mainly of:

- Clearing the vegetation

- Excavating the trench in natural ground in sequences
- Preparation of the pipe bed (laying adequate material)
- Laying the pipes (with all fittings, bends, etc.): DCI Pipe DN 200/C40 (PN 25)
- Backfilling, compacting and closing the sub-sections
- Construction of a concrete chamber as a relief connection chamber between the DCI pipeline and the HDPE pipeline
- Upgrading the entire access road with compacted excavation, gravel material and asphalt over a length of 350 m.

Antenna to LA WTP (PE pipe)

As per feasibility study the preferred option for this part of the transmission line is the Option 1. The option starts at the Antenna location 1910 (Chainage 4⁺⁹⁵²) and follows a line through West of the mountain ridge to the LA water treatment plant. It's a gravity flow transmission line.

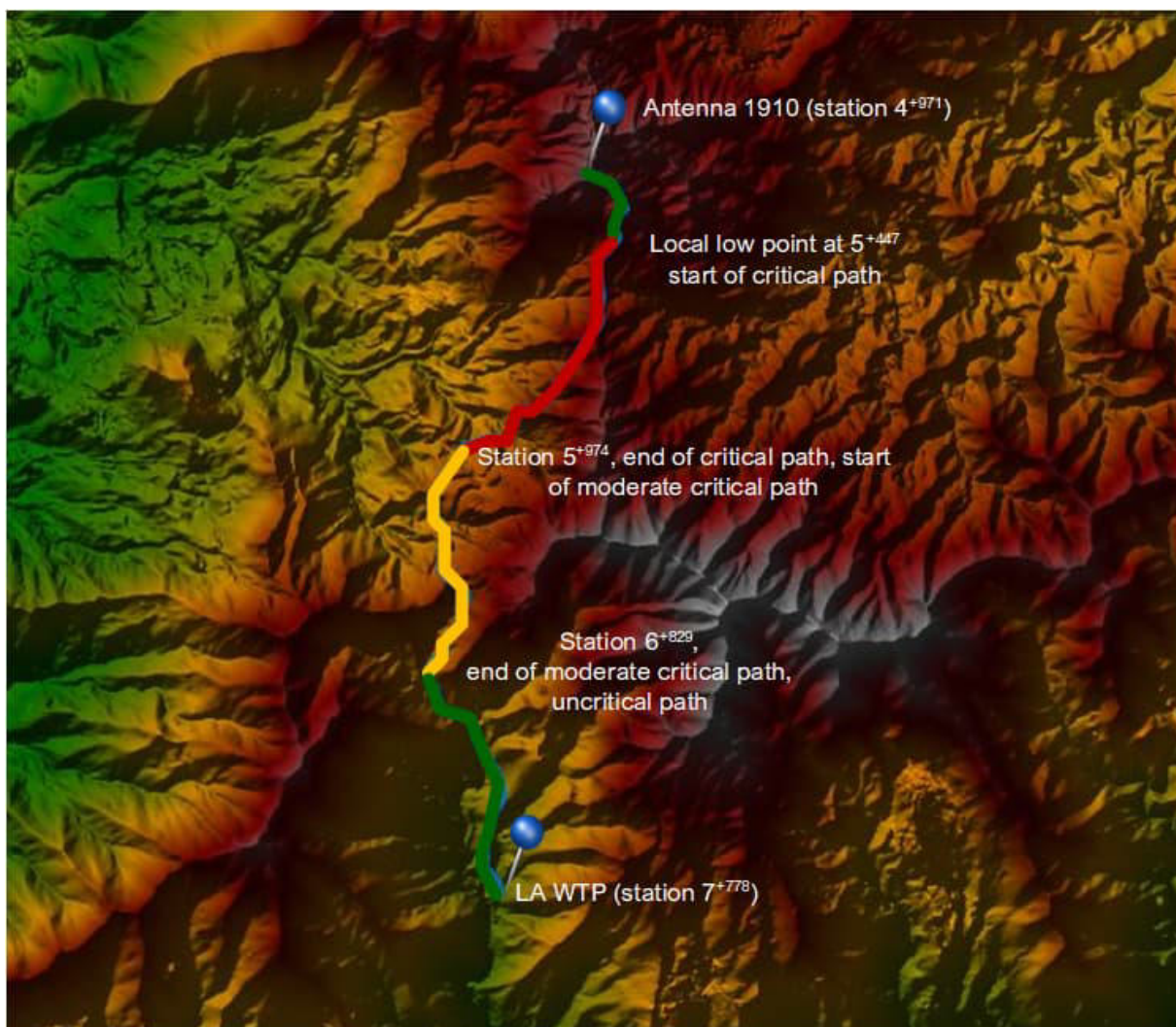
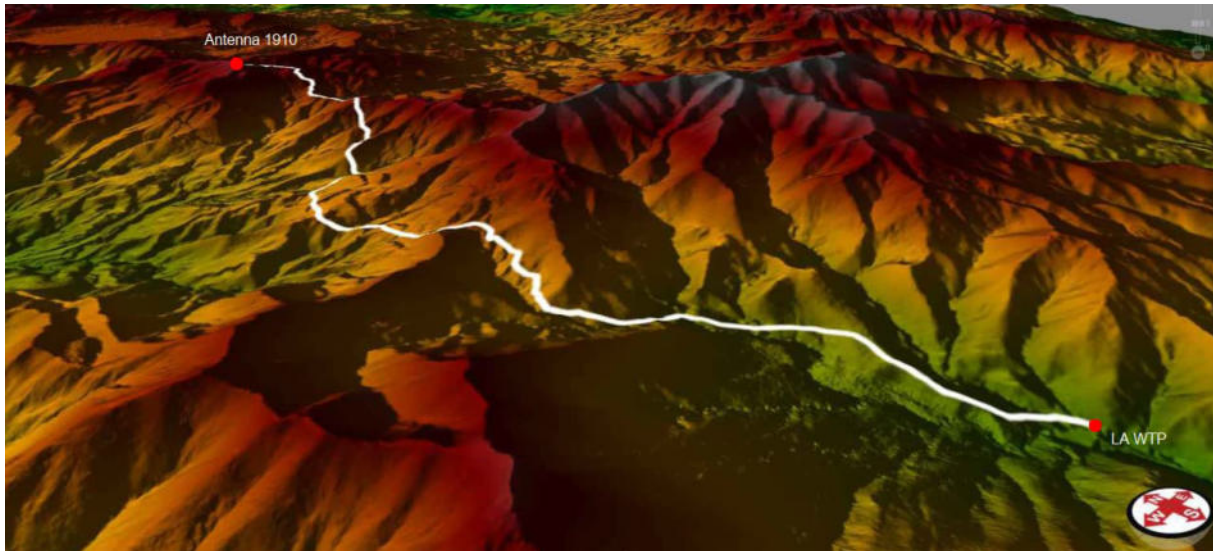


Figure 22: 3D Digital elevation model of preferred option from Antenna to LA WTP



It is characterized by 4 distinctive sections:

Section 1 : over 476 m follows the hiking trail to a local low point situated at 5⁺⁴⁴⁷. The steepness of this section allows the laying of underground pipes (excavation in natural ground).



Figure 23: Start of the path Option 1 from Antenna 1910



Figure 24: First common path eastern direction

Section 2: Critical path (5⁺⁴⁷⁷-5⁺⁹⁷⁴) over 497 m is characterised by a succession of steep up and downs with a steepness of 60-70% maximum (30-35°) with local peaks. This part is the most difficult for the pipe laying.

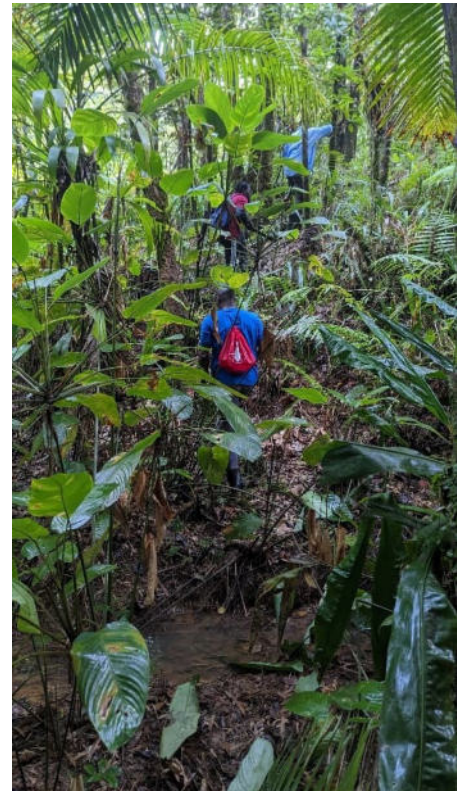


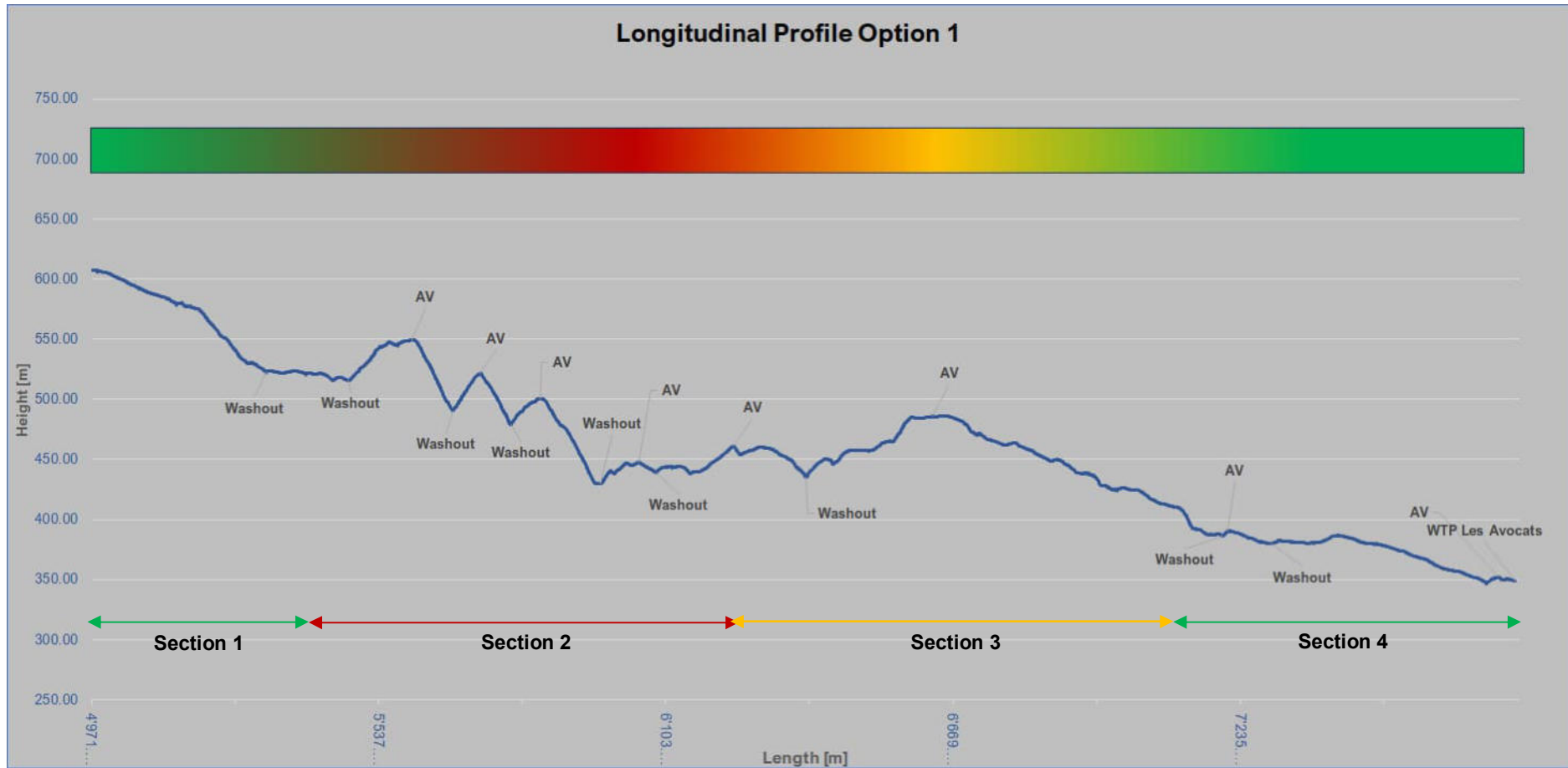
Figure 25: Critical path option 1

Section 3: moderate critical path (5⁺⁹⁷⁴-6⁶²⁹) over 655 m with a succession of moderate ups and downs up to a local high point at 6⁺⁶²⁹ and height 485,67 m over N.N. The maximum steepness is 60% (30°)



Figure 26: Moderate critical path option 1

At the local high point (around 6⁺⁶²⁹-6⁺⁶³⁵) a pressure reducing system is to be installed. This will lead to a reduction of the pressure and consequently the use of pipes and fittings in PN 16.



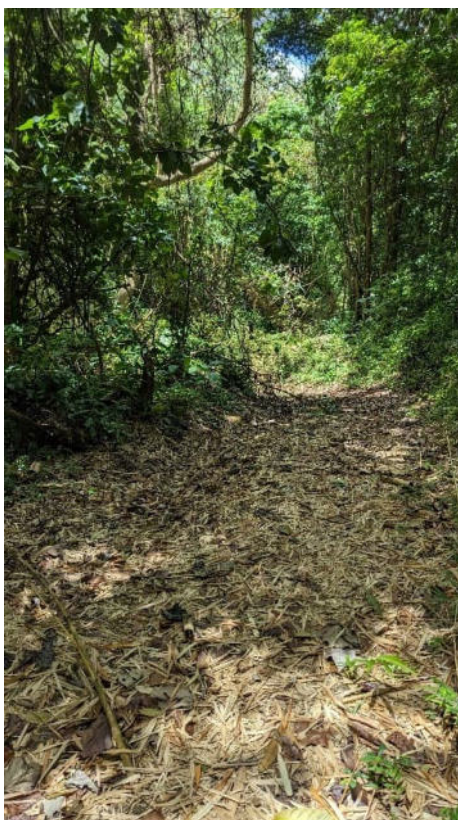
Legend



Length of the critical path	497 m
Length of moderate critical path	655 m
Length of the uncritical path	1,655 m
Total Length of option 1	2,807 m

Section 4: “flat”/uncritical part to les Avocats

The last section is relatively flat over a length 1,149 m (6⁺⁶²⁹-7⁺⁷⁷⁸) to LA WTP.



The works in this section consist mainly of:

- Clearing the vegetation
- Excavating the trench in natural ground in sequences
- Preparation of the pipe bed (laying of adequate material)
- Laying the pipe (with all fittings, bends, etc.): HDPE pipe OD 160 SDR 11 (PN 16)
- Backfilling, compacting and closing the sub-sections
- Placing of 8 air valves (local high points) and 10 washouts (local low points)
- Construction of the pressure reduction system (incl. concrete chamber)
- Construction of an outflow structure into the reservoir of LA (concrete structure)

This section will be built with PE Pipes OD 160/SDR 11 (PN 16). As there is no heavy traffic expected in this section the burying depth is reduced to 40 cm below the ground but depending on the topography (particularly in section 2) it cannot be excluded that part of the line will be placed over the ground.

3.2.5 Project Alternatives

Various options to address the water supply problem within the southeastern communities were discussed and reviewed by the NAWASA/GIZ technical team. Based on this analysis, the

two dams that were initially planned (i.e., the Les Avocats extension and the new Petit Etang construction) were deemed too expensive and not sufficiently effective. Other possible sites for constructing a dam in the neighbouring catchments were investigated. Mount Williams Dam would have been an alternative. However, this would require the construction of a relatively high dam to guarantee the desired effect of fulfilling the water demand including during dry years. The construction of the new dam at Mt. William was therefore cancelled due to the scale of the intervention needed and the budgetary and time constraints to operationalize this solution.

A more cost-effective solution with much less impact on nature was the preferred idea to transfer water from the neighbouring Great River catchment area to the existing Les Avocats system. No huge dam construction is required under this alternative option. Rather under this scenario, transfers are only necessary during the dry season, when there is not enough water available. During the rainy season, Les Avocats can continue to meet the demands. It should also be noted that when the Grand Etang Nature Reserve was established in the beginning of last century, one of its objectives was to secure the water supply for Grenada.

Various routes were investigated to transfer the water from the Great River. One possibility would have been to pump the water from the Great River into Grand Etang Lake, store it there temporarily and channel it to Annandale during the dry season. This would have had an additional impact on the Grand Etang ecosystem and necessitate restructuring of the St. George's supply network to reach the southern area supplied by Les Avocats from Annandale. Besides, this proved to be too costly, especially as additional pumping stations would have been necessary. An alternative transfer via a southern route, following the Great River and subsequently pumping the water along the Eastern Coast back to St. George's would also have been too costly. The team therefore decided in favour of the currently planned route, from the Great River, through the Grand Etang Forest Reserve and then unto Les Avocats.

3.2.6 Complementary Projects/Programmes – Ongoing and Planned

To address the water supply challenges in the target communities and within Grenada generally, the following complementary interventions are planned or are ongoing with positive implications for the proposed project. These interventions designed to strengthen the resilience of the water sector in Grenada are planned and/or implemented by the G-CREWS Project, the government of Grenada, and other entities.

1. NAWASA is presently building a new water treatment plant with a capacity of 600,000 gal/day at Laura Lands, St. David's. The site is located about 1756m away from the Les Avocats facility. This forms part of NAWASA's capital expenditure (CAPEX) Projects. The intervention has already started and is projected to be completed in the third quarter (Q3) of 2024. The design of this facility is not part of the proposed Seven Sisters project. Additional water storage capacity at this facility is also envisaged.
2. The construction of a new glass-fused steel tank for treated water at the Petite Etang Water Treatment Plant. This new facility will provide an additional 1,364 m³ (299,944 GPD) of storage capacity.
3. Promotion and training in the setting up and maintenance of rainwater harvesting (RWH) systems targeting various groups across the country. This initiative is implemented through the G-CREWS Project and the Ministry of Agriculture, particularly through its Extension and Land Use Divisions.
4. Prioritization of demand reduction strategies to include:
 - a. Public awareness and education aimed at reducing water consumption across the sector.
 - b. Promotion of water-efficient technologies, including at the household level.

- c. A possible ban on the importation of non-water efficient fixtures and related technologies.
5. Implementation of remote monitoring and control (SCADA) systems and sediment proofing of intakes to address the concerns of increased turbidity in the water stream after heavy rainfall. Funding for a pilot initiative is planned under the G-CREWS project.
6. Setting up of the Water Resource Management Unit (WRMU) consistent with Component 1 of the G-CREWS project, “Climate-Resilient Water Governance.” The WRMU will be responsible for managing Grenada’s water resources as provided for in the National Water Policy, the Water Resources Management and Regulations Action 2021, and related instruments.

3.3 Topography and land use

Areas of planned works within the project site range in elevation between 262 m at the intake to almost 700 m at the high point along the route to Les Avocats. While a few parts of the site from the antennas at 1910 to Les Avocats are moderately flat to gently sloping, a considerable part of this section of the route has slopes more than 30 degrees. There are areas along the route particularly as one approaches the Mt. Sinai and Mt. Lebanon high points which are quite challenging to traverse, compounded by very narrow ridges and sharp cliffs. Integration of landslide and soil erosion risk reduction measures during any planned works within this part of the reserve would be imperative.



Photo 1 (top left): gently sloping lands from the antenna moving southward

Photo 2 (top right): One of few flat areas before ascending up the mountains

Photo 3 (bottom): Steep to very steep terrain in the upper parts of the ridge

Source: Roberts Caribbean

Figure 27: Photos showing topography across the route from 1910 to upper ridges in the Reserve

Three land use systems are dominant within the project site: abandoned cropland, forest, and agriculture (see Figure 28 and Table 7). The former is observed primarily in the “Gangadee” area. Although a considerable percentage of available lands remain abandoned post Hurricane Ivan and Emily in this part of the project site, agricultural activities have recommenced subsequent to the development of the updated Land Use Map. The majority of the site is described as forest in line with the Reserve designation. The area of land moving towards Les Avocats is considered agricultural based on the land use map. This is somewhat different to what currently exists as evidenced during the vegetative assessment. Most of the lands close to the treatment plant and reservoir are primarily secondary forest.



Figure 28: Land use across the project site and wider study area

3.4 Road and Transport Network

Connecting the eastern town of Grenville to the city of St. George is a primary transportation artery that passes through the Grand Etang Forest Reserve. This is a primary road that connects the eastern part of the island including the town of Grenville to the south, passing through the central mountain range. The road traverses the communities located downstream of the proposed intake (including Grand Bras, Balthazar, Adelphi, and Birchgrove) up to 1910 and then moves in a southwesterly direction to the city of St. George. Due to the topography of the upper part of the Great River Watershed, the Grand Etang Main Road winds through steep areas across the forest reserve. The water pipes leading from the access road in “Gangadee” to the 1910 ridge are proposed to be installed along this major road (section 2 of the pipeline route).



Figure 29: Road and transport network map

The Road is in good condition and is heavily used by both public and private vehicles. Approximately 45 buses part of the Grenville to St. George’s fleet use this road daily as part of their operation, completing on average two trips daily. The estimated number of other private and public vehicles is not documented. Vehicular traffic increases during the annual tourist season. Consistent with other main roads across mainland Grenada, the peak hours for traffic are between 6 a.m. and 8:00 a.m. and during the afternoon and early evening periods (2:00 p.m. to 5:00 p.m.). Adoption of the necessary traffic management measures is required during the construction phase to limit the impact of delays, congestion, and other related issues.

Two other unpaved roads are located within the project site: (i) A 10-foot unpaved road from the intake to the Grand Etang Main Road, representative of Section 1 of the pipeline, and (ii) a road from the Grand Etang Main Road to the antennas just off 1910 (part of Section 2 of the pipeline route). Both roads are lightly used. The former is used largely by farmers and landowners with property within the “Gangadee” area, as well as persons accessing the river and the “Gangadee”/Adelphi Falls for recreational purposes. The latter is mainly accessed by utility companies and to a lesser extent persons accessing the area for relaxation and/or recreation (e.g., to use the 1910-Apres Tout trail).

3.5 Environmental Noise

Noise is generally unwanted sound that affects or may affect people physiologically or psychologically (Muzet, 2007). WHO also defined environmental noise as noise from all sources except from the industrial workplace (WHO 1999). Major sources of noise include vehicles, outdoor activities, and natural sounds such as waves and wind. Environmental noise affects everyone, hence, the importance of noise assessments.

For this study, environmental noise was recorded at four (4) sites along the proposed route for laying the pipes using a sound level meter (CEM DT- 8852). Measurements were undertaken on October 18, 2023 during the afternoon hours (1pm – 4pm). At each site, environmental noise was recorded for three minutes, noting the minimum and maximum levels (dBA).

The objectives for this assessment were to determine the level of noise exposure at various critical points along the route between the intake and the forest zone. It also established a benchmark for future reference. The guidelines for the assessment were adopted from the World Health Organization (WHO) as shown in Table 4.

Table 4: Guidelines for noise levels in specific environments (WHO, 1999)¹

Specific environment	LA (eq)/dBA	Time base (hours)	LA Max (fast)
Dwelling , indoors ⁸	35		
Outdoor living area	55	16	-
Industrial, commercial shopping and traffic areas (indoor and outdoor)	70	24	110
Parkland and conservation areas	Quietness to be preserved and the signal-noise ratio kept low	-	-

Table 5 outlines the results of the environmental noise assessment. The average noise level along most sites assessed were within a threshold of 50 dBA. Generally, the average noise

⁸ To avoid sleep disturbance, bedrooms should be 30dB LAeq for continuous noise and 45 dB LAmax for single sound events (WHO, 1999).

levels at all sites studied were less than 45 dBA and complied with the requirement for parks and conservation areas, except for the main recreational area along Grand Etang Main Road.

Many studies agree upon a 70 dBA limit to prevent any adverse effects on human health. From our findings, the average dBA for each site was substantially less than 70 dBA. In conclusion, the proposed project area is generally quiet and consistent with the protected area designation. Therefore, it is of paramount importance that the proposed project adopts measures to mitigate activities that may exceed 70 dBA to prevent any disruption to public health and the general tranquil setting within the Grand Etang Forest Reserve.

Table 5: Results from the environmental noise survey

Site #	Sites	GPS Coordinates		Minimum/ dBA	Maximum/ dBA	Average/ dBA
		Latitude	Longitude			
1	1910 Antenna	12.0901775N	61.7027063W	41.3	48.1	44.7
2	Grand Etang Visitor Center	12.0939736N	61.6953301W	52.6	54.2	53.4
1	Riparian Adelphi	12				
3	First house along access road to intake (from Grand Etang Main Road)	12.1040520	61.6773880	39.5	46.2	42.9
4	Last house along access road to intake	No satellite reading	No satellite reading	41.1	43.2	42.1

3.6 Climate

Grenada experiences a tropical climate characterized by warm temperatures and significant rainfall throughout the year. The island's climate is influenced by its location in the northeastern Caribbean Sea, which exposes it to the northeast trade winds.

3.6.1 Temperatures

Grenada's temperatures are consistently warm, with relatively minor seasonal variations. Average temperatures range from around 24°C (75°F) to 30°C (86°F) throughout the year. The warmest months typically occur from June to October.

3.6.2 Precipitation

Average Rainfall:

Grenada experiences a distinct wet season from June to December and a dry season from January to May. The average annual rainfall across the island varies between approximately 1,500 to 2,000 millimetres (mm), with some regions receiving slightly more or less depending on local topography and exposure to pre-vailing weather systems. The reserve for example has an average precipitation of 2,500 mm.

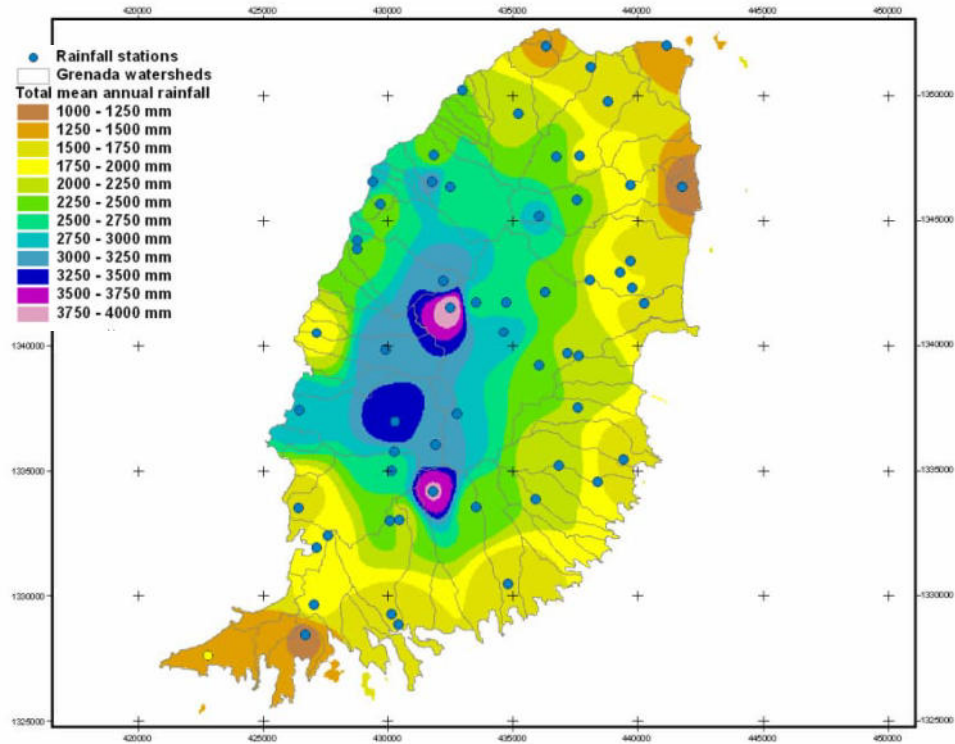


Figure 30: Mean annual rainfall

Monthly Rainfall Patterns:

During the wet season (June to December), rainfall in Grenada tends to be heaviest from July through November, with September and October typically being the peak months for precipitation. Monthly rainfall averages during this period can range from 150 mm to 300 mm or more, especially during tropical storm or hurricane events.

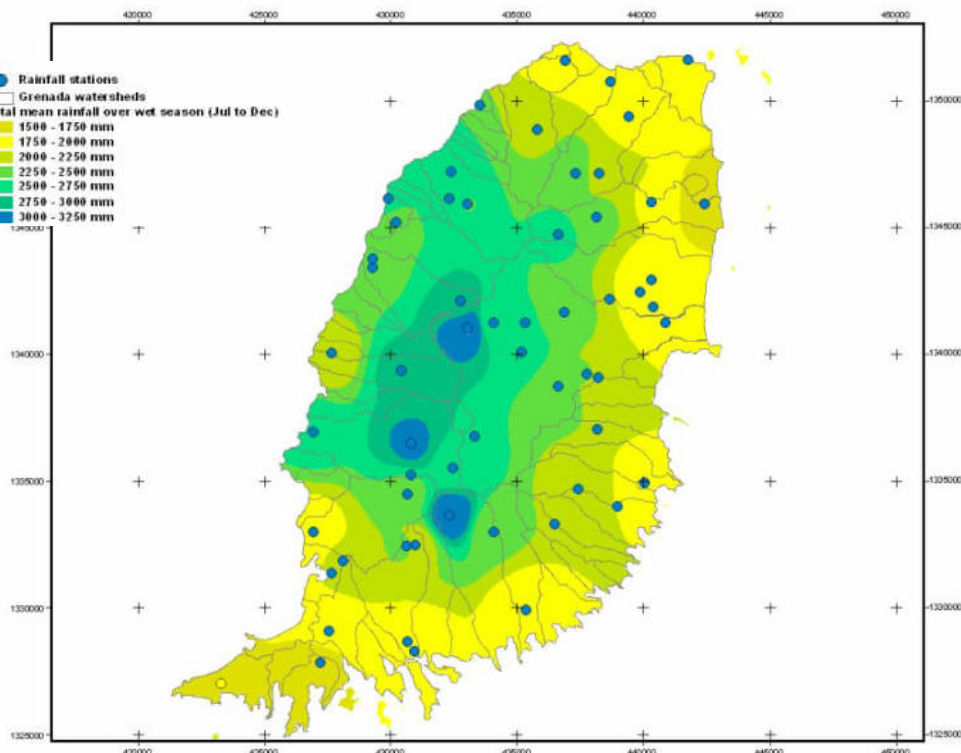


Figure 31: Mean wet season rainfall

Dry Season Rainfall:

Even during the dry season (January to May), Grenada still receives some rainfall, albeit at reduced levels compared to the wet season. Monthly rainfall during these months generally ranges from 50 mm to 150 mm, with February and March typically being the driest months.

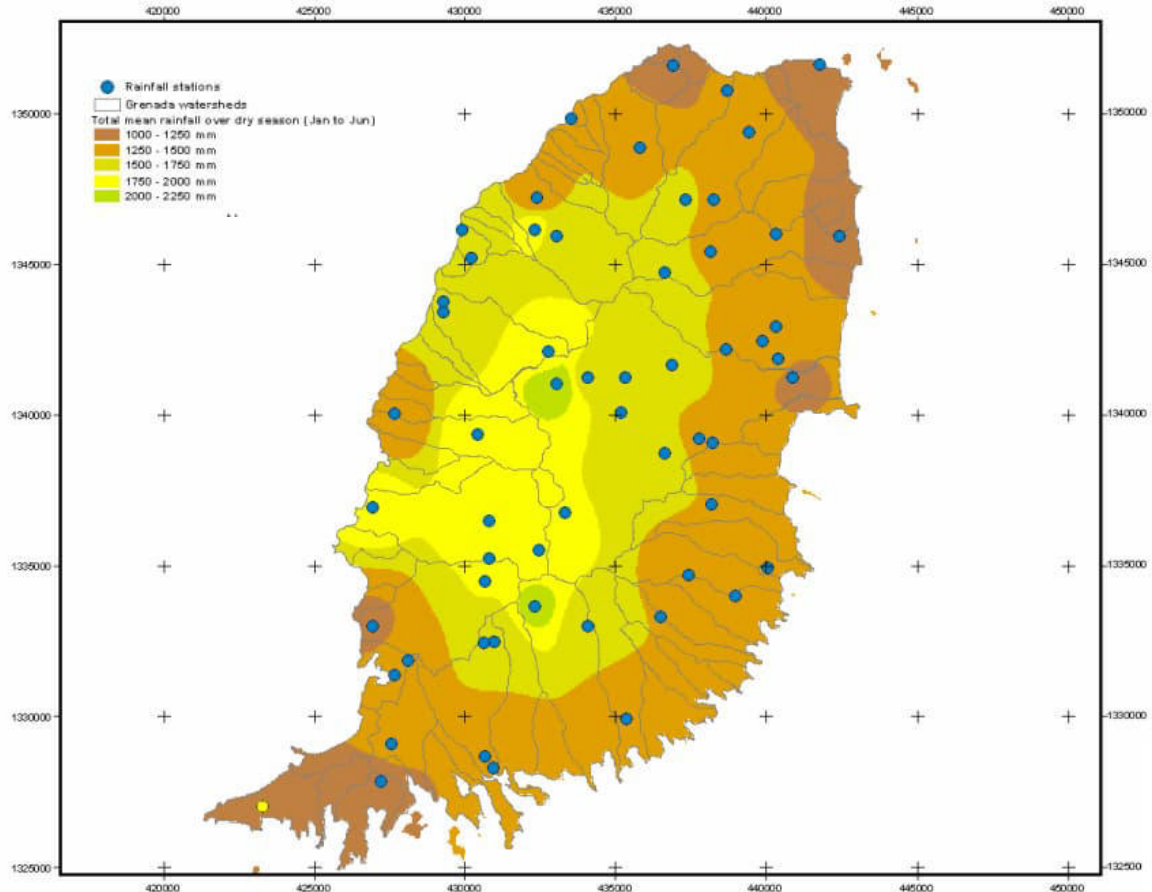


Figure 32: Mean dry season rainfall

Impact of Hurricanes and Tropical Storms:

Grenada is susceptible to hurricanes and tropical storms, especially during the peak of the Atlantic hurricane season (August to October). These weather events can cause significant spikes in rainfall and lead to localized flooding, particularly in low-lying areas and river valleys.

3.6.3 Humidity

Humidity levels are consistently high in Grenada, especially during the wet season. Humidity typically ranges from 70% to 90% year-round, contributing to the island's lush vegetation and tropical feel.

3.6.4 Local microclimate

In terms of specific parishes, St. Andrew Parish, located in the northern part of Grenada, experiences similar climate patterns to the rest of the island. It receives ample rainfall during the wet season, making it one of the lushest areas on the is-land. The temperatures are moderated by its proximity to the ocean, with refreshing breezes. St. David Parish, located on the southeastern tip of Grenada, also experiences a tropical climate but may be slightly drier compared to other areas of the island during the dry season. It is influenced by the northeast

trade winds and can have higher temperatures during the day, with rainfall patterns aligning closely with the rest of Grenada.

3.7 Geology

From a geological standpoint, Grenada is located at the southernmost end of the volcanic chain of islands comprising the Lesser Antilles arc. Almost all rock types are volcanic in nature with a few exceptions, such as Gouyave, Mount Parnassus Valley, and Mt. Alexander. This is an indication that igneous activity was part of the country's geological history possibly from the Eocene and into the Oligocene periods (Arculus as cited in The UWI Seismic Research Center, n.d.).

Lava flows and pyroclastic rocks are the two main categories of volcanic rocks in Grenada. The former produced Olivine Basalt, Augite Andesite and Hornblende Andesite; the pyroclastic rocks are Agglomerates, Ashes and Tuffs (pronounced "tiff"). The lava flows are slower moving and can be found close to craters such as Mt. St. Catherine, Grand Etang, and St. George's Bay. Materials that would have been blown further from its points of origin are the pyroclastic rocks. Therefore, most of the perimeter of Grenada is made up of hills and mountains ranging from Agglomerates to Tuffs. The Tuff is seldom found above elevations of 700 ft. The Olivine basalt rocks are uniformly fine grained, very dense and black or dark greenish-grey.

Grenada is characterized tectonically by two conjugate fault trends (Martin-Kaye and Arculus as cited in UWI SRC, n.d.). The main one runs NNE-SSW and corresponds to the elongation of the island. The other is approximately normal to the main trend. One of these lines passes through the southwestern end of the Grand Etang Forest Reserve. Martin-Kaye (1969) and Arculus (1976) have suggested that the orientation of the explosion craters may be controlled by the main NNE-SSW fault trend (UWI SRC, n.d.) (see Figure 33). This provides evidence of a possible weakness in the crust around this part of Grenada and pre-historic geological activity. However, there is no evidence that these areas are currently or historically active. This however, does not preclude activity in these areas in the future (Richard. Robertson, UWI Seismic Research Center, Personal Communication, October 18, 2023). Consistent with best practice, integration of the necessary due diligence to prevent and reduce the risk of geological movements on installed infrastructure is strongly advised.

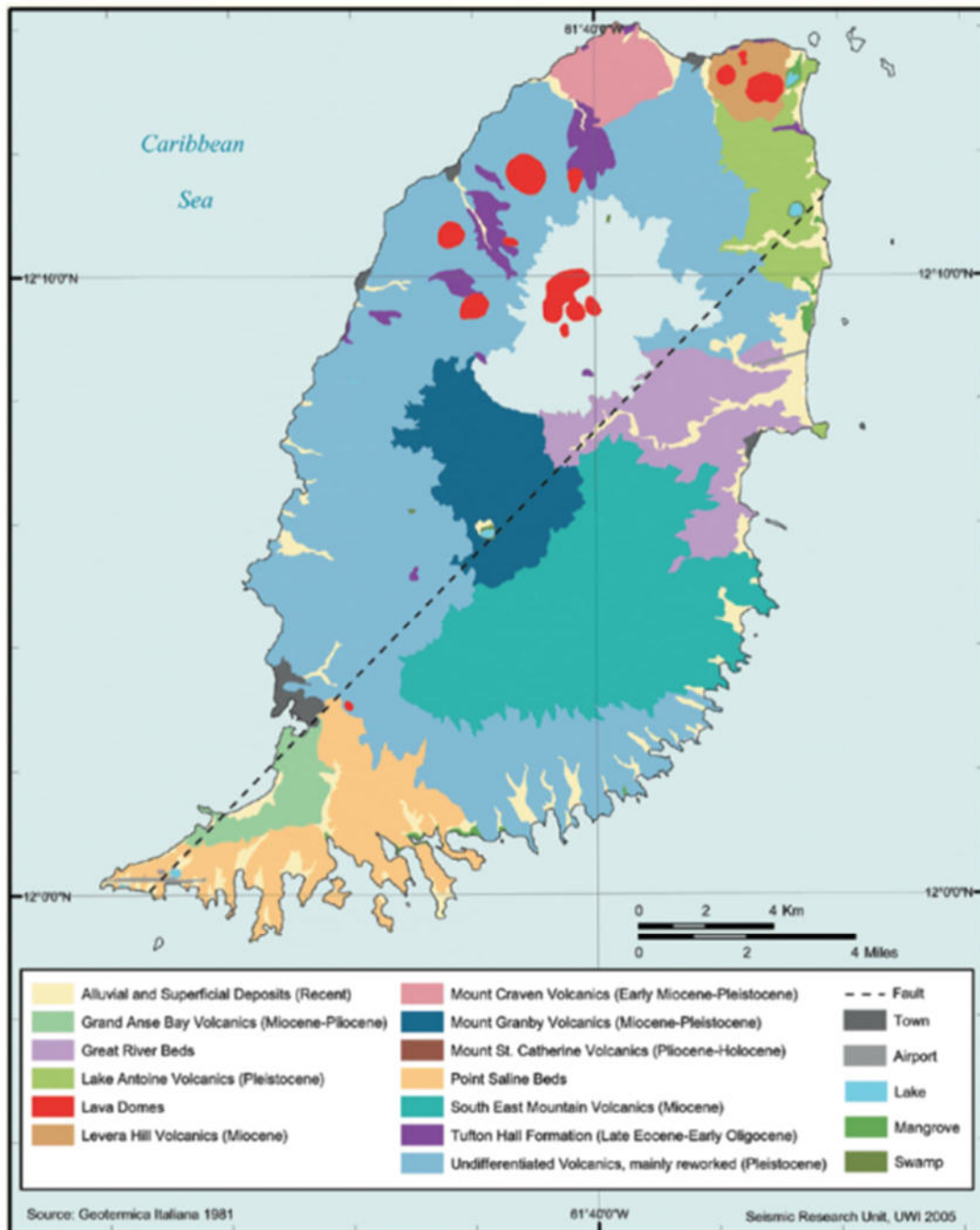


Figure 33: Geology map of Grenada (Seismic Research Unit, UWI)

The Southeast Mountain, part of which is located within the Grand Etang Forest Reserve was active during the Miocene period⁹. The area is composed of andesite domes, lava and pyroclastic flow deposits that radiate from the Southeast Mountain. Located in the west of the Southeast Mountains is the Mt. Sinai, Mt. Maitland, and Mt. Moritz Volcanic Center. This area is generally agreed to have become active during the Pliocene. The center of activity appears to have been located somewhere in the vicinity of Mt. Maitland and Mt. Sinai. The sequence of activity appears to have involved the emission of a series of mainly basaltic lava flows and pyroclastic deposits during the upper Pliocene and lower Pleistocene periods (Seismic Research Center, UWI, n.d.).

⁹ Miocene - 23.03 to 5.3 million years ago (Source: University of California Museum of Paleontology).

Generally, the Great Riverbeds is the main geological base for the Great River. Other important geological base within the proposed project site are the Mount Granby Volcanics and the Southeast Mountain Volcanics located along the route from 1910 to Les Avocats (see Figure 34).

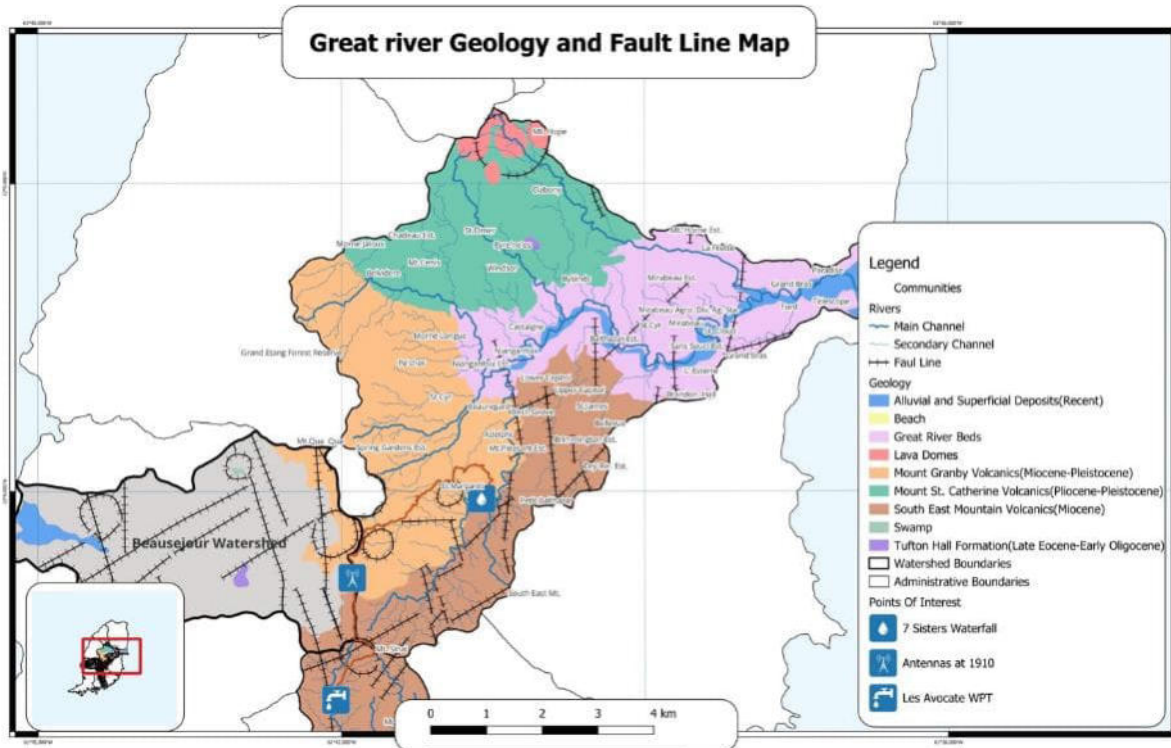


Figure 34: Geology within the project site & study area (Land Use Division)

3.8 Soils

Based on the Ministry of Agriculture’s soil classification system, capitol clay loam is the principal soil type dominating the project site and wider study area. capitol clay loam is a fine textured moderately well to well-drained soil of variable depth. Such soils are suited for forested areas in shallow steep areas with high rainfall as found in the Grand Etang Forest Reserve.

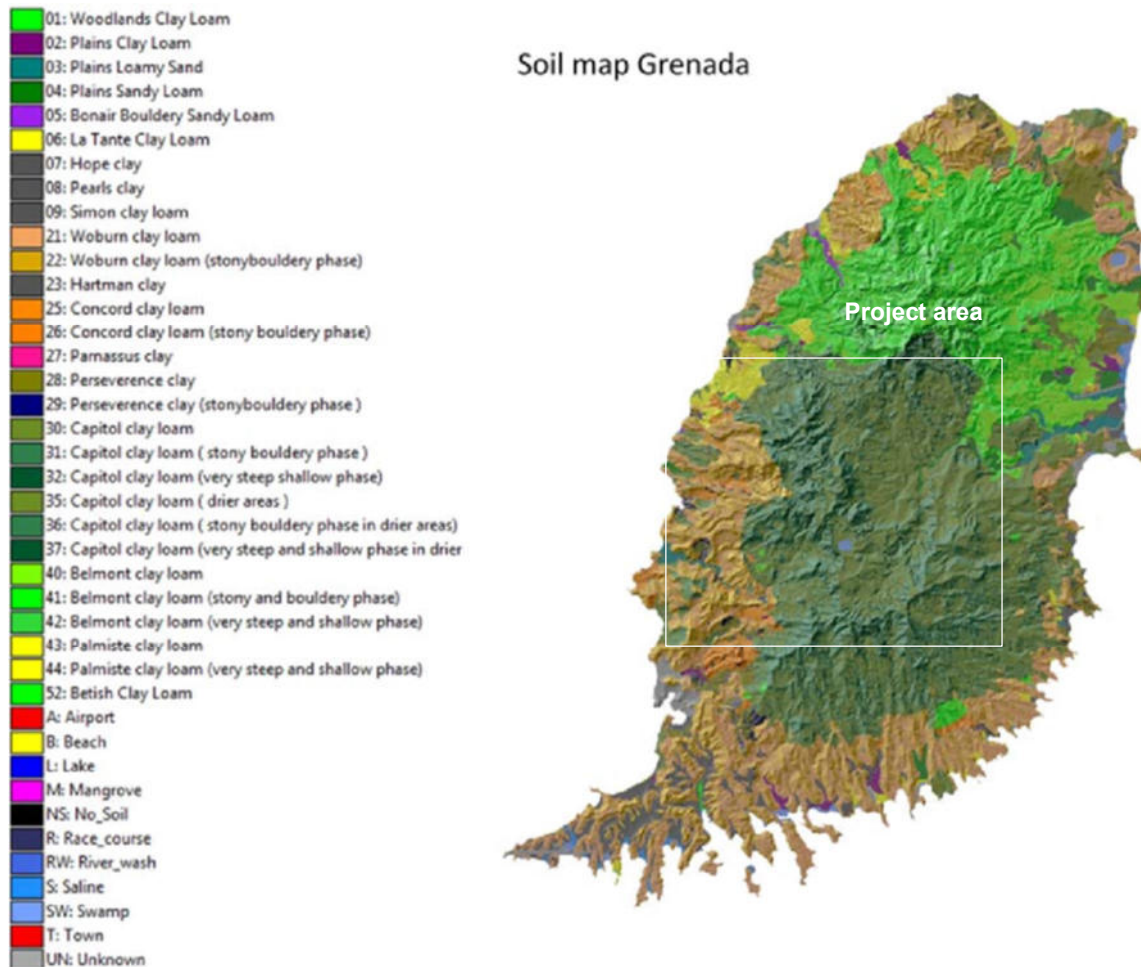


Figure 35: Soil types within project site

3.9 Point and Non-point Sources of Pollution Around Intake

A review of the catchments around the intake shows that the river is drained by an area of higher elevation on the north-westerly end. Local people have reported that during periods of heavy rain, large volumes of runoff flow from the higher embankment and enter the land area that is proposed for installing Pump #1. Although farming occurs in this area, it appears that most farms are located downstream of the proposed intake. Some low-intense subsistence farming has occurred in the lots close to the intake, however, based on reports from farmers and visual observation, it appears that this activity is not currently active. Along the upper parts of the access road in this area, an estimated 10 farms are involved in active production, focused primarily on tree crop production (e.g., bananas and nutmegs). The effects of weedicide on roadside vegetation and along byroads leading into these farms were also observed.

3.10 Hazards, Vulnerability, and Climatic Risks

Disasters caused by natural hazards and climate change are existential threats to the state of Grenada, with resultant annual losses from these events estimated at 1.7% of gross domestic product (GDP) (IMF, 2022). The most significant hazards for Grenada are hydro-meteorological, geophysical, and biological. Given the nature of the project site and study area, the most pertinent hazards are likely associated with tropical cyclones, earthquakes, landslides, drought, and the introduction of invasive species into sensitive ecosystems. Most of these events are highly likely to be aggravated by climatic factors, resulting in increased intensity and severity. Within this context, Grenada was ranked in the top 2% for climate-related natural

disasters as a percent of GDP during 1997-2017 when compared to the 182 countries in the Climate Risk Index (IMF, 2022). Climate proofing the proposed development is an absolute necessity. This is congruent with the mandate of the G-CREWS project to build climate resilience in all its funded subprojects.

3.10.1 Tropical Cyclones (Hurricanes and storms)

Tropical storms and hurricanes typically occur within a region of the North Atlantic Ocean referred to as the Hurricane Belt, which is an area of ocean that extends between 56° to 95° West longitude and 10° to 25° North Latitude (Bowie, 1922). Grenada's location at the southern end of the hurricane belt is at less risk of devastating tropical cyclonic activities compared to its Caribbean peers (IMF, 2022). Nonetheless, the country was adversely impacted by previous hurricanes, most recently by Category 3 and 1 Hurricanes Ivan and Emily in 2004 and 2005 with devastating effects on the forest sector. The macro-socioeconomic assessment of Hurricane Ivan reported that 91% of forest lands and watersheds were bare and stripped of vegetation with potential negative implications for the provision of ecosystem services such as aquifer recharge (OECS, 2004). Water supply infrastructure including distribution lines, treatment plants, and related buildings also experienced damage that required rehabilitation. Flooding associated with storms and hurricanes can also affect pumping systems and the efficiency of water treatment plants. Cognizant of the IPCC's prediction that climate change can increase the intensity of hurricanes and storms, it is paramount that the proposed development be designed to include changes in frequency and/or intensity of cyclonic activity due to predicted climatic conditions.

3.10.2 Earthquake and Landslides

Earthquakes occur as the plates slip or grind against each other along the subduction zones. Within the last decade, 10 earthquakes of magnitudes above 5.0 with epicentre between 75km and 293km from St. George's were documented (Earthquake Track, 2023). Nine events (90%) had magnitudes between 5.1 and 5.9. The strongest earthquake occurred on August 21, 2018, reporting 7.3 on the Richter scale with its epicentre about 190km from St. George (Earthquake Track, 2023). Generally, earthquakes are felt at varying degrees across the state. Risk of damage and losses is linked to among other factors the integrity of the built infrastructure. Although earthquakes remain impossible to predict with current technology, such events can be expected intermittently. Consequently, the design, materials, and method utilized in the construction should integrate measures to reduce the risk of earthquakes during the operational phase.



Figure 36: Landslide susceptibility map

Further, due to the steep landscape within a substantial part of the Grand Etang Forest Reserve, the risk of landslide is moderate to high under conditions that expose and disturb bare soil coupled with heavy precipitation and runoff. There is no documented evidence available on the number and scale of landslide events at the project site. During walkover reconnaissance and site visits of the project site, landslides were not observed. Soil movement was seen in few instances moving through the route from 1910 to Les Avocats due to a toppled tree most likely caused by natural occurrences. Albeit this, due to increased anthropogenic impacts associated with the proposed project, integrating landslide risk reduction measures is pivotal, particularly in Section 3 of the pipeline route aimed at maintaining forest integrity and the health and safety of workers' and other users.

3.10.3 Drought

The Intergovernmental Panel on Climate Change (IPCC) in its Sixth Assessment Report noted that freshwater systems on small islands, especially SIDS are increasingly stressed by changing climatic factors (IPCC, 2022). This is driven by increasing air temperatures and variations in rainfall patterns. A vulnerability assessment of the water sector in Grenada found that a deficit of 22,800m³/day (5,015 gal./day) already exists between water demand and available yield in the dry season on mainland Grenada (GoG, 2017d), an indicator that the impacts of climate change are already occurring. Higher temperature extremes are also predicted. The mean annual temperature is projected to rise by about 2.9oC on average by the end of the century (i.e., 2017-2100 compared to 1981-2010) under a high emissions scenario. If emissions decrease rapidly, the temperature rise is limited to about 0.9oC (WHO, 2020). The percentage of hot days¹⁰ is projected to increase substantially. By 2100, almost 100% of days on average will be considered 'hot' under a high emissions scenario¹¹. If emissions decrease rapidly, about 90% of days on average are defined as 'hot' (WHO, 2020). This has serious implications for surface water resources and the capacity of the NAWASA to meet future demands. Related to this, drought risk projections for Caribbean SIDS aligned with observations from the Shared Socioeconomic Pathway (SSP) 2 scenario indicate that a 1°C increase in temperature (from 1.7°C to 2.7°C) could result in a 60% increase in the number of people likely to experience severe water resources stress from 2043 to 2071. These and related projections should be considered in the design of the proposed project.

3.10.4 Invasive Species

Very little documentation on invasive species in the Grenada protected forest exists. The Annandale and Grand Etang Forest Reserves Management Plan identified bamboo as an introduced invasive species in the former reserve (Turner, 2007). A major effort was planned under the Ridge to Reef project to remove and reuse the large tracks of bamboo at Annandale Forest Reserve. The extent to which this has been carried out however, is not clear. Of the 19 species of terrestrial herpetofauna (frogs and reptiles) found on the islands of Grenada, Carriacou and Petite Martinique, two are considered definite introductions or invasives (*Eleutherodactylus johnstonei* and *Anolis sagrei*), while the *Geochelone carbonaria* is viewed as a possible introduction. At Grand Etang, the *Eleutherodactylus johnstonei* was encountered in February 2004, before the passage of Hurricane Ivan (Henderson and Berg, 2006). Evidence for this invasive in Grenada was also reported by others, although the specific locations sighted were not identified (Yuan et al., 2022). Kaiser (1997) comments that the expansion of the *Eleutherodactylus johnstonei* into new areas occurs largely parallel to human expansion

¹⁰ A hot day is a day when maximum temperature exceeds the 90th percentile threshold for that time of year (WHO, 2020).

¹¹ Representative Concentration Pathway (RCP) 8.5.

associated with habitat disturbance through land development and extreme climatic events such as hurricanes and other natural hazard events.

3.11 Biological and Ecological Aspects

3.11.1 Terrestrial Ecology

Background

Generally, spanning altitudes ranging from 250 meters to 760 meters within the South-Central Mountains and extending across the parishes of St. John, St. Andrew, St. David, and St. George, the Grand Etang Forest Reserve contains the finest representations of four of Grenada's six primary forest types: Cloud Forest, Montane Thicket, Secondary Tropical Forest, and Rain Forest/Lower Montane Rain Forest (Turner, 2007). An estimated average rainfall of 2500mm is received within the Reserve annually.

The forest reserve is influenced by prevailing winds and occasional hurricanes, providing habitats for various wildlife. This includes amphibians (such as the piping frog and giant toad), reptiles (like the tree boa), birds (including the broad-winged hawk, Blue-ground dove, and Gray kingbird), and mammals (such as the nine-banded armadillo, Mona monkey, and Burmese mongoose). In 1988, the Forest Reserve was recognized as providing habitats for four (4) endangered¹², one (1) threatened, five (5) vulnerable, and two (2) rare wildlife and bird species (Government of Grenada, 1988). Information regarding invertebrates in the Reserve remains undocumented.

Situated on geological formations featuring some of the oldest rocks known in Grenada, including andesite domes, basalt flows, a volcanic crater lake, and the origins of numerous streams, totalling around 120. Moreover, the Reserve is of paramount importance to the local communities in Grenada as it serves as the primary source of water for these surrounding areas, crucial for their everyday needs and livelihoods.

Ecological Survey Method

The vegetation field survey was conducted to identify habitats and key species that could be found within the project's area of influence. The site was surveyed using walkthroughs and a modified rapid assessment protocol developed by the Center for International Forestry Research in Indonesia (Gillson, 2006), which had been adapted and utilized.

Two main sites were surveyed.

- Site 1: Riparian around the intake.
- Site 2: 1910 to Les Avocats along the Option 1 route¹³.

The rugged terrain and limited ability to access the dense understory of the Grand Etang Rainforest guided the choice of transects for habitat sampling used primarily in Site 2. A stratified sampling approach using a number of transects was used. Transects were 100 meters long and 10 meters wide. Five transects (C1 to C5) were conducted along the project site from 1910 tower at Grand Etang to Les Avocats in St. David (See Appendix 2). A complete list of plant species was recorded along each transect.

Surveys were carried out to identify the habitats and all the major taxonomic groups notably plants found in and around the proposed sites. The survey was undertaken during the period September 22-30, 2023. A major focus was placed on the identification of species of

¹² Three of these species were rated as possibly extinct.

¹³ The route along Option 1 was not surveyed due to the rugged terrain. In addition, it was not considered to be a viable route in the preliminary study report. Albeit this, the vegetative communities are likely to be similar to those found along the Option 2 route.

conservation importance that had the potential to be impacted by the project. Guided by the IUCN Red List, species listed as threatened or protected at a national level, endemic/restricted range and non-native species were recorded. Any faunal species or field indications of such species observed along each vegetation transect were also noted and documented. Birds sighted and heard were also documented.

Results

Site 1: Riparian ecology

The riparian assessment was done at Adelphi (Gangadee) and included the area approximately 50 meters upstream and 50 meters downstream of the proposed point of abstraction. Thirteen (13) families of plants were recorded during the fieldwork undertaken. This area is characterized by a mix of agricultural crops (e.g., cocoa, avocado, and coconut) and plants common to riparian zones. Plants such as *Piper dussii* (Mal lestomak), *Justicia secunda* (Brazilian Plume), and *Crinum* sp., associated with riparian areas tolerant of seasonal and permanent standing water, were also prevalent at this location. None of the plants found within the riparian are listed as threatened by the IUCN or other sources (see Appendix 2 for a list of plants along the riparian). However, they provide considerable ecosystem services including protection of the riverbank and adjacent lands from erosion, food production, lower ambient temperatures, and habitat for birds and wildlife.

Site 2: 1910 to Les Avocats - Summary of area

The species composition along this area is consistent with Cloud Forest, Secondary Tropical Forest, and Rain Forest/Lower Montane Rain Forest. These vegetation types exist within the Grand Etang Forest Reserve with remnants of mixed agricultural land found on the fringes of the reserve. Along the transects running from C1 to C5, an estimated 49 families of plants were observed, comprising 37 families of trees, herbs, shrubs and vines, and 12 families of pteridophytes and lycopodiophytes.

There is a significant secondary growth of plants on land formerly destroyed by hurricanes Janet and Ivan. Additionally, non-woody vegetation (*Gleichenella pectinate* and *Scleria secans*) dominate the forest understory in most areas. The landscape is also punctuated with prominent dandycayo (*Albizia niopoides*), mountain gommier, mountain palms, bois canot, maruba, and *Ficus* sp., towering over the other vegetation types found in the area. The presence of 'bamboo stools' (*Bambusa vulgaris*), commonly regarded as an invasive watershed plant, is ubiquitous throughout the slopes of the Grand Etang Forest. The flora species observed within 100m transects are provided in this report (Appendix 3 and 4). The Grand Etang forest is home to a wide variety of pteridophytes. Pteridophytes (ferns and lycophytes) are free-sporing vascular plants that have a life cycle with alternating, free-living gametophyte and sporophyte phases that are independent at maturity. The stem is either underground or aerial. Tropical rainforest environments are characterized by a wide variety of ferns. Ferns found at Grand Etang are indigenous and sometimes endemic to Grenada and the wider Caribbean.

A total of 49 families of plants comprising 37 families of trees, herbs, shrubs and vines, and 12 families of pteridophytes and lycopodiophytea were documented along the area of the proposed trail studied based on tree structure and species composition. Details are provided below.

Grand Etang Zone (C1)

This part of the site moves from 1910 into the lower elevation of the trail. The study site at Grand Etang (C1) is a rich and diverse environment, featuring a wide array of plant species that contribute to its ecological richness. The forest is consistent with cloud forest type vegetation. However, as elevation decreases the cloud forest characteristics change to typical

tropical and lower montane forest and palm brake vegetation. Among the notable plant species found in this area are *Richeria grandis*, *Meliosma herbertii*, *Byrsonima spicata* (seawet), *Gleichenella pectinata*, *Prestonia montana*, *Micropholis guyanensis*, *Dacryodes excelsa*, *Stachytarpheta* sp, *Monstera adansonii*, *Heliconia* sp, *Miconia racemosa*, *Euterpe broadwayi*, *Guarea glabra*, *Conostegia icosandra*, and *Oplismenus hirtellus*. The most abundant tree species observed within the transect was the *Euterpe broadwayi* (evergreen palm), *Dacryodes excelsa* (Gommier), and *Prestonia montana*. The understory is dominated by *Oplismenus hirtellus*, *Scleria secans* and *Heliconia* sp. Within the transect, the endemic, Mountain Cabbage Palm (*Euterpe broadwayi*), was observed.

Grand Etang (C2)

The Grand Etang (C2) site is at a lower elevation than C1. This area is characterized by seasonal puddles of stagnant water. The result of this increased soil moisture is a near riparian type habitat. The site is characterized by trees that dominate lower montane forest such as mountain gommier (*Dacryodes excelsa*), bamboo (*Bambusa vulgaris*) and *Ficus* sp. The trees found within this region was generally of a higher Diameter at Breast Height (DBH) than the trees in C3. This could be due to the fact that the area is more covered and protected during adverse events (e.g., storms and hurricanes) and as such less disturbed over time and to a lesser extent the effect of phototropism. Within the transect, the endemic, Mountain Cabbage Palm (*Euterpe broadwayi*), was observed.

Grand Etang (C3)

Grand Etang (C3) site spans the lower elevation and moves to a higher elevation towards the Mt. Sinai and Mt. Lebanon areas. This site is characterized by plants that do well in cloud forests. There is greater light penetration to the forest floor. The tree species composition was similar to that found in the C2 zone², however, this area is dominated by a higher concentration of tree ferns, mosses, epiphytes, and razor grass (*Scleria secans*) evidence of the higher moisture and humidity content. Other plants such as those in the family of the malestomaceae dominated this transect. Trees found in this zone were also more windswept and stunted at the highest points.

Les Avocats (C4)

Descending towards Les Avocats site are two main vegetative types. The upper part of the Les Avocats site (C4) is dominated by lower montane and tropical rainforest type vegetation. The forest in this area is relatively mature, comparable to other rainforests of the island (e.g. Mount St. Catherine and Annandale). This part of the forest is dominated by mountain gommier (*Dacryodes excelsa*), which is the climax species of the Grenada forest. While not been able to confirm that this part of the forest can be characterized definitely as a climate forest since precise measurements with respect to DBH (diameter at breast height) and tree canopy cover were not done, its growth and development are along that trajectory. A climax forest is a vegetative community that emerges in the last stage of the growth succession of the forest due to its resilience and ability to adapt to environmental conditions, including periods of stress. The site at C4 transitioned from one dominated by mountain gommier (*Dacryodes excelsa*) to the blue mahoe (*Talipariti elatum*) as described below.

Les Avocats (C5)

The lower end of Les Avocats is consistent with lower montane altitude and should be characterized by vegetation depicting this forest type. However, the lower part of the trail closest to the Les Avocats water treatment was mostly secondary forest dominated by blue mahoe plantation forest (*Talipariti elatum* or *Hibiscus elatus*). Blue mahoe is the dominant species that occupies the plantation forest within key forested areas in Grenada, including Grand Etang, Les Avocats, Vendome, St. Margarets, Panama, and Petite Etang (Paterson, n.d.).

It was introduced primarily to reforest degraded lands, reduce soil erosion, maintain watershed integrity, increase production of select forest products, and create employment opportunities in economically depressed rural areas (CCA, 1991 as cited in Patterson, n.d.). This introduced species has taken over and outcompeted many native species of trees. See Appendix 2 and 3 for complete list of plants observed.

Fauna

Very few birds and other wildlife were sighted and heard during the period of assessment. As such a Simpson diversity of index was not conducted since the results would not accurately represent the diversity and abundance in the zones assessed. The Mona Monkey (*Ceropithecus mona*) was heard around C2 and one Nine-Banded Armadillo/Tatoo (*Dasypus novemcinctus*) was spotted around C3. Birds heard and/or sighted were the Green-Throated Carib Hummingbird (*Eulampis holosericeus*), Lesser Antillean Tanager (*Tangara cucullata*), the Banana quit (*Coereba flaveola*), Gray Rumped Swift (*Streptoprocne zonoris*), Scaly-Naped Pigeon Ramier (*Columba squamosa*), Black- Whiskered Vireo (*Vireo altiloquus*). According to the Department of Forestry, nine or more additional bird species are likely to inhabit the surveyed area.

Recently introduced species of birds on the island in the last thirty years (30) include the Channel-billed Toucan (*Ramphastos vitellinus*), the Orange winged Parrot (*Amazona amazonica*), and the Scarlet Macaw (*Ara macao*). These species have been heard and sighted in the high mountainous regions of the island inclusive of the Grand Etang Forest Reserve. Based on historical records, other known extinct species centuries ago include the Euler’s Flycatcher last seen in the Grand Etang area, and the Grenada Parrot (Anthony Jeremiah, Personal Communication, September 4, 2023). See Appendix 6 for a list of birds and wildlife sighted, heard, and/or likely to be found in the locality.

A literature review and field survey were conducted to establish the presence of rare or threatened plants within the proposed project area. The research on the status of local flora populations is limited and outdated in some parts. Care must be taken to preserve all endemics. The common opossum (*Didelphis marsupialis*) and the scaly naped pigeon (ramier) are hunted for recreation and as a source of bushmeat amongst some locals. Wildlife such as opossums, mona monkey and birds feed on the fruits of plants such as the hog plum (*Spondias mombin*) trees and berries from Fije (*ficus sp*) and build their nest in the canopy of those trees.

3.11.2 Riverine Ecology Around Intake

Water Quality Assessment

Table 6 shows the results obtained for the parameters assessed as well as their respective standards for aquatic health. The related analysis and interpretation are provided below.

Table 6: Results of water quality assessments around the proposed intake

Customer/Source	Great River Watershed		Acceptable limit (authorized entity/s)
	20/05/2022 (Sample 1)	23/05/2022 (Sample 2)	
pH	7.84	7.18	6.5 – 9 (USEPA, 2016)
Total Dissolved Solids (mg/L)	60	48	-
Salinity (‰)	0.06	0.05	< 0.5 (USEPA, 2006)

Customer/Source	Great River Watershed		
Date taken	20/05/2022 (Sample 1)	23/05/2022 (Sample 2)	Acceptable limit (authorized entity/s)
Conductivity ($\mu\text{S}/\text{cm}$)	125.7	101.5	150 – 500 (USEPA, 2012)
Alkalinity (mg/L as CaCO_3)	31	23	20 (USEPA, 2016)
Chloride (mg/L, Cl^-)	11	11	230 (USEPA, 2016)
Hardness (Total) (mg/L as CaCO_3)	39	27	0 to 60: soft 61 to 120: moderately hard 121 to 180: hard > 180 mg/L as very hard (USGS, 2018)
Nitrate (mg/L, NO_3^-)	1.3	1.6	32.8 (British Columbia, 2009)
Sulphate (mg/L, SO_4^{2-})	< 2	< 2	128 – 218 (British Columbia, 2013)
Phosphate (mg/L PO_4^{3-})	0.10	0.10	Ultra-oligotrophic < 0.004 Oligotrophic 0.004 -10 Mesotrophic 0.01 - 0.02 Meso-eutrophic 0.02 - 0.035 Eutrophic 0.035 - 0.1 Hyper-eutrophic > 0.1 (CCME,2004)
Iron (total) (mg/L, Fe)	0.04	0.06	1 (USEPA, 2016)
Total Organic Carbon (mg/L, C)	2.0	1.6	-

Source: NAWASA Laboratory

pH - The pH scale indicates the acidity or basicity of water. Seven is considered neutral and the range is 0 to 14. A pH of less than 7 denotes acidity, while a pH of more than 7 denotes baseness. Physical harm to the gills, exoskeleton, and fins happens at the extremes of the pH range, 2 or 13 (USGS, 2019). The results obtained show a pH of 7.84 and 7.18 which is well within the USEPA's standard range of 6.5 to 9, thus indicating that negative effects on the riverine ecosystem are unlikely to occur from pH levels.

Total Dissolved Solids (mg/L) - Total dissolved solids refer to the inorganic salts and trace amounts of organic matter that are dissolved in water (WHO, 2016). Total dissolved solids can cause increases in salinity, which can alter biotic communities, restrict biodiversity, drive out species that are less tolerant, and have either short-term or long-term effects at key points in the life cycle (Weber-Scan & Duffy, 2007). The results obtained showed a total dissolved solids reading of 60 48 mg/L and 48 mg/L.

Salinity (‰) - Salinity refers to the concentration of dissolved salts in water. The results obtained showed salinity readings of 0.06% and 0.05% which is well within the USEPA's standard of < 0.5%.

Conductivity ($\mu\text{S}/\text{cm}$) - The breakdown of dissolved particles into positively and negatively charged ions is what gives water its conductivity, which is a reflection of its capacity to conduct

an electric current (Pooja, 2017). Substantial variations in conductivity might be a sign that pollution was introduced to the aquatic resource via a discharge or another source (USEPA, 2023a). The results obtained showed conductivity readings of $125.7\mu\text{S}/\text{cm}$ and $101.5\mu\text{S}/\text{cm}$ which are well within the USEPA's standard of $150\mu\text{S}/\text{cm}$ to $500\mu\text{S}/\text{cm}$. This indicates that it is unlikely that the levels recorded would seriously endanger the vast majority of species in this particular ecosystem.

Alkalinity (mg/L as CaCO_3) - Natural water is inherently alkaline because of the presence of bicarbonates, which are produced by reactions in the soil that happen as the water percolates. It is an indicator of the water's buffering ability and measures its ability to neutralize acids. Fish and other aquatic organisms depend on alkalinity because it buffers or protects against abrupt pH fluctuations (Pooja, 2017). Alkalinity results show readings of 31 mg/L as CaCO_3 and 23 mg/L as CaCO_3 which are both above that of the USEPA's criteria value of 20 mg/L as CaCO_3 . This indicates that the obtained levels may pose a threat to aquatic life in this riverine system. Geology is one of the natural variables that affect alkalinity. Alkalinity is influenced by the various types of rocks that surround the stream. This high alkalinity reading may be due to the presence of rocks such as phosphates, limestone, and borates surrounding the stream (Utah State University, 2020).

Chloride (mg/L, Cl^-) - Many species require chloride to perform their essential biological processes. Nevertheless, high concentrations can lead to cellular desiccation (i.e., results in cells losing water) which can kill fish, amphibians, plants, and other aquatic life. The chloride levels obtained were both 11 mg/L, Cl^- , which was well within the USEPA's limit of 230 mg/L, Cl^- . Therefore, this suggests that it is not likely that the chloride levels obtained would severely harm species in this system.

Hardness (total) (mg/L as CaCO_3) - Calcium and magnesium found naturally in the water is responsible for us responsible for the degree of hardness in the resource (Pooja, 2017). For aquatic life, other metal toxicity generally decreases with increasing water hardness. Hard water causes some metal ions to precipitate out of solution and form insoluble precipitates, rendering them unavailable for consumption by living things. The values obtained for hardness were 39 mg/L as CaCO_3 and 37 mg/L as CaCO_3 . According to the United States Geological Survey (2018), this riverine system would be categorized as soft water, thus suggesting that metal ions (if any) present in the system would be more bioavailable to aquatic life which can lead to harmful effects.

Nitrate (mg/L, NO_3^-) - In aquatic environments, nitrogen may take on several forms, one of which is nitrates. Although nitrates are necessary plant nutrients, excessive nitrate concentrations can seriously harm water quality. Excessive nitrates can hasten eutrophication in conjunction with phosphorus, leading to notable shifts in the kinds of plants and animals inhabiting the stream as well as significant increases in the development of aquatic plants (USEPA, 2012). The values obtained for nitrate were 1.3 mg/L, NO_3^- and 1.6 mg/L, NO_3^- which are lower than the acceptable limit of 32.8 mg/L, NO_3^- set out by British Columbia.

Sulphate (mg/L, SO_4^{2-}) - In freshwater habitats, sulphate is a frequent source of sulfur for bacteria and plants. In most freshwater systems, sulfate is typically present in low quantities (Davies, 2007). The two readings obtained for sulphate were $<2\text{ mg/L}$, SO_4^{2-} . According to British Columbia (2013) water guidelines, based on the water hardness obtained, the sulphate levels should be between 128 mg/L, SO_4^{2-} to 218 mg/L, SO_4^{2-} thus suggesting that the levels obtained pose no threat to aquatic life in this system.

Phosphate (mg/L PO_4^{3-}) - One of the frequent contaminants in water is phosphates, which are oxides of phosphorus. Plant growth depends on phosphorus, an essential mineral. Aquatic plant growth is frequently restricted in aquatic settings by phosphorus deficiency (Badamasi et al., 2019). A phenomenon known as eutrophication can be brought on by an excess of

phosphorus, which can lead to the growth of excessive aquatic plants and algae and a decline in dissolved oxygen levels (USEPA, 2023b). Both readings obtained for phosphate were 0.10 mg/L PO₄³⁻ which are in CCME's Eutrophic 0.035 - 0.1 range. This suggests that this system may be subjected to the impacts of eutrophication which includes the presence of algae blooms. Since these were snap shot readings, more long term analysis of water quality is required before any generalization of the water quality can be ascertain.

Iron (total) (mg/L, Fe) - Iron is a trace element that is essential to both plants and animals. For all vertebrate species and certain invertebrate animals, it is an essential component of the hemoglobin system, which transports oxygen throughout the body. Results obtained for iron were 0.04 mg/L, Fe and 0.06 mg/L, Fe which were within the 1 mg/L, Fe standard set for aquatic life by the USEPA. This suggests that the majority of species within the riverine system are not projected to be significantly at risk from the levels of iron obtained.

Total Organic Carbon (mg/L, C) - Organic content is directly proportional to the amount of oxygen consumed within the riverine system. The proliferation of microorganisms that contribute to the depletion of oxygen sources is increased when there is a high organic content. The total organic carbon content levels obtained were 2.0 mg/L, C and 1.6 mg/L, C. Refer to Appendix 7 for an analysis of the samples' respective standards for human health.

Methods for Riverine Ecological Assessment

For this project, the proposed extraction site is located at N12°05.941, W061°40.583. The stream flow above this site is steady and relatively moderate as water flows from a natural pool above. However, stream flow declines as the channel widens below the extraction point. At the time of this assessment (September 2023), the water level was moderate due to minimal rainfall experienced in recent weeks. The country was also experiencing an unprecedented heatwave at the time as reported by Grenada Meteorological Service and the National Disaster Management Agency (NaDMA). For the aquatic assessment, benthic macroinvertebrates and fish were sampled at two locations, approximately 150m away from the proposed abstraction site as depicted in Figure 37.

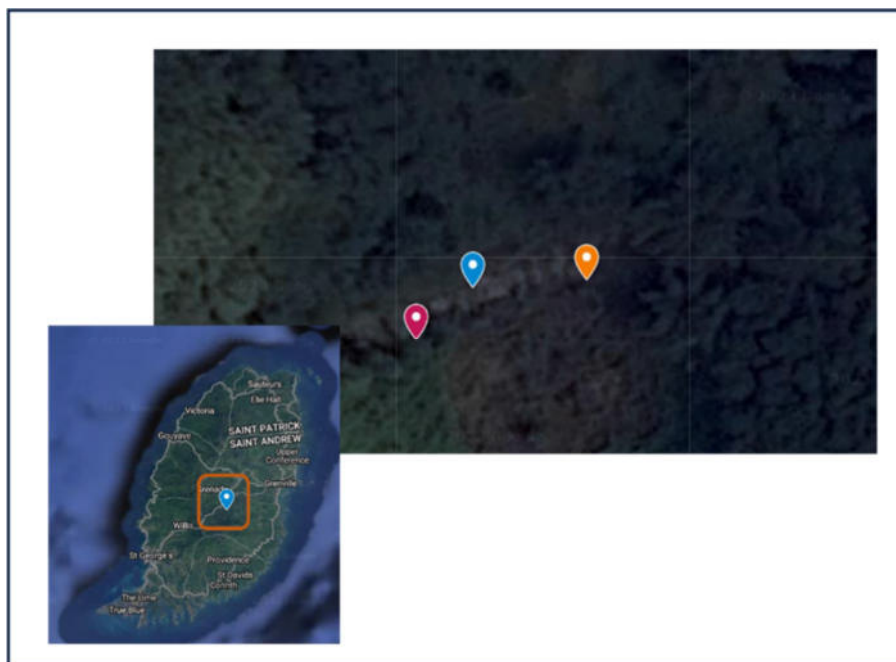


Figure 37: Map showing riverine ecology sampling sites

Site A: Sample area above the proposed extraction site.

Site B: Site below the proposed site as indicated

A 1-m² kick net was used to sample macroinvertebrates on 14th September 2023. The kick net was placed on the riverbed in the direction opposite to the directional flow of the river. While partially submerged, the area immediately at the front of the net (1m²) was disturbed for two minutes, thereby allowing organisms to detach from any substrate and wash into the net. Specimens were collected and preserved in 70% ethanol. Within each sample area, three samples were taken 5m apart moving upstream. Species identification was done using a benthic macroinvertebrates field guide.

The freshwater survey was conducted on 2nd October 2023 at the same sampling location. Fish were sampled using gillnets with very fine mesh. The gillnet with the fine mesh was used to target smaller fish, specifically those with lengths of less than 20 centimetres (cm). In order to conduct a survey of the larger fish, a submerged gillnet was placed at two different depth strata: between 1 and 3 meters and between 3 and 6 meters.

Shannon-Wiener's Diversity Index was used to analyse taxonomic diversity for both sites surveyed using the formula below.

$$H = -\sum[(p_i) \cdot \log(p_i)]$$

Where:

- H = Shannon Diversity Index
- p_i refers to the abundance of an individual species with respect to the others
- p_i = n/N
- n = No of individuals in a given species
- N = the total number of individuals in a community (Calculator-online.net., n.d.)

Findings

Macroinvertebrates

The macroinvertebrate assemblage within the study site is relatively diverse with several taxonomic groups inhabiting the area. From this assessment, a total of 8 different taxonomic groups were identified and recorded at the family level.

At Site A, water pennies (Psephenidae), mayflies (Leptophlebiidae), and caddisflies (Hydropsychidae) were predominant and recorded the highest taxonomic densities as illustrated in Figure 38.

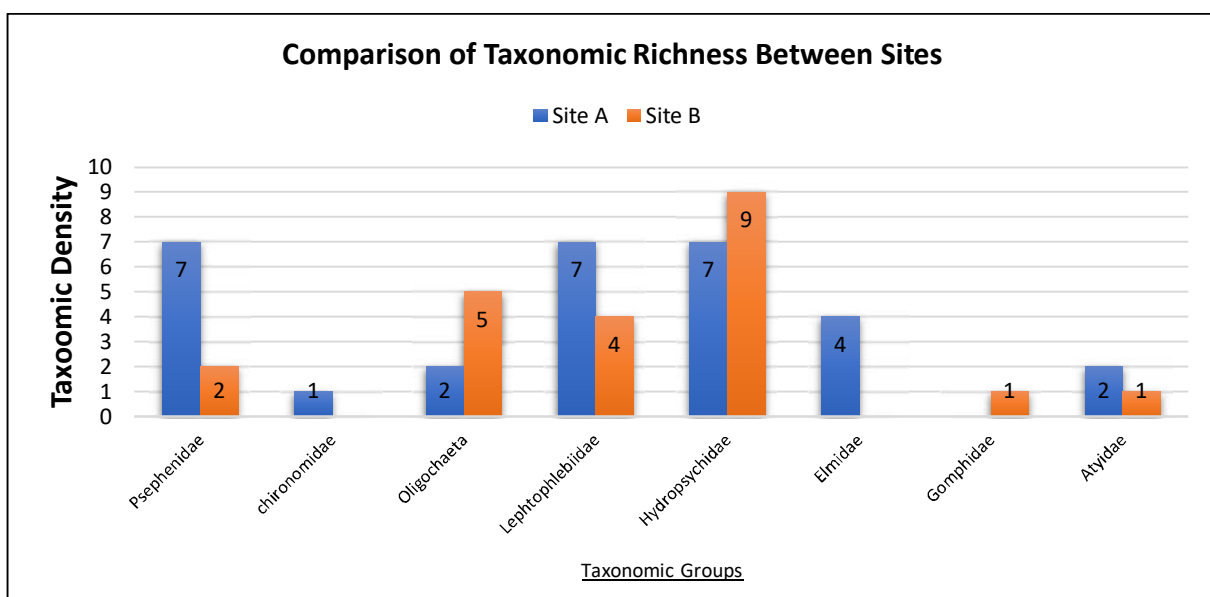


Figure 38: Macroinvertebrate taxonomic groups by site

In contrast, caddisflies (Hydropsychidae) recorded the highest taxonomic density at Site B. Although aquatic worms (Oligochaeta) and caddisflies (Hydropsychidae) were recorded at both sites, a higher density was observed at Site B.

Table 7: Macroinvertebrate taxonomic groups by site

Pollution Tolerance	Taxonomic Classification			Taxonomic Density	
	Order	Family	Common Name	Site A	Site B
Group 1 Less Tolerance	Coleoptera	Psephenidae	Water penny	7	2
	Trichoptera	Hydropsychidae	Caddisfly	7	9
	Ephemeroptera	Lephtophlebiidae	Mayfly	7	4
	Coleoptera	Elmidae	Riffle beetle	4	0
Group 2 Intermediate	Odonata	Gomphidae	Dragonfly	0	1
	Decapoda	Atyidae	Crayfish	2	1
Group 3 High Tolerance	Diptera	Chironomidae	Midge	1	0
	Diptera	Oligochaeta	Worm	2	5

Nonetheless, organisms such as the rifle beetle were seen at different stages of development. Similarly to the crayfish (Atyidae), both adults and juveniles were seen. Table 8 lists the taxonomic groups recorded within the sampling area, categorized by level of tolerance to pollution. Refer to Appendix 8 for pictures of macroinvertebrates on site.

Table 8: Macroinvertebrate taxonomic groups identified, close to the proposed intake

Pollution Tolerance	Taxonomic Classification			Taxonomic Density	
	Order	Family	Common Name	Site A	Site B
Group 1 Less Tolerance	Coleoptera	Psephenidae	Water penny	7	2
	Trichoptera	Hydropsychidae	Caddisfly	7	9
	Ephemeroptera	Lephtophlebiidae	Mayfly	7	4
	Coleoptera	Elmidae	Riffle beetle	4	0
Group 2 Intermediate	Odonata	Gomphidae	Dragonfly	0	1
	Decapoda	Atyidae	Crayfish	2	1
Group 3 High Tolerance	Diptera	Chironomidae	Midge	1	0
	Diptera	Oligochaeta	Worm	2	5

Fish

Three (3) freshwater fish species were observed at Site B as shown in Figure 37. These were Suck-stone (Sirajo goby), Mountain Mullet (Agonostomus monicola), and the River Goby (Awaous sp.). In contrast, only one (1) fish species, Suck-stone was observed at Site A.

At Site B, Suck-stone (Sirajo goby) and Mountain Mullet (Agonostomus monicola) were the most dominant and represented the highest taxonomic density or abundance. A total of 57 Suck-stone was identified compared to 36 Mountain Mullet, and one (1) River Goby (Awaous sp.) at Site B.

Taxonomic density was much lower at Site A. Only nine (9) individuals of the Suck-stone (Sirajo goby) were observed (n=9) (see Figure 39).

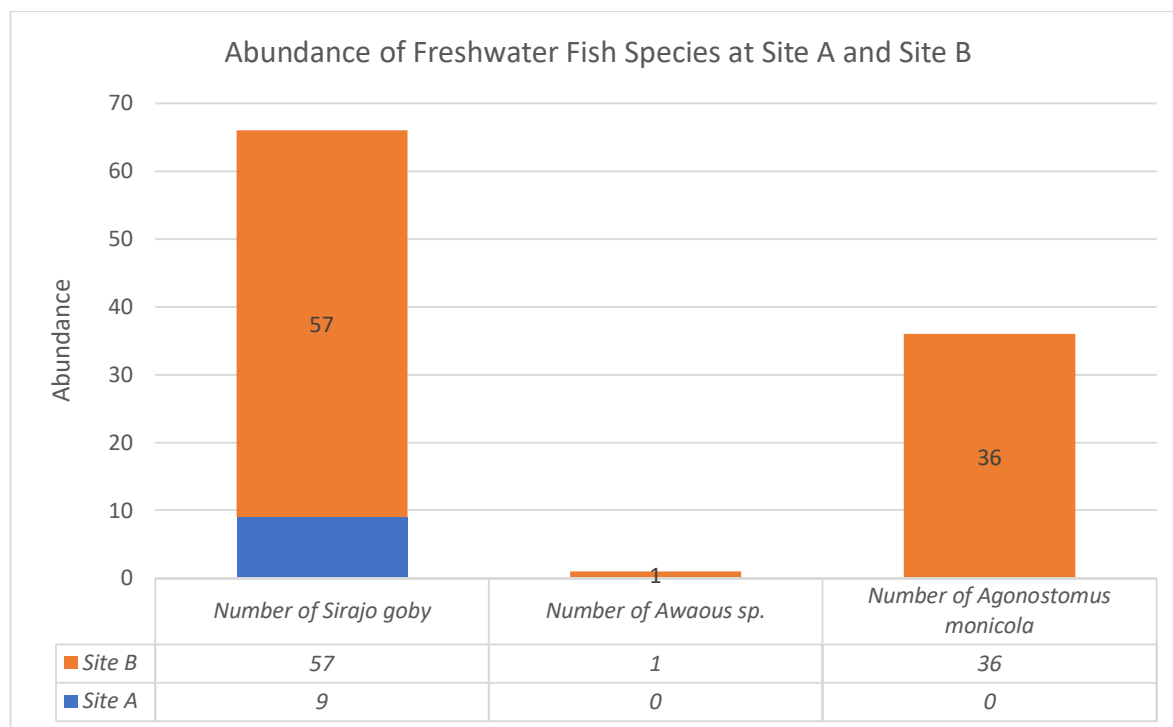


Figure 39: Abundance of Freshwater Fish Species found at Sites A and B

The Suck-stone (Sirajo goby) and River Goby (Awaous sp.) were mainly seen resting on submerged smooth rocks away from rough rapids, whereas Mountain Mullet (Agonostomus monicola) preferred high gradient streams with strong currents and rocky bottoms (Jaggernath and Kristen, 2012). Unfortunately, the life stages and sex of each species were not accounted for in this research and would require more time and effort to do so. In addition, there is no baseline study of the life stages of freshwater fish species in the rivers of Grenada to aid in this research.

It is well known that the presence of physical obstacles influences the migration and distribution of species. It has been discovered that the particular kind of substrate that serves as a "niche" for certain species is essential to their continued existence. River Goby (Awaous sp.) is the only fish in its habitat that feeds on chironomid larvae and other insects, which it filters from the sand to obtain food (Superville, 2015). Because of this, the River Goby (Awaous sp.) serves an important and distinctive role in the ecosystem in which it lives (Superville, 2015). According to NatureServe (2013), this species may be adversely affected by the degradation of its habitat, the presence of pollution, and the presence of foreign items, all of which may cause damage to the animal's body and the surfaces of its respiratory organs (NatureServe, 2013 Jaggernath, Kristen, 2012). In select places, such as Grenada and St. Vincent and the Grenadines, the fingerlings (tri tri or ti ti ri) of Mountain Mullet (Agonostomus monicola) and the Suck-stone (Sirajo goby) are a significant component of the commercial and local fishing industry. On the other hand, very little information is known about this species (see Box : species description).

The Suck-stone (Sirajo goby) is at risk in the Caribbean region (U.S. Fish & Wildlife Service 2018). This is due to the depletion of its natural habitat caused by anthropogenic activities such as dam construction. These activities pose significant risks to the long-term survival of the species (U.S. Fish & Wildlife Service, 2018). Also, conservation efforts are lacking for all the species mentioned in the report.

Box : Species description

The Mountain Mullet (*Agonostomus monicola*) is a diadromous omnivorous species found in freshwater and saltwater environments (Nirchio et al., 2008, Jaggernath, Kristen 2012). It is also a member of a genus considered the most primitive of all living mugilid fish (Nirchio et al., 2008).

The Suck-stone, Sirajo goby (*Sicydium* spp.) can obtain its food by scraping algae off of rocks found in woodland streams (El Yunque National Forest - Nature & Science n.d.). It does this by using a sucker generated by its modified ventral fins, which enables it to move up vertical surfaces (El Yunque National Forest - Nature & Science, n.d.). Because of this "sucker," it is able to move with relative ease up vertical wetted surfaces (El Yunque National Forest - Nature & Science, n.d.).

River Goby (*Awaous* sp.) is a type of gobiid fish that lives in freshwater environments (Superville, 2015). The members of this species are predominantly herbivorous and eat pieces of plants and filamentous algae. They have also been known to feed on animal matter, such as aquatic insects, when algae are no longer available as a food source (Superville, 2015).

Shannon Diversity Index

Using the Shannon-Wiener diversity index, taxonomic diversity was calculated and compared between sites as illustrated in Figure 39. Site A showed a significantly higher diversity ($H=1.90$) compared to Site B ($H=1.36$).

Discussion

Benthic macroinvertebrates are very sensitive to environmental changes, therefore, they are good indicators of ecological health in their natural habitats. These organisms inhabit the bottom substrate of rivers as well and some attach to rocks and other available substrate material. Many of these organisms such as mayflies, stoneflies, and beetles spend a significant portion of their lifetime in the riverbed. During their lifecycle in rivers, these organisms have a pivotal role in the start of food chains for larger organisms. This is indicative of good food web dynamics as benthic macroinvertebrates are preyed upon by fishes and birds. Additionally, they exhibit different tolerance levels to pollution and can be grouped accordingly as shown in Table 8 above. Water pennies, mayflies, and caddisflies are very intolerant to pollution thereby deemed as excellent indicators of clean, undisturbed areas as they exist in high densities. This has been observed at both sites, particularly at Site A, thereby indicating good water quality and a healthy ecosystem. This pattern was also observed at the headwaters of the Beausejour and Concord Rivers, Grenada in the assessment conducted in February and March 2022. Moving downstream, with a possible increased introduction of pollutants into the river, more species tolerant to pollution would dominate. The major contributing factor that affects the survival of macroinvertebrates in disturbed rivers is sedimentation which subsequently impacts the water temperature and dissolved oxygen (Harfouche & Jung 2014). From this assessment, the study area can be categorized as fairly clean with minimal disturbance from human intervention. However, Site A is less disturbed as compared to Site B. Site B is below a main access point to the river. Therefore, the possibilities of persons using the area immediately above Site B for washing (maybe agricultural equipment, etc)

Overall the richness and evenness of macroinvertebrate and freshwater species present were slightly higher at Site A compared to Site B resulting in a higher diversity index.

Limitations and Conclusion

Although this assessment observed a relatively high taxonomic diversity in the area, there were limitations. The assessment was done within a short period of time and the area was surveyed once. Surveys across seasons would identify differences in taxonomic assemblage between seasons which may be accompanied by streamflow. Additionally, water quality was not tested to accompany the biological data recorded. However, based on research and our findings, it is assumed that the water quality is moderate and not loaded with sediments and nutrients. Therefore, it is important to mitigate the likelihood of sedimentation from the proposed project.

3.11.3 Ecological Flow Analysis

An environmental flow framework for guiding the sustainable abstraction of water from freshwater and estuarine resources is not yet in place in the state of Grenada. Therefore, an environmental flow target to inform decision-making when water withdrawal projects do not exist.

The ecological flow analysis is estimated to judge the impact of the retraction of the planned 16 l/s during the dry season on the ecological health of the river.

Definition

The determination of ecological flows follows different methods in different countries. Some definitions of the ecological flow are:

- The minimum ecological flow in a river is the minimum amount of water that must flow through a river to maintain its ecological health.
- The quantity, quality and timing of water flows required to sustain freshwater and estuarine ecosystems and the human livelihoods and well-being that depend on these ecosystems (2007 Brisbane Declaration).
- Dyson et al. (2003) in the IUCN guide on environmental flows define the concept as the water regime provided within a river, wetland, or coastal zone to maintain ecosystems and their benefits where there are competing water uses and where flows are regulated.
- The 4th International Ecohydraulics Symposium (2002) defined environmental flows as the water that is left in a river system, or released into it, to manage the health of the channel, banks, wetland, floodplains, or estuary.
- Hirji and Davis (2009) describe environmental flows as "the quality, quantity, and timing of water flows required to maintain the components, functions, processes, and resilience of aquatic ecosystems which provide goods and services to people".
- Arthington and Pusey (2003) define the objective of environmental flows as maintaining or partially restoring important characteristics of the natural flow regime (i.e. the quantity, frequency, timing and duration of flow events, rates of change and predictability/variability) required to maintain or restore the biophysical components and ecological processes of instream and groundwater systems, flood-plains, and downstream receiving waters

Approach

A scientific determination of the ecological flow of the river would entail the collection of rain data over several years, the measurement of the discharge of the river over a long period, measurements of erosion and the determination of the aquatic ecosystem. This effort cannot be undertaken under present feasibility study, and a simpler approach to estimate the ecological flow is required.

A precipitation run-off model was prepared for the preparation of the present project. This model is a simplified representation of the actual situation. It considers the rainfall, has run-off

coefficients, a baseflow coefficient and a few other parameters. Groundwater flows are difficult to consider. The results are of rather theoretic character.

At the beginning of the project, NAWASA started to measure the flow at the proposed intake location. The measurements were carried out monthly and provide actual discharge information of the river (see Table 9). The minimum flow measured in 2023 was 4,925 m³/d in the month of May. The measured minimum flow is the lowest figure and will be used to estimate the ecological flow.

Table 9: Flow measurements at intake location

Date	m ³ /d
16.02.2023	17,366
21.03.2023	8,554
10.04.2023	6,998
10.05.2023	4,925
16.06.2023	9,072
13.07.2023	16,070
28.08.2023	10,714
19.09.2023	8,122
28.09.2023	10,454

Table 10 shows the minimum flow rates generated according to the hydrological model produced by GIZ in 2023.

Table 10: Minimum flow rates according to the run-off model

Year	Q _{min} [m ³ /d]
2015	6,066
2016	5,373
2017	5,888
2018	6,742
2019	5,898
2020	5,714

To get a grasp on the scale of the ecological flow, literature values for the flow in percentage to the normal flow were compared. This percentage can vary depending on the specific conditions of the river and the surrounding environment. The UK's water resource standards for good ecological status in rivers propose an acceptable abstraction of between 8% and 35%, depending on the river type, season, and flow rate.

The situation at the proposed intake location is outline in Table 11 below.

Table 11: Minimum flow

Actual min flow in May 2023				Extraction		Remaining flow
m ³ /d	m ³ /h	m ³ /s	l/s	l/s	%	%
4.925	205	0,057	57	16	28%	72%

The extraction is 28% and the remaining flow in the driest month in 2023 is 72%. These figures are significantly above the percentages cited before. The envisaged extraction of 16 l/s does not decrease the flow to a value below the ecological flow and can be used for the water supply.

We recommend that the flow measurements be continued during the operation of the new system so that any mid- and long-term changes in the discharge can be considered for future decisions. Flow measures should also include water depth and velocity as part of the parameters assessed.

3.12 Demography and population

3.12.1 Communities Connected to the Les Avocats/Petite Etang System

The present Les Avocats and Petite Etang Water Supply System supplies water for 10 southeastern communities located in the parishes of St. David and St. George. In 2011, more than 6,000 persons lived in these areas, with slightly more females (51.3%) than males (CSO, 2011). In 2023, taking population growth and other factors into consideration, an estimated 11,400 persons are reported to benefit from the Les Avocats/Petite Etang System (GIZ, 2023) which comprises residential, business, and institutional customers. The system supplies potable water to an estimated 10.8% of the national population¹⁴ and is therefore considered a significant asset in meeting this basic need to communities.

Table 12: Population of communities connected to the existing CWSN by sex

Community	Males	Females	Total of both sexes	Percent (%) of total population
Minorca	9	23	32	0.5
Laura Land	257	268	525	8.9
Vincennes	194	208	402 (401)	6.8
Windsor Forest	226	273	499	8.5
Permontemps	446	476	922	15.7
Petite Esperence	59	40	99	1.7
Tocobay	134	131	265	4.5
Mt. Parnassus	531	551	1082	18.4
Morne Jaloux	439	491	930 (929)	15.8
Aspley				
Laborie	573	555	1128	19.2
Total (N)	2868 (48.7%)	3016 (51.3%)	5884 (100%)	100%

Source of Data: Central Statistics Office, 2011

Generally, persons living within this water supply area are young, with approximately 47.2% under 30 years. Another 41% are involved in the active labour force, while one of every 10 are older adults, 65 years and above (see Table 12).

¹⁴ Based on a national population of 105,542 2011 est.

Education

Considering the youthfulness of the population within the southeastern communities, the majority of persons attained a primary and/or secondary education at the highest level (62%) (Table 13).

Table 13: Age range of population

Age	No. of both sexes	Percentage distribution
<15 years	998	21.0
15-29	1247	26.2
30-44	928	19.5
45-64	1065	22.4
65+	515	10.8
Total	4753	100.0

It can be expected that a portion of this group will pursue further higher-level post-secondary education, including at the New Life Organization (NEWLO) and the T.A. Marryshow Community College (TAMCC). Cognizant of Government's policy for free universal education for all students up to 18 years in the State of Grenada starting September 2023, it is highly likely that the number of persons completing post-secondary and tertiary level educational activities will increase.

Table 14: Highest education attained – Communities connected to the LA & PE system

Educational Level	Both sexes /(Males & Females)	
	n	Percent (%)
Daycare & pre-school	460	9.6
Pre-primary or primary	1669	34.9
Secondary (lower and upper)	1297	27.1
Post-Secondary	612	12.8
Tertiary Level - Bachelor	165	3.4
Tertiary Level - Masters	64	1.3
Doctoral Level Programmes	15	0.3
Other	62	1.3
None	342	7.1
Not Stated	98	2.0

Educational Level	Both sexes /(Males & Females)	
	n	Percent (%)
TOTAL	4784	100.0

Source: Central Statistics Office

3.12.2 Communities Downstream the Intake

Along the downstream part of the Great River intake are nine communities comprising almost 5,000 residents in 2011 as shown in Table 15 (CSO, 2011).

Table 15: Population of communities downstream the intake by sex

Community	Males	Females	Total of both sexes	Percent (%) of total population
Adelphi	104	121	225	4.6
Birchgrove	189	187	376	7.8
Castigne	51	41	92	1.9
Balthazar	208	198	406	8.4
St. Cloud	58	55	113	2.3
Grand Bras	365	359	724	14.9
Ford	78	155	233	3.2
Paradise	524	526	1050	21.7
Telescope	886	818	1704	35.2
Total (N)	2,462 (50.8%)	2,383 (49.2%)	4,845 (100%)	100%

Source of Data: Central Statistics Office, 2011

Although the 2022/2023 census results are not yet published, a moderate population increase of about 0.3% annually is likely to have occurred in these residential areas over the last decade. Very little variation is observed in the population by sex. The most populated communities based on the last available census were Telescope (1704) and Paradise (1050) (see Table 15). This remains the current status quo.

Education

Consistent with other communities across the island, more than 90% of persons who reside within these communities have attended or are currently attending school. Primary and secondary education constituted the highest number of persons who reported this as their highest level of education (60.7%) followed by post-secondary education (14.4%). Pursuit of the tertiary level of education was slightly less among these communities compared to the southeastern beneficiary communities. Proximity to St. George’s University and possibly greater awareness of such opportunities including other socioeconomic factors is responsible for this observation.

Progress has also been made in school enrolment, both for primary and secondary. In terms of education, the country showed progress in the net enrolment rate for primary education, going from 93.6 percent in 2008 to 95.8 percent in 2018 and secondary school net enrolment went from 86.4 percent to 87.7 percent for the same period (World Development Indicators (World Bank Group, 2021). This applies to both the beneficiary and the communities downstream of the intake.

3.12.3 Disability Status

While the number of persons with disability (PWD) within the beneficiary and downstream communities are not certain, mainland Grenada reported 13,587 (PWD) in 2011. Almost 3,000 more females (8796) than males (5859) were reported to have a disability across the tri-island state. Less than half of these individuals lived in the parishes of St. David and St. George (43%). Disability was most reported among persons 45 years and above. Challenges with sight and walking were the most commonly reported disability (CSO, 2011). The Grenada National Council of the Disabled noted that the population of PWD has increased in the last decade (H. Gabriel, Personal Communication, October 12, 2023). While the number of PWD within the zone likely to be impacted by project works is not known at this stage, integrating measures to limit any adverse effects on this group, particularly the visually and physically impaired during the construction phase is paramount. This is also applicable to any residents and tourists who visit the Grand Etang Recreational area during the construction period.

3.13 Baseline Setting Water Supply and Access

3.13.1 National Level

Access to better potable water sources has improved considerably in Grenada between 2008 and 2018, notwithstanding the challenges imposed by climate change and other anthropogenic factors. According to the World Bank Group (2021), access to better water sources has increased from 85% of households in 2008 to 87% percent in 2017. In addition, access to potable water at the household level shows a higher Human Opportunity Index (HOI), a measure consistent with Sustainable Development Goal 6 (clean water and sanitation). The HOI is a measure of children's (0-18 years) opportunities based on access to basic services deemed critical for individual universal access to such services. The World Bank Group (2021) reports that the HOI for access to tap water in the dwelling place showed a HOI of 77.9% and coverage of 86.2% in 2018 compared to 63.5% and 74.1% in 2008 (see Figure 40). Importantly, access to water in a pipe within the household is a key indicator that points to the effectiveness of poverty reduction programs.

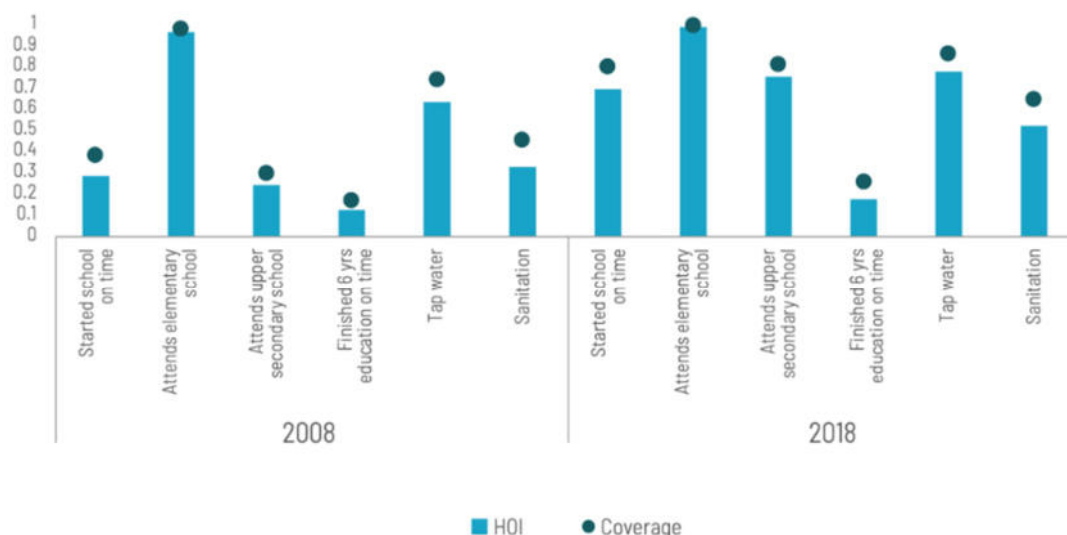


Figure 40: Human Opportunity Index and coverage for Grenada, 2008-2018 (World Bank Group, 2022)

3.13.2 Beneficiary Communities

Generally, most communities served by the Les Avocats/Petite Etang system do not receive a 24-hour water supply year-round. Inconsistencies in supply are most pronounced during the dry season from January to June. However, throughout periods of reduced precipitation in the wet season, in particular September, reliability decreases substantially. Residents reported that the heat wave that occurred from July to October 2023 has intensified this occurrence. It is important to note that variations occur in the reliability of the water supply received at the village level across the different communities. For instance, during both the rainy and dry seasons, villages such as “Behind the Fence” and Charlotte Value in Perdmontemps reported receiving a reliable water supply between 90-95%. In contrast, there are many villages such as “McMillian Cocoa” in Permontemps, Morne Jaloux, and parts of St. Pauls whose supply decreases considerably during the dry season and in drier periods of the wet season (e.g., September). Reliability can decrease to as low as about 40% or less in these areas due to daily disruptions and the operation of a valve regulation system.

Communities within the forgoing supply area also complained about the unsatisfactory water quality received, due to elevated turbidity levels, an occurrence that is most pronounced after heavy rains. According to stakeholders, this issue is not accounted for in the monthly bill generated by the NAWASA. As such, this unintended “cost” is absorbed by the homeowner/end user. This inefficiency in the treatment process should be addressed in any planned upgrade to the Les Avocats and Petite Etang system according to beneficiary stakeholders.

Generally, customers in the southeastern block served by the Les Avocats and Petite Etang System experienced water supply challenges in particular supply interruptions during the dry season. As a mitigation measure during the dry season, NAWASA implements a valve regulation schedule to facilitate the provision of water to the affected communities based on available supply. Based on the value regulation mechanism operational in May 2022, water was made available to select communities in 12-hour shifts three days per week from 5:00 am to 5:00pm¹⁵. Affected customers in this block were also advised that they may receive low pressure residual supply on off days during the regulation period. Other communities within

¹⁵ Communities affected by the 12-hour shifts 3 days/week were: Morne Jaloux, Richmond Hill, Baileys Hill, Defo, White Gun, Creighton, Marian, Lyda, Coconut Whaft, and Cocoa Road.

the water supply area received water on one or two days a week during the peak dry season for a 12-hour period¹⁶. These communities were encouraged to storage water to meet the needs of their families and pets prior to the interruption of supply (NAWASA, n.d.).

While most households have adapted to the situation through the installation and operation of storage tanks to buffer such events, this has created inconveniences for households and has diverted time that could have been utilized for relaxation, family bonding, and educational and professional advancement. Women, single-headed households, and adults who are not employed within the households are most likely affected due to their primary domestic and support responsibilities. Moreover, the disruption in supply has had major negative effects on the daily functioning of the affected households. Increased absenteeism from work and school was reported by stakeholders during prolonged periods of inconsistent water supply with negative implications for productivity in the workplace and the teaching-learning process. Table 16 summarizes the baseline conditions of water supply in the existing Les Avocats/Petite Etang Supply Network.

Table 16: Summary of baseline setting - water supply

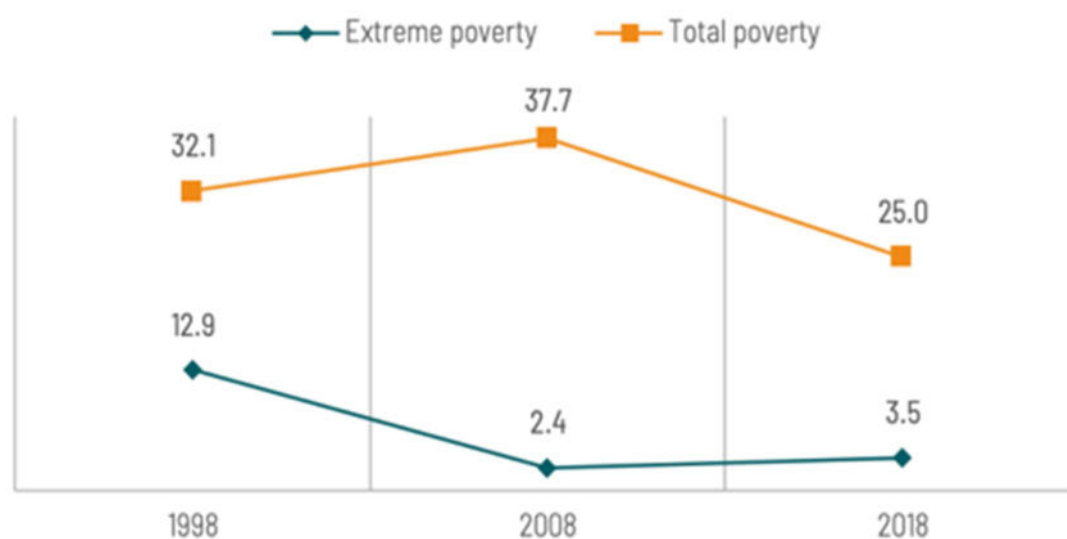
Network	Percent (%) communities/customers receiving a reliable water supply
Les Avocats/Petite Etang	<ul style="list-style-type: none"> ▪ <25% ▪ Supply interruptions and low pressure during the dry season and dry periods of the rainy season. ▪ Major issues experienced in some villages and communities, for example, “McMillan Cocoa in Perdmontemps, Morne Jaloux, and parts of St. Pauls. ▪ Unsatisfactory water quality due to elevated turbidity, especially after heavy rains. ▪ No evidence directly linking baseline water quantity and quality to health conditions among end users.

3.14 Socio-economic situation

3.14.1 Living Conditions & Economy at the National Level

The 2021 Living Conditions in Grenada – Poverty and Equity Update prepared by the World Bank Group (2021) reported a significant reduction in poverty rate from 37.7% in 2008/09 to 25.0% in 2018/19 across the tri-island state. Extreme poverty, however, increased from 2.4% to 3.5% in the same period (Refer to Figure 41)

¹⁶ Communities receiving water one or 2 days per week were: La Borie, Upper St. Pauls (from the Green’s), Mt. Airy, Morne Delice, The Bocas, Mt. Parnassus, Creighton, Parade, Holder Hill, Lower St. Paul’s (NAWSA, n.d.).



Sources: SLCHBS 1998, 2007-08, and 2018-19.

Figure 41: Poverty trends, State of Grenada – 2008 - 2018

In contrast, inequality between the top 10 percent in the national population and the other 90 percent increased slightly for 2018/19 compared to the previous decade (World Bank Group, 2021). For instance, in 2018 a person in the top 10% of the national population consumed 7 times more than a person in the other 90%, exposing the existing inequality. The report further noted that poor households had on average twice the family size of a nonpoor household, evidenced by a dependency rate of 1.02 and 0.70 respectively (World Bank Group, 2021, p. 43). Poverty was higher for unemployed individuals (38.8%) compared to employed persons (20.8%), and among those who worked in the human health/social work (30.1%) and the agriculture, forestry, and fishing (29.1%) sectors.

Moreover, from a gender perspective, women-headed households were likely to be poorer than male-headed households. Further, single women in Grenada, including those in women-headed households, comprise the largest segment of the poorest quintile of the country's population. This group is particularly susceptible and is most likely to lack the capacity to cope/respond to shock events (e.g., economic shocks, pandemics, and natural disasters). With respect to the relationship between disability and poverty, the assessment indicated that 20.3% of poor households had members with some disability, compared to 17.5% of nonpoor households. The assessment, however, did not report living conditions and poverty indices disaggregated by parish or community. However, the 2008/09 poverty assessment conducted over 10 years ago indicated that the parishes of St. David and St. George were ranked 5th and 6th respectively of the eight areas assessed concerning severity of poverty (Kairi, 2008).

Changes in the national poverty line were also underscored. The new National Poverty Line is estimated at EC\$ 6782 per year, per person at 2019 prices – a 16% increase from EC\$ 5842 per year in 2009/09¹⁷ (See Table 17). This points to a higher cost of living in the country over the 10-year period (World Bank Group, 2021). Such increased costs are likely to continue, due to the residual impact of the COVID-19 pandemic and other geopolitical events internationally. The present government is committed to ensuring that its citizens are empowered, through a strategic focus on the poor and vulnerable (GoG, 2022).

¹⁷ This is based on the Survey of Living Conditions and Household Expenditures and Income (SLCHEI).

Table 17: Poverty lines by year of survey, 2007-08 and 2018-19 (EC\$)

Poverty lines	2007-08	2018-19
Total poverty line	5,842	6,782
Nonfood poverty line	3,448	3,852
Food poverty line	2,394	2,899

Source: Kairi, 2008; SLCHEI 2007-08, SLCHEI 2018-19, and official CPI values

The State is recovering well from the adverse effects of the 2020/21 COVID-19 pandemic. While the pandemic caused extreme hardships for individuals and households and worsened the long-standing issues of poverty; vulnerability, gender, income, and other inequalities, it did not result in additional development challenges at the macro level (GoG, 2020b). The country has begun to see improvements in its macroeconomic condition post 2022. Moreover, government's plans for socioeconomic growth and development are projected to continue along a positive growth path with benefits to be experienced at all levels, allowing for the restoration of the economy.

3.14.2 Livelihoods Provided by the Great River and Grand Etang Forest Reserve

Grand Etang Forest Reserve

The natural resources inherent in the Grand Etang Forest Reserve support important livelihoods for key segments of the national populace. The Reserve represents a central component of the national tourism product and promotion of the Pure Grenada brand. It constitutes one of the nation's flagship ecotourism experiences for soft to moderate recreational ventures. The rugged and diverse peaks, varying vegetative forest communities, and resident biodiversity (e.g., the Mona Monkey) offer a unique package of ecological services invaluable for mental health and well-being, recreation, and tourism.

On average, an estimated 8,000 tourists along with an unidentified number of local people visit the Grand Etang Reserve each year, the majority of which consume the services around the visitor center and the Grand Etang Lake. The largest number of visitors correlates with the annual cruise ship season between November to April and to a lesser extent the month of August.

The trail system within the Reserve provides excellent hiking and nature tour opportunities. Data on the number of persons disaggregated by age and sex that utilize the trails is not available. The Ministry with responsibility for Tourism reported that the relatively short and easy Morne Labaye Trail structured around the scenic visitor center is the most popular. This, however, is outside the zone likely to be directly impacted by project works. Of the existing 12 trails within the Reserve, three are directly linked to the proposed route for the transmission lines (see Table 18). The 1910 to Apres Toute Trail forms a substantial part of the proposed surface route of the Seven Sister's pipe network to Les Avocats.

Table 18: Trails within Grand Etang Forest Reserve (Adapted from GTA, n.d.)

Name of trail	Details	Interact with pipe route
Morne LaBaye	200 m trail	No
Beausejour	300m ridge-crest trail	No

Shoreline	2 Km	No
Mt. Qua Qua	3Km	No
Concord	6 Km	No
7 Sisters	5Km	No
Annandale Trail	6Km	No
Vendome-Les Avocats	3Km	Yes
Cross Trail	5Km	Yes
Fedon's Camp	TBD	No
1910 to Apres Toute	TBD	Yes

From an economic perspective, several individuals, as well as micro, small, and medium enterprises, all locally owned generate a livelihood from the tourism and recreational activities that occur within the Reserve. Currently, seven (7) women-owned souvenir shops sell local spices, clothing, and jewelry within the recreational zone of the Grand Etang Forest Reserve. In addition, two (2) businesses owned by local men sell food and drinks, which complement the services offered at the reserve. All nine (9) establishments employ an additional local woman to support their daily operations. In addition, several private tour guides, primarily males provide related services to local and foreign visitors desirous of accessing the trail system within the property (see Figure 42).

Moreover, all of the major tour operators across the island integrate components of the Reserve in their package of services. All of these entities have benefited directly from the ecosystem services provided by the Grand Etang Forest Reserve, a key natural asset since the 1980s (see Table 18).

In 2007, annual revenue of EC\$ 600,000 generated from projected visits, entrance fees, and permit costs for timber and non-timber forest projects was projected. The current economic revenues generated have likely exceeded this projection. However, a detailed economic valuation of the Reserve for recreation and tourism has not been undertaken in recent times. This was identified as a key action under the 2007 Management Plan of the Grand Etang and Annadale Reserves (Turner, 2007).



Figure 42 Livelihood activities in the Grand Etang Forest Reserve & along pipeline route – male (left) and female owned enterprises (right)

Great River Downstream the Intake

The Great River, located in the heart of the Great River Watershed is Grenada's largest and longest river. With its headwaters in the upper Grand Etang area, the river flows along several communities and empties in the low-lying parts of Telescope, along the northern end of the Grenville Bay Area. The river downstream the proposed intake supports and sustains four (4) main livelihood activities as elaborated below.

1. River Tubing and Related Adventures: River tubing along the Great River is a highly sought-after adventure offered by three local businesses – Funtastic Island Adventures, Mellows Entertainment Complex, and Adventure River Tubing. This nature-based tourism enterprise commenced in 2005 with the launch of the Adventure Tours River Tubing operation more than 18 years ago. All three businesses are 100% Grenadian, with 75% of the owners being male (n=3) and 25% female (n=1). The businesses encompass guided river tours in large vinyl tubes, conducted primarily during the daytime. A few tours were requested for the night period, largely by persons from the St. George's University community. One of the businesses, Funtastic Island Adventures pairs the highly in-demand river tubing excursion with other land and water-based tours, such as visits to the rainforest and/or select waterfalls.

The principal clientele are cruise ship and stay-over visitors and to a lesser extent returning nationals and locals. Huggins Tour Company and Sandals Resort are the largest provider of clients for the eco-tourism adventures. Operation is year-round but peaks during the cruise ship season from November to April. Peak daily operation is between 10:00 a.m. and 2:00 p.m. During the years 2019 to 2023 (not including the COVID period from March 2020 to December 2021), an average of 2367 foreign visitors/tourists utilized the services of one of the river tubing companies annually. The highest number of visitors was reported pre-COVID in 2019 (3416) compared 1381 users in 2022 (see Figure below).

Great River Tubing Industry	
➔	100% Grenadian owned
➔	Ownership 75% male, 25% female
➔	32-36 Employees; 100% male
➔	>90% employees from neighbouring villages
➔	November to April peak operation period
➔	Estimated annual gross income EC\$ 1 million

It is important to note that this figure did not include locals and/or returning nationals who used the services during the period under study or the other two river tubing companies. Data on the other two companies were not available during the preparation of this report.

The river tubing industry is a major supporter of the rural economy and generates on average an estimated combined gross annual income of about EC\$ 1 million (US\$ 370,000). Altogether, the industry currently employs on average 32 seasonal workers who function on a needs-to basis throughout the year. All companies have committed to employing local people; as such, the existing staff is 100% Grenadian with approximately 90% or more residing within the adjacent communities of Mirabeau, Sab, and Balthazar, St. Andrew. Less than 10% of workers reside outside the Great River Watershed in other parishes. Due to the physical rigours associated with river tubing, 100% of the positions are carried out by males, notwithstanding an interest in recruiting female employees. The river tubing industry supports the growth of the rural economy in St. Andrew through the purchase of supporting goods and services, such as breadfruit snacks and rum punch to augment the client’s experience.

Cognizant that a considerable part of the operation occurs during the designated dry season (January to April), businesses have adopted adaptation measures to ensure continued functioning under conditions of reduced streamflow. This reduced streamflow is most pronounced during April and May. Operators reported (i) “damming” of the river and (ii) the temporary relocation of select stones to enhance the flow of water in strategic areas along the route to maximize guests' experience. Stakeholders reported that during periods of prolonged reduced precipitation, with resultant lower streamflow, guiding the tubes downstream can be extremely challenging. Such conditions impose heightened physical pressure on workers to safely move the tubes and clients downstream, which can result in damage to equipment in some instances. Evidence of infrastructure built to support the Great River Tubing industry is observed at the end of the route (see Figure 43).

2. Bamboo Rafting: A bamboo rafting operation led by a Grenadian male who resides within the Great River catchment was reported. This additional riverine adventure uses the same route as one of the river tubing enterprises. The outfit appears not to be as established as the river tubing companies but offers a promising livelihood and tourism opportunity. Efforts to connect with the owner were not achieved during the preparation of this report.



Figure 43: River tubing, Great River, Grenada @ Funtastic Island Adventures



Figure 44: Sanitation and water storage facility at the end of River tubing route

3. Farming: An estimated 10 producers farm along the water's edge of the Great River downstream of the proposed intake from Adelphi to Telescope, St. Andrew's. The greatest concentration of farmers is located from Balthazar to Paradise. Most are smallholder producers farming on less than three (3) acres (95%), with a high proportion of males (92%). Farmers utilized the river for irrigation of their crops at least once or twice daily during the dry season and during periods of low rainfall in the traditional wet season¹⁸. The production system of most farmers is dominated by tree crops, vegetables, and ground cover produce such as melon. A few livestock farmers also depend on the river to support the water needs of their animals. Some backyard

¹⁸ PS: The Permanent Secretary in the Ministry of Agriculture only assigned an officer to assist us in getting the information on farmers on January 11, 2024. We are still awaiting the list of names to contact this group directly. It should be noted that we tried a snowball approach to secure the names, but this did not prove effective. The Draft Final document will provide information generated from consultation with farmers.

style farming production systems are also along the river's edge. Farmers currently integrated these measures in their farming production system to adapt to the effects of the dry season and drought are: (see Table 19).

Table 19: Estimated number of farmers that use Great River downstream the proposed intake

Community	# of farmers	Male	Female
Adelphi	20-25		5
Birchgrove & Castigne	Included		
Balthazar & St. Clouds	35		
Grand Bras			
Ford			
Paradise			
Telescope			
TOTAL	55-60		5

Under the Challenge Fund for Agriculture implemented through Component 2.1 of the G-CREWS Project, 61 farmers in St. Andrew's were audited in November 2023 to benefit from improved irrigation systems and additional RWH systems. Almost four of every 10 of these farmers (38%) currently use either the Great River or the Hope River as a source of water (GIZ, 2023). Stimulating enhanced water management among the farming community to better adapt to the impacts of climate change continues to be a major thrust nationally.

4. Aquatic/Riverine Fisheries: River fishing continues to be a livelihood and culturally important subsistence activity along the river. Crayfish is the main species caught. Fisherfolks are largely males who live within communities along the river and to some extent outside the parish of St. Andrew. Stakeholders reported that the number of persons who fished along the river has decreased over time due in part to reduced access to the river's edge due to fallen logs. Notwithstanding this, in the Balthazar area alone, about 5-7 males catch crayfish to supplement their main source of livelihood. The price per pound of crayfish has increased to EC\$ 60 (US\$22) due to an apparent reduced supply and higher demand based on anecdotal evidence. Stakeholders in Balthazar have reported an observed reduced size of the mature crayfish compared to previous years. This was not confirmed scientifically by the authors of this report. Residents have also indicated that a wall installed as part of works carried out in 2015 to reduce the risk of flooding over the Balthazar bridge has hindered the movement of the diadromous migratory "Saad fish" upstream, which has substantially reduced the abundance of the aquatic species above the bridge.

3.14.3 Other Uses of the Great River Downstream the Intake

The Great River is strongly bedded in the culture and way of life of the communities that live along its edge. This is most pronounced among residents in the Balthazar, Birchgrove, Castigne, and Ford communities. It is also used for bathing, swimming, and washing to some extent (the latter practice has reportedly reduced considerably in the upper communities). For instance, in the case of Balthazar, due in part to the proximity of the river to the community and

the fact that not every household has an indoor pipe as reported by residents, each day community people visit the river for bathing, washing, relaxing and “cooling off”. In fact, young males who play football in the playing field adjacent to the river at Balthazar, visit the river almost every day to bathe after a game before going home. The use of the river for the foregoing purposes has reportedly increased in 2023, due to the heat wave which started around midyear. Other important cultural and developmental uses of the river downstream of the proposed intake are as follows:

- Adults, youths, and children from within the downstream communities use the river for recreation, especially swimming and picnicking. This is done most frequently on weekends and on public holidays and in some cases when residents are unable to travel up to the Seven Sisters Waterfall.
- The point along the river where the river tubing route ends is becoming a sort-after recreational area for river tubers and local people. Individuals and families of all ages within and outside the parish of St. Andrew’s have also been observed using the area to swim, cook, picnic, and relax. Use of this part of the river occurs mostly on weekends and on public holidays. Figure 45 and Figure 46 show a sample of how people use the downstream parts of the river.

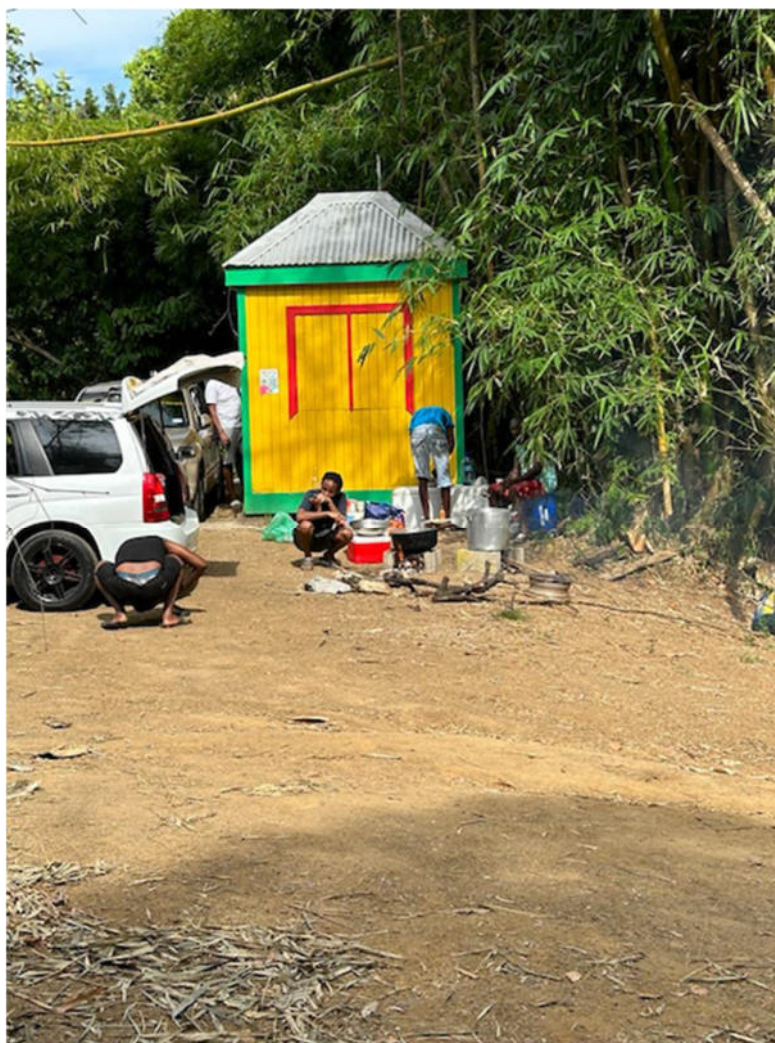


Figure 45: Men cooking along Great River – at point where river tubing route ends

- Learn to Swim national program through a partnership with Mellows Entertainment Complex, located at Balthazar. This program targets children 5 to 12 years. Every

Saturday during the school academic term, except when it is raining, about 25-50 children from the surrounding areas come out to swim in the river, in the upper Balthazar area. Bathroom and changing facilities including monitoring the suitability of the river for swimming based on weather conditions are provided by the management of Mellows Entertainment Complex. A few older adults are also involved in this swimming program.



Figure 46: Young community boys swimming downstream the proposed intake (top) and individuals and families recreating at the endpoint of the river tubing tube route (bottom)



3.15 Critical Infrastructure Within the Project Site

Three main types of infrastructure are located within the proposed project site.

1. Real property – Only four observable residential homes are located within the project site; two along the byroad that leads from the intake to the Grand Etang main road and another two along the upper part of the main road. While an official valuation has not been done, houses are estimated to be <EC\$ 100,000 to EC\$350,000. The higher priced properties are located along the upper part Grand Etang Main Road compared to inside the semi-agricultural “Gangadee” Adelphi area.
2. Utility infrastructure – The Grenada Electricity Services (GRENLEC) and the telecommunication company FLOW have installed communication antennas and related infrastructure at Hurricane Ridge, just off 1910. Digicel is piggybacking off those structures. Along the route from the Adelphi Road to 1910 are the usual poles and wires to support electricity and telecommunication services to the various communities.
3. Tourism and recreational infrastructure – Within the central recreational area of the Grand Etang Forest Reserve are the Great House and Interpretation Center, and various small boots and bars (see Section 5.3.2). Specific to the proposed pipeline route, three recreational trails are of significant due to their interconnection at select points. Limiting adverse impacts and maintaining trail integrity would be important.

3.16 Land Tenure

More than 90% of the lands likely to be directly impacted by the project are owned by the State. Private lands are found almost exclusively along the roadside in the “Gangadee” area from the intake to the Grand Etang Main Road. According to data from the Valuation Division (2023), 19 parcels of land are situated along the linear stretch of road in “Gangadee” - 11 on the western end and 8 on the eastern end. Parcels range from 1 to 33 plus acres (see Table Appendix 9). Tenure shows 59.1% male versus 40.9% female ownership based on available data. Farming, largely under tree crop production system (e.g., nutmeg and bananas) coupled with abandoned lands are the main land use within that small area. Based on plans for the proposed project, one pump will be placed on part of a 6-acre plus lot situated directly adjacent to the intake. The NAWASA has already commenced discussion with the property owner, who has agreed in principle to the installation of the pump on the property. The necessary negotiations and contractual arrangements are ongoing. Involuntary Resettlement is not foreseen as part of this project.

3.17 Social and Security Issues of Concern in the Study Area

Crime

Although criminal activity has increased in Grenada in 2023, violent crimes remain lower compared to other Caribbean nations. The Royal Grenada Police Force (RGPF) remains committed to ensuring a safe country through the delivery of the highest quality of law enforcement services in partnership with key stakeholders (RGPF, n.d.). Notwithstanding the efforts of law enforcement officials, crime of varying types occurs within all parishes of the State.

Analysis of crime data for parishes of St. David and St. Andrew over the period 2019-2022 showed that the most prevalent offenses applicable to the proposed project were threats and assault, property offences including theft and harm offences (RGPF, 2023). In almost all cases, the reported offense was committed by males. There were no national statistics or reporting on cases of gender-based violence, sexual harassment, and bullying at the workplace. Within

the context of the proposed project, extreme caution should be exercised during the construction phase to limit the potential of opportunistic crimes such as stealing at the project site as well as any kind of gender-based and/or sexually related offenses. This is important in preventing adverse implications for communities around the project site, the tourism industry, and any undue burden on the RGPF.

Table 20: Types of Major Crimes Detected and Solved in St David's, 2019 – 2022

Crime and minor offences	2019	2020	2021	2022	4-year Average	Percent(%)
Harm offences	310	309	483	449	387.8	13.2
Threats and assaults	864	948	952	973	934.3	31.76
Sexual offences	72	32	120	37	65.25	2.22
Fraud offences	2	2	0	0	1	0.03
Property offences	529	697	599	740	641.3	21.8
Drug offences	54	36	32	28	37.5	1.27
Weapon offences	52	36	72	120	70	2.38
Others	14	16	12	4	11.5	0.40
Offences not enumerated	675	810	885	800	792.5	26.94
TOTAL	2572	2886	3155	3152	2941.3	100.00

Table 21: Types of Major Crimes Detected and Solved in St. Andrew's, 2019 – 2022

Crime and minor offences	2019	2020	2021	2022	4-year Average	Percent (%)
Harm offences	1011	890	887	1115	975.75	11.9
Threats and assaults	2261	2489	2367	2481	2399.5	29.4
Sexual offences	166	115	85	110	119	1.5
Fraud offences	25	6	7	0	9.5	0.1
Property offences	1831	2137	1812	2077	1964.3	24.0
Drug offences	238	208	134	118	174.5	2.1
Weapon offences	100	218	326	394	259.5	3.2
Others	48	42	24	30	36	0.4
Offences not enumerated	1856	2303	2602	2178	2234.8	27.3
TOTAL	7536	8408	8244	8503	8172.8	100.0

Source of Data: RGPF

The Women's Health and Life Experiences Study conducted in 2018 reported that the lifetime prevalence of physical and/or sexual intimate partner violence in Grenada is 29 percent (GoG,

2018). The report further noted that one in every four Grenadian women (25%) has suffered physical violence at some point in her life, and close to one in every ten Grenadian women has experienced sexual violence in her lifetime. According to UNICEF (2021), the study also highlighted the feminization of sexual violence and that girls like women are at a high risk of sexual abuse and exploitation. Moreover, gender-based discrimination is catalyzed by historical gender stereotypes. Mitigating the likelihood of such gender-based forms of violence and discrimination in the project is a required expectation.

Vector Borne Risk

Within the context of occupational health and vector-borne diseases, a relatively high population of mosquitoes was observed during the descent to Les Avocats. These are likely mosquitoes belonging to the Flaviviridae family such as *Aedes aegypti*. This has implications for workers' health, due to an increased exposure to mosquito-related diseases such as Dengue Fever, Zika, and Chikungunya, particularly during the rainy season. Appropriate mitigation measures to limit likely risks to workers' health would be important to protect from such vector borne diseases.

3.18 Road Network and Traffic

The St. George's-Grenville thoroughfare which cuts across the central range within the Grand Etang Forest Reserve is the principal road traversing the project site and study area. This is a primary road that connects the eastern part of the island to the south. This is the main route used by the Grenville-St. George's buses (No. 6). Other private, commercial, and institutional vehicles utilize this route as a primary road to access the eastern and southern towns and adjacent northern and eastern communities. Consistent with other main roads across mainland Grenada, the peak hours for traffic are between 6 a.m. and 8:00 a.m. and during the afternoon and early evening periods (2:00 p.m. to 5:00 p.m.). Adoption of the necessary traffic management measures is required during the construction phase to limit the impact of delays, congestion, and other related issues.

3.19 Human Health and Medical Services

Medical services on mainland Grenada are provided by a network of public and to a lesser extent private sector facilities offering primary, secondary, and tertiary care. Two public hospitals are located on mainland Grenada, the principal of which is the General Hospital situated in the town of St. George approximately 11 km from the project site. The secondary hospital, Princes Alice is situated within the 8km of the site in the parish of St. Andrew. St. Augustine Medical Services is the sole private hospital on mainland Grenada located a bit further away in the community of St. Pauls. Several public primary health care clinics and medical stations are found throughout the island. The closest to the project site are the Grand Bras Medical Station in St. Andrew and the St. George's Medical Center situated in the heart of the city. Supportive allied health services offering diagnostic tests are offered through various public and private sector laboratories, based mainly in St. George and St. Andrew.

Construction injuries and compensation

A review of available data from the National Insurance Scheme (NIS) for the 5-year period spanning 2018-2022 showed that 590 persons were compensated for construction-related injuries across the State of Grenada. Consistent with the gender profile in the construction sector, males dominated the compensation received (n=548 ~ 92.9%) compared to females (n=42 ~7.1%). On average, about 110 and 8 males and females respectively were compensated annually over the 5-year period. Relatedly, a total of EC\$ 514,625.94 was paid

out in the form of compensation for the entire timeframe, with 94.1% of all monies paid to men by the NIS (NIS, 2023).

Regarding the nature of injuries, the highest proportion of monies was paid for the following nine (9) conditions over the period assessed.

- Injuries to the wrist and hand
- Injuries to the knee and lower leg
- Injuries to the ankle and foot
- Dorsopathies
- Injuries to shoulders and upper arm
- Injuries to the elbow and forearm
- Soft tissue disorders.

Compliance with all applicable occupational health and safety measures on site for all workers, with a particular focus on males is deemed central to injury prevention during the construction phase of the proposed project.

3.20 Archeology and Cultural Heritage

A few cultural heritage resources are documented for the Grand Etang Forest Reserve (Tuner, 2009). The Fedon Camp, which is associated with the Julien Fedon's uprising in 1795 against British colonists is part of a trail situated towards the western end of the reserve. This historical landmark is situated away from the proposed pipeline route. Use of the reserve by the earliest settlers the Arawak is reportedly unknown, although historians indicate that it is likely that the Grand Etang Forest was used occasionally for hunting, gathering, ceremonial, and spiritual purposes. The Caribs in contrast maintained a camp at Grand Etang (Grenada Tourism Authority, n.d.). it is possible that there might be remnants of this historical past within the reserve. While not certain of any historical artifacts along the pipeline route, adoption of a chance find protocol for archaeological remains during the construction phases would be strongly encouraged.

4 Impact prediction and determination of significance

This section identifies and evaluates the potential beneficial and significant adverse environmental and social impacts of the proposed design concepts prepared by KOCKS Consult. Determination of significant adverse impacts that result in a change in the environmental, social, and economic conditions is a core outcome of the ESIA process. A significant impact refers to an anticipated change in the environment that necessitates the identification and implementation of relevant measures to avoid, reduce, and/or compensate for the consequences of such alterations (Noble and Martin, 2015). Jones et al. (2016) concur that such impacts would require mitigation measures to ensure that the residual effects¹⁹ are acceptable. While there are many different methods and frameworks for the determination of significance in environmental assessment, there is no universal procedure. The unique nature of the project and the national context, including existing environmental assessment legislation play a key role in the approach used (Noble and Martin, 2015).

A survey of the literature and approaches employed in various jurisdictions indicates that significance determination comprises a characterization of the impacts while also considering the value of the affected receptor (Noble and Martin, 2015). The nature of the impacts is typically determined through an interpretation of the findings emanating from the baseline assessments. In contrast, value speaks to the acceptability of the level of change by an affected group or segment of society (Gibson et al, 2005, Glasson et al., 2012, Martin et al., 2015), the social and cultural significance of the impacts, and/or the sensitivity of the receptor.

4.1 Methodology

Impact prediction and significance determination for this study are guided by an adapted methodology from the IUCN and other entities. It is intended to provide a reasonably transparent and repeatable approach for identifying the significant impacts associated with the proposed project before and after mitigation.

Significance Criteria and Weighting

For evaluating significance, the likelihood that a given risk event or impact is expected to occur, and the magnitude²⁰ of the event were considered. Table 22 lists the criteria which guided the impact prediction for this study. Weights were assigned in increments of two based on the increasing importance of the rating to the determination of significance (1, 3, and 5). This was done for all criteria except for the direction of impact and reversibility which were rated +3 or -3, and for likelihood.

Table 22: Criteria and weighting informing impact prediction

Criteria	Rating	Weighting	Description
Direction of impact	Positive	-3	Creates baseline improvement or generates a positive change in the receptor.
	Negative	3	Results in an adverse change from the baseline or generates an undesirable element to the baseline.
Criteria	Rating	Weighting	Description

¹⁹ Residual effect - effect of a project that remains or is predicted to remain, even after mitigation measures have been implemented (Government of Canada, n.d.).

²⁰ Magnitude - extent to which a risk event or impact might negatively affect environmental or social receptors (IUCN, 2020).

Criteria	Rating	Weighting	Description
Magnitude	Minor	1	Detectable but minor change to the specific conditions of the receptor assessed.
	Moderate	3	Detectable change to the specific conditions of the receptor assessed, resulting in non-fundamental temporary change. Do not exceed national standards.
	Major	5	Fundamental change to the specific conditions of the receptors assessed, resulting in long-term or permanent change, typically widespread in nature and requiring significant intervention to return to baseline; exceeds national standards.
Geographic extent	Site	0	Effects of an impact experienced within or in close proximity to the stressor.
	Local	1	Effects of an impact experienced within the project study area.
	Regional	3	Effects of an impact experienced within areas in close proximity to the project area (e.g. adjacent water service areas and systems and communities and livelihoods outside of the project area).
	National	5	Effects experienced at the country level.
Duration	Short-term	1	Impacts predicted to last only during construction.
	Medium-term	3	Impacts predicted to last for an intermediate period extending beyond the end of construction.
	Long-term	5	The impact and its effect will continue or last for the entire operational life of the project.
Reversibility	Reversible	-3	Impact is potentially temporary and reversible.
	Irreversible	3	Impact is potentially permanent and not reversible, by application of mitigation measure (if adverse).
Value of receptor	Low	1	Minor importance of receptor to most persons, communities, and governance agencies. Impacts or level of change to receptor unacceptable to only a small proportion of key stakeholders. Receptor is replaceable.
	Medium	3	Moderate to high importance for select stakeholders due to the significance of receptor in supporting environmental integrity or social and economic wellbeing. Level of change of receptor deemed acceptable for a moderate number of persons.
	High	5	Receptor deemed highly important by a substantial percentage of persons, communities, regulatory/governance authorities due to rarity, protected status by legislation, criticalness for national sustainable development. Level of change to receptor deemed unacceptable by most stakeholders.

Criteria	Rating	Weighting	Description
Likelihood	Low	1	Impact is unlikely to occur, but may occur at some time, under normal operating conditions (accidents).
	Medium	2	Likely to occur at some time under normal operating conditions.
	High	3	The impact is very likely to occur under normal operating conditions.
Directness & cumulative impacts	Direct	N/A	Results from a direct interaction between a proposed project activity and a receptor.
	Indirect	N/A	Results from non-project activities that occur as a consequence of the project.
	Cumulative	N/A	Impacts that act together with other impacts to affect the same environmental and social receptors.

Source: Adapted from IUCN, 2020; EPA, 2002; Hydea, 2017; African Development Bank Group, 2010; SLR Environmental Consulting Namibia Pty Ltd, 2017, GIZ, n.d.; Noble and Martin, 2015

Impact Assessment and Significance Determination

Guided by the criteria and weighting above, an evaluation of the likely impacts of project actions on sensitive receptors or valued components was undertaken guided by the formula below.

Significance = Likelihood x Magnitude

$$\text{Significance} = L \times (D_i + l_i + G_i + D_{ui} + R_i + V_r)$$

- L Likelihood of event
- D_i Direction of impact i
- M_i Magnitude of impact i
- G_i Geographic extent of impact i
- D_{ui} Duration of impact i
- R_i Reversibility of impact i
- V_r Value of receptor r

Sensitive receptors or valued components for this study are social systems (e.g., people, downstream and beneficiary communities, and livelihoods), and biophysical elements (e.g., individual species, vegetation, habitats, and soil) likely to be impacted. Scores for each impact were calculated to determine the level of significance for each exposure to the sensitive receptor. Three significance levels consistent with the GCF, World Bank, and other development agencies' ratings are presented. These are based on the description and score ranges as outlined in Table 23

Table 23: Significance levels prior to mitigation

Significance	Scores	Description
Minor	-3 to 24	Disturbs environmental and social conditions over a short period, is localized and reversible. Consequences occur but impacts are rather low. Impacts are below accepted limits and standards.
Moderate	25 to 52	Affects social and environmental conditions within short to medium term. Impact

Significance	Scores	Description
		is within accepted limits and standards and is reduced to a level that is “as low as reasonably practicable.” Receptor can recover.
Major	53 to 78	Affects social and environmental conditions over the long-term and may substantially alter the local and regional baselines affecting sustainability. Accepted limits or standards may be exceeded or large magnitude impacts occur to highly valued receptors. There may be major residual impacts after mitigation has been implemented.

4.2 Evaluation of Impacts – Construction Phase

4.2.1 Installation of the Intake

The main receptors likely to be impacted by the intake construction are water quality, aquatic biodiversity, soil, riparian vegetation and riverbanks, traffic levels along the access road to the intake, and the community’s access to the intake location.

Impact on soil, vegetation, and aquatic fauna

Installation of the intake infrastructure necessitates the temporary relocation of the river to one side of the channel to facilitate construction works. The periphery of the relocated part of the river would be “dammed” temporarily using stones, soil, or other similar materials. This action is typically required to ensure that the base area or riverbed on which the works are carried out remains dry throughout construction. The simultaneous damming and construction work on either side of the river is likely to act as a barrier, restricting the movement of aquatic organisms, including both fish and macroinvertebrates within the riverine ecosystem at the point of impact. The estimated period required for construction of the intake is approximately three weeks depending on weather conditions.

Excavation is the method of choice to prepare the riverbed for construction of the concrete intake. This activity is expected to disturb the riverbed, resulting in the resuspension of sediments and an increase in turbidity concentration within the water column. Gaining access to the riverbed will also disturb soil and damage vegetation along the riparian zone, and can cause erosion of the river bank in the affected area. Increased sedimentation associated with these actions is likely to smother aquatic organisms particularly sessile benthic macroinvertebrates which inhabit the bottom part of the riverbed. Invertebrates are an important part of the food chain and an indicator of pollution levels in riverine systems. Although sediments are a natural part of the functioning of riverine ecosystems, sediment introduction, especially very fine material, which exceeds the natural baseline levels in a running water system may alter faunal abundance and composition over time (Leitner et al., 2023). Heavy sediment loads can trigger invertebrate decline in various ways including scour damage, the burial of immobile species, clogging of gills or feeding structures, and reduction in primary production (Newcombe and MacDonald as cited in Wildfish, 2017). This may affect the aquatic faunal community around the intake but is most likely to affect sensitive and less tolerant taxa such as the water pennies (Psephenidae), caddisflies (Hydropsychidae), and the mayflies (Lepthophlebiidae). Importantly, as an ecological adaptation measure, organisms tend to move away from stressors into safer zones to protect themselves and would reoccupy the area on the culmination of related works (Leitner et al., 2021).

One of the risks associated with the use of heavy equipment is oil and fuel leaks and/or spillage. Any such occurrence can result in contamination of the affected soil and adjacent water body. This can create a nuisance for recreational activities downstream from the point of impact and can smother aquatic organisms. The likelihood of leaks and spills associated with the use of

excavators in Grenada, though a possibility, is low. The resultant impact is therefore linked to the volume of substance introduced into the receiving environment and the actions that are taken for prompt response.

Impact on traffic within the access road to the intake

The primary equipment required for the installation of the intake is an excavator and concrete mixing machine. A few additional vehicles associated with the Contractor, Client, and possibly the Engineering Consultant supervising the works are likely to access the road to the intake. Vehicular traffic would increase slightly within the targeted area. This can result in inconveniences, particularly for farmers and property owners, including the three (3) householders residing within that area. Pedestrians and motorists using the road to access the river and/or the Adelphi Waterfall for recreational purposes may be impacted if work is carried out on weekends and public holidays. Inconveniences include minor delays, motorists pulling to the side of the road and/or reversing to allow project vehicles to move, due largely to the very narrow road in that locality. Similarly, the associated works to construct the intake would hinder community people from accessing the river and work zone for health and safety reasons. This reduced access would be most pronounced on the landowners near the intake location and/or others who typically cross the river to access their properties or other common resources (e.g., the Adelphi Waterfall).

Significance determination

Construction of the intake would therefore adversely affect water quality, aquatic biodiversity, soil, and the riparian zone in the affected site. The magnitude of these impacts would be moderate due to the sensitivity of the listed receptors to the stressor, the likely disturbance of habitat albeit the small scale of the construction activity involved. This prediction is also linked to impacts that are short-term in duration, site-specific, and reversible once the stressors are removed. The likelihood of the impacts occurring is characterized as medium. The level of change to the receptors is also generally acceptable for the scale of work undertaken. Therefore, the significance of construction related impacts to the receptors is predicted to be moderate.

Traffic levels and the community's access to the river will also be impacted during the construction phase. The magnitude of these impacts would be minor due to the relatively limited number of persons likely to be affected and the short term duration of the activity. Impacts are predicated to be site specific and reversible with medium likelihood of occurrence. Overall significance of construction to traffic and people's access to the river is predicted to be minor.

Mitigation measures for reducing the overall adverse effects of the construction of the intake are therefore in order (see Section 5.0).

4.2.2 Installation of Pumps

Impacts on soil and biodiversity

The erection of the proposed two pumping stations would require the inevitable clearing of vegetation. An excavator would be used for land preparation to accommodate the submerged parts of the structure. The exact location of the pumping station close to the intake is not yet decided. However, based on the vegetation in the general location, the loss of grass species, agricultural crops, and other riparian vegetation is anticipated within an area of about 65m². Similarly, the land area proposed for the siting the booster station towards the back of the antenna at 1910 is likely to result in a loss of grass species and a few clusters of vegetation. Additionally, the clearing of land to accommodate the pump stations at the intake may also contribute to increased sedimentation in the river. This can lead to further sedimentation in the

river channel. This clearing is likely to affect a very small area of land and is associated with loss of ecological services provided by the affected vegetation, particularly those related to soil protection, habitat for wildlife (e.g., mongoose, insects), and maintenance of cooler site-specific microclimatic conditions.

Significance determination

Impacts associated with the pump construction though adverse are predicted to be minor, site-specific, and short-term. Loss of vegetation within the footprint of the pump will be long-term. However, the soil protection functions previously provided by the vegetation would be achieved through the newly installed structure. The significance of construction related impacts associated with the pump at the intake are predicted to be minor. In contrast, around 1910, impacts of pump construction to soil and biodiversity are predicted to be insignificant due to the small area to be impacted and existing land use of the area, albeit within a reserve.

4.2.3 Upgrade of the Access Road to Intake

General impacts

The proposed upgrade of select sections of the unpaved access from the Grand Etang Main Road to the intake site, inclusive of the last 250m, is predicted to be positive compared to the existing baseline. Improvement of the road infrastructure may enhance property values, especially for the lots along the 250m closest to the intake and is likely to increase the ease of vehicular movement for all users (i.e., farmers and landowners, householders, and local and foreign visitors to the Adelphi Falls). Road improvements are also linked to the development of the physical infrastructure that supports poverty reduction and community development, with positive secondary effects. In addition, this project action is likely to be a well-received intervention by landowners and road users, resulting in an acceptable level of change to the quality of the road generated through the proposed project. The indirect risk of land use change from agricultural to residential is a possibility based on trends seen elsewhere in Grenada. The likelihood of this risk is low since the entire road would not be retrofitted under the proposed project.

Significance determination

The significance of upgrading the infrastructure is characterized as minor due to the very small number of beneficiaries and the comparatively limited area of road affected. Since the impacts associated with this action are positive, this measure would not be considered in the overall analysis of project significance.

4.2.4 Pipeline Routing

Along Sections 1 and 2 – Intake to Grand Etang Main Road and unto 1910 Antenna

Installation of the pipe along Sections 1 and 2 is likely to affect five main receptors: roadside vegetation and related physical infrastructure, soil, traffic, access to real property and farms on route to the intake, and workers and community health and safety.

Impacts on soil and vegetation

An excavator would be utilized to create trenches to accommodate the underground pipes. This would require disturbance of soil and removal of roadside vegetation within the affected area. Some loss of vegetation, primarily grass species, fern (*Diplazium* sp), and other undergrowth would occur. It is also possible that some limited encroachment into the Reserve's boundary would be required to install the pipe at select points. Depending on the weather conditions, soil disturbance can increase the risk of small landslides and sedimentation into the receiving river. In the case of the roadway leading from the intake to the Grand Etang Main

Road, a few agricultural commodities, such as dasheen, coconuts, golden apples, and nutmeg planted along the roadside would be damaged or destroyed. Based on the crops currently cultivated, an estimated EC\$ 800.00 of crops would be damaged or destroyed guided by the Ministry of Agriculture's valuation system. Of course, the actual financial costs would depend on the nature of the crops planted and the stage of development during actual land preparation and construction. The variations from these figures are not anticipated to be considerable since most farmers/landowners do not typically plant many crops along the roadside.

Impacts on soil and vegetation are predicted to be adverse, minor, of short-term duration, site specific, and reversible. The sensitivity/value of change is low since the impacts are within what is acceptable for projects of this nature. The significance derived from works related to pipeline routing along Sections 1 and 2 on vegetation and soil is determined to be minor.

Impacts on traffic and road network

Routing of the pipe along Sections 1 (intake to Grand Etang Main Road) and 2 (Grand Etang Main Road to 1910 towers) is also predicted to impose stress on traffic dynamics, with a greater intensity of impact expected along the second section of the road. Road works associated with the proposed project will very likely result in traffic back-up and delays along the Grand Etang Main Road particularly during the peak periods – early morning (6:00 am to 8:00 am), early afternoon (2:00 to 3:00 pm), and after work (i.e., 4:00 pm – 5:00 pm). While data on these effects are not formally studied in Grenada, traffic delays due to ongoing construction works are related to wasted time spent en route, increased fuel consumption, and the heightened risk of punctuality issues at work, school, or other time-sensitive destinations. In relation to traffic congestion in Jamaica, one local psychologist reported that such stressors can increase the risk of indirect secondary impacts such as stress, frustration, fatigue, irritability, and anxiety with resultant adverse impacts on employee's productivity in the workplace (Scott, 2023). Moreover, increased traffic volumes during the cruise ship season which occurs from November to May is likely to compound these impacts.

Along Section 2, this would most probably affect the bus operators plying the Grenville to St. George's Route, private vehicle owners from the eastern and northern parishes, distribution and sales businesses, emergency vehicles, and tourists during the cruise ship season. To a lesser extent persons exercising in the early mornings or late evenings would also be affected. In addition, single-headed men and women households with dependents can be unduly impacted particularly if their aftercare pickup time is not flexible. Effective mitigation is required to limit adverse impacts on motorists, commuters, bus owners, businesses, and pedestrians along the route particularly in the Grand Etang Area.

Adverse impacts on traffic along Section 2 are predicted to be of moderate intensity due to the relatively large volume of motorists, passengers, and to some extent tourists likely to be affected. In contrast, the intensity of impacts on traffic along Section 1 is predicted to be low. Geographic extent is predicted to be site-specific along Section 1 compared to a regional rating along Section 2 since persons both within and outside the project area would likely be affected. The duration of impacts would be short-term and reversible at the culmination of the construction phase in both instances. The significance of pipe routing on traffic movement along Sections 1 and 2 is predicted to be low and moderate respectively.

Impacts on road integrity

Some deterioration of the road along Grand Etang is possible due to the increased movement of heavy vehicles to support the construction phase. This is likely to require an investment from the Ministry with responsibility for Infrastructure Development to repair and maintain the affected parts of the road, as necessary. Impacts on road integrity are predicted to be of minor magnitude, site-specific, and occurring over a medium time frame since repairs, if any, are likely to be completed after the construction phase. The level of change to the roads is

considered within normal expectations and is therefore predicted to be low. Some cumulative effects are predicted due to the implementation of other capital projects affecting road integrity across the state. Overall, impacts accompanying the installation of pipes along the Grand Etang Main Road (Section 2) on road integrity are determined to be of minor significance due to the small proportion of the road affected compared to the total area of primary roads connecting the main towns across mainland Grenada.

Section 3 – 1910 Antenna to Les Avocats

Routing the pipe through the forest reserve is likely to be one of the most concerning aspects of the proposed project due to the high sensitivity and value of the resource and the extremely steep topography in select areas. Sensitive receptors likely to be affected in this routing section are vegetative communities and supporting habitats, birds and wildlife, soil and subsurface geological assets, recreational trail and landscape aesthetics, and workers and community health and safety. Mitigating the effects on soil and vegetation will be pivotal. This subsection evaluates the impacts and significance associated with the pipeline routing as presented in Options 1 and 2. Option 3 (Horizontal Directional Drilling) would not be considered further since it was deemed by the design engineers in the updated Draft Feasibility Report as technically unfeasible. This is because the maximum drilling length and the need to access both sides of the mountain with machinery does not allow the implementation of this technical alternative. This decision is in line with the Department of Forestry's concern to avoid the creation of a motorized road to allow access of the drilling machine into the forest due to the high value and sensitivity of the Reserve (Refer to Appendix 12 for analysis of the HDD option).

1910 to 300 m southwards towards the valley

The approach proposed to lay the pipes from 1910 Antenna southward approximately 300 m is consistent for both Options 1 and 2. The land is gently sloping as it moves along this part of the route (~10-15°). Trenching to facilitate the underground pipeline will unavoidably result in the removal and damage of resident vegetation and the disturbance of soil in the affected area. This action is likely to affect resident grass species and other undergrowth, ferns (*Diplazium* sp), and a few seaweet plants (*Byrsonima spicata*) along the edge of the unpaved access. This would result in a reduction of the ecosystem services provided by the affected vegetation (e.g., soil protection, and habitat provision). During such disturbances, most affected fauna including bird species would find other suitable foraging ground within the adjacent forested area.

Impacts though adverse to vegetation, soil, and wildlife are predicted to be minor site-specific, short-term in duration, and reversible due to predicted regrowth after the culmination of the activity. The level of change generated is predicted to be within acceptable levels. The significance of laying the pipe along the first part of Section 3 is determined to be low.

Option 1: Using the initial preferred route

Impacts on biodiversity and soil: Although an ecological assessment was not conducted for the route proposed in Option 1, it is expected that the vegetative composition and habitats are similar to that observed along the Option 2 route with some variations influenced by topography and light exposure. Similar to the impacts predicted for Option 2, installation of the transmission line is predicted to adversely affect resident vegetation, wildlife habitats and soil resources. Due to the steeper slopes along the proposed Option 1 route, the risk of soil erosion and landslides and the accidental and/or unnecessary destruction of vegetation catalyzed by a challenging work environment are likely to be greater compared to Option 2. This may have profound negative implications for the Reserve's integrity within the affected area.

Significance determination

Based on the foregoing analysis, impacts associated with laying the pipe along the Option 1 route on soil and biodiversity are predicted to be negative. While there is some level of

uncertainty in predicting impacts along the Option 1 route since a complete walkthrough was not undertaken due to safety reasons, and it may not be possible to comprehensively predict the actual impacts in this unique terrain, the magnitude of the impacts on soil is predicted to be a moderate to major, dependent on work approach adopted onsite and the extent of challenges faced by the workforce during pipe laying. The scale of impact is likely to be localized or regional depending on the actual magnitude/intensity of impact. In addition, impacts on soil arising from using the Option 1 route are direct and possibly medium to long term since it might take a longer time for restoration of affected areas. The actual degree of reversibility in very steep areas is somewhat uncertain. The overall significance of impacts on soil is predicted to be moderate to major.

The impact on vegetation is predicted to be of moderate magnitude and significance. Impacts on wildlife are determined to be of low to moderate significance due to the adaptive capacity of most motile species.

Impacts on Landscape Aesthetics: Similar to Option 2, laying pipes along the proposed Option 1 route introduces a man-made physical structure within the natural forest ecosystem. Since utilization of this part of the Grand Etang Forest Reserve is not frequented by recreational users, impacts on the cultural ecological services provided by the forest though negative are predicted to be minor, site-specific, and of medium to long-term duration. The overall significance of the landscape aesthetics under an Option 1 scenario is characterized as minor.

4.2.5 Impacts on Employment, Livelihoods and Economy

Mobilization of Workforce and Employment

Like other capital projects, the proposed venture is predicted to positively impact the workforce. While the exact number of persons to be employed has not yet been determined, it is expected that various skilled, semi-skilled, and unskilled workers will be needed for the construction phase. The primary skillsets required include machine operators, pipe installers, labourers, project managers, engineers, and traffic control operatives. While suitably qualified persons within the project's area of influence have a heightened possibility of being recruited, employment impacts are expected to be experienced at both the community and national levels due to the scale of work envisaged. Men are predicted to be the principal beneficiaries of employment opportunities under the proposed project due to the nature of work and gender-stereotypical roles within the construction workforce. Measures to encourage qualified women participation should be encouraged.

Impacts are highly probable and are predicted to be direct, temporary, and of short to medium-term duration. Moreover, related impacts associated with employment is deemed to be of moderate magnitude with benefits experienced at the national level due to the opportunities for workers to be recruited from different parishes across the state. The duration of effects is short-term, and impacts are reversible on completion and commission of the project. Overall significance on employment is predicted to be positive.

Impact on Community and National Economy

A project of this magnitude is likely to create a positive multiplier effect on the community-based economy around the project site as well as the economic system operating at the national level. Procurement of select hardware supplies (e.g., sand and gravel) and other ancillary goods and services (e.g., trucking and equipment rental services) from local companies are predicted to increase the revenue of these enterprises. In addition, workers attached to such projects have been known to provide an additional market for existing and start-up micro and small food businesses, generating increased revenue in the short term for such entities. There is also a low probability that construction activities can hinder some clients from accessing select community bars or shops, possibly within the Grand Etang area. In

addition, NAWASA's procurement of water pipes outside of the island is likely to affect the project's overall impact on the economy. Albeit this, the proposed project in the construction phase is predicted to generate positive and direct impacts on local and national micro, small, medium, and large enterprises. The magnitude of impacts is minor, short-term, and reversible. Overall significance to the national economy and livelihoods is predicted to be minor.

Cumulatively, the ongoing implementation of other government-led capital projects can generate synergistic positive impact on the economic situation within the state.

4.2.6 Land Tenure and Rights

The project does not necessitate the relocation/resettlement of households or communities since the proposed designs do not require large tracts of land. The proposed need to acquire the relevant land tenure interests to construct the pump is not anticipated as a significant concern within the context of this project since the owner has already agreed to lease the property to the Authority. NAWASA has commenced discussion with the interested landholder and as such would be guided by appropriate legislation to ensure an equitable leasehold arrangement as needed. Importantly the water authority also has excellent experience in such negotiations guided by best practice.

4.2.7 Impacts on Workers Health and Safety

Due to the topography and sensitivity of the site, excavators and other motorable equipment would not be allowed within the Reserve. As such all materials for the construction of the supportive concrete blocks and laying of the pipes would be carried manually by workers throughout the route (e.g., water pipes, cement blocks, sand, gravel, steel, water for mixing). This presents an extremely challenging work environment due to high annual rainfall received within the Reserve, the damp soil conditions throughout a considerable part of the year, and the steep to very steep terrain (>30o) along a substantial proportion of the site. The site may therefore be potentially hazardous with implications for the safety of personnel and equipment as well as the quality of the pipe-laying operation, if not efficiently managed. Moreover, the preparation of the site and laying of the pipe present considerable musculoskeletal and ergonomic risks that can cause injury, accidents, and other adverse events. Risks of slips and falls are also likely aggravated by the material weight that workers would be expected to carry under the prevailing physical conditions. The daily back and forth movement of workers along the route can also increase the risk of falls arising from soggy and slippery soil (which can also increase the risk for soil movements). Constructing ditches to install the concrete blocks can also create risks of cave-ins or soil material covering site workers depending on the depth of the excavated hole and the ambient conditions. The above risks are likely to increase considerably during inclement weather conditions.

An assessment of compensation for employment injury paid by the National Insurance Scheme for the period 2018-2022 showed that the majority of payments were associated with injuries of different parts of the body – head, hip, thigh, shoulder, upper arm, thorax, wrist, and hand. It is of paramount importance that such incidences are prevented and/or reduced to a minimum. A comprehensive occupational health and safety plan that includes protective measures for working on steep terrain characterized by moderate to high rainfall is another top priority action for the proposed project.

Impacts on workers' health generated from pipe laying in Option 2 as detailed above are predicted to be adverse, rated at moderate magnitude. Duration of impacts can vary (short to long term) depending on the nature of the impacts. Most construction impacts are reversible, however, there is some uncertainty in predicting the reversibility associated with the human

health impacts, since it is dependent on a range of factors, including the nature of the impacts generated. Significance to health is predicted to be moderate.

4.2.8 Impacts on Community Health and Safety

Community health and safety can be impacted at various points during project construction: (i) construction of the intake and pump, (ii) running the pipeline along the road network, and (iii) through the forest reserve. Various risks are likely to occur at each of these strategic points.

Excavation of trenches along areas used by community people if left open presents a risk of falls, injuries, and other adverse events. While not reported formally, such incidences have occurred at the community level associated with projects operated by local private contractors. Along the proposed pipeline route the risk is greatest for children, older adults, hikers, pedestrians, and tourists traversing these sites. Persons who are visually and physically impaired can also be affected if using these sites without the appropriate health and safety risk reduction measures in place. Risks of noise can also be a concern which is elaborated on in Section 3.5. There are also risks of injury from poorly managed solid waste material including used steel for constructing the concrete blocks. NAWASA’s experience in installing the infrastructure for water pipes would offset some of these risks. However, integrating the necessary measures for reducing health and safety risks to community people is a core part of the construction management plan for the proposed project.

4.2.9 Construction Generated Emissions

Noise

Use of heavy machinery and supporting transportation systems is anticipated. Noise emissions from non-impact and impact equipment is expected from construction related activities based on existing information (Refer to Table 24). Project generated noise levels based on secondary literature are likely to be higher than the ambient decibels measures during the baseline analysis and the recommended thresholds at sensitive locations as specified by the World Health Organization.

Table 24: Typical noise levels of equipment likely to be on construction site (USDT, 2011)

Equipment Description	Impact device	Spec. 721.560 L (Max) @ 15 m (dBA) slow	Actual measured L (Max) @ 15 m (dBA) slow
Concrete mixer	no	85	81
Excavator	no	85	81
Flatbed truck	no	84	74
Front end loader	no	80	79
Generator	no	82	81
Jackhammer	Yes	85	89
Pickup truck	no	55	75
Compactor (ground)	no	80	83
Dump truck	no	84	76

Construction activities are therefore predicted to result in adverse impacts on ambient noise levels, with disproportional effects to wildlife within the reserve, the residential occupants along the route to the intake, and business and patrons at the visitor center at Grand Etang. Elevated noise exposure can be linked to various health outcomes including increased irritability and annoyance, headaches, sleep disturbance, heightened blood pressure, cognitive impairment in children, hearing impairment, and reduced productivity (European Environment Agency, 2020; WHO, n.d.). The resultant impact is dependent on varying factors, including the length of exposure, time of exposure (night verses day), and the sensitivity of affected persons. While adverse, impacts are predicted to be of minor magnitude short term, generally reversible although some impacts on human health can, however, persist on very sensitive individuals residing within that locality. Every effort should therefore be made to adopt best practices for noise management. The significance of noise on human health is predicted to be low due to the limited number of people who will be exposed for a very long period within the vicinity of the proposed project site.

The effect of noise on biodiversity in Grenada has not been studied. However, based on existing literature and expert judgment, increased noise levels can affect terrestrial organisms and some fish. This can be more pronounced if the noise is continuous. While negative, most species move away temporarily from the introduction of a new noise source into more suitable locations and adapt/acclimatize readily to such changes in environmental conditions. Once the noise source is removed, such organisms are highly likely to return. Impacts though negative are predicted to be minor, short-term, site specific, and of minor significance.

Waste

The waste stream is likely to include primarily excavated soil/spoil material and stones/boulders associated with trench construction. If inappropriately managed, this can introduce increased sedimentation in the nearby water sources, particularly under rainy conditions. Such waste is also unsightly and can affect the ambiance of the surrounding site. In addition, cement bags, unused steel, and related materials are also likely to be generated as part of the construction of the concrete blocks. There is also a minimal risk of injuries to workers and community persons accessing that area from this material. Impacts are negative, localized, short-term, reversible, and of minor significance.

Other emissions

Increased occurrence of dust and other emissions, particularly during drier periods could negatively affect exposed persons with hypersensitive airway diseases. This can also be generated during the transport of materials to and from the project sites. This is of particular concern for persons with existing health conditions, young children, and older adults stationed in homes, within proximity to the project site. Fortunately, the number of persons residing or working for long hours along the project site is low. While risks of dust and related emissions are adverse, they are predicted to be of minor magnitude, localized, short-term, reversible, and within acceptable levels for this kind of work. Most likely to affect workers within the project site/s, pedestrians using the roads, and small and microbusiness along the route. The overall significance is predicted to be minor. Adoption of the necessary noise, dust, and waste management strategies is required and highly recommended.

4.2.10 Impacts on Criminal Activities

Implementation of the proposed project is not a direct cause of crime. However, it can create conditions that encourage certain kinds of criminal activities. Consultation with competent authorities within the Government Service pointed to a possibility for increased opportunistic crimes (e.g. theft) in areas where valuable project items are stored, for instance around project sites. This is consistent with the profile of crimes in the parishes of St. Andrew and St. David.

Over the four-year period 2019-2022, almost 25% of the offenses were property-related. In addition, crimes associated with threats and assaults were comparatively high (almost one in every three crimes). The occurrence of similar incidents at the site or related to the project therefore requires management, particularly under tense work conditions. Impacts of the project on criminal activities though negative, are predicted to be short term, localized, and minor in magnitude and significance. Younger unemployed or underemployed males are most likely to be associated with such petty crimes.

Based on data provided for the foregoing period, on average the frequency of sexual offenses in St. David and St. Andrew was low (1.5-2.2%). The risk of such occurrences including sexual exploitation and harassment (SEAH) increases when workers enter a new community and/or during an influx of foreign workers. Both young girls, women, and young males are at risk. While it is difficult to predict the occurrence of SEAH due to among other factors the value system of the workforce and the receiving community, every effort is needed to prevent and mitigate this occurrence. Based on available information, impacts of the proposed project on SEAH are predicted to be of minor magnitude, site-specific, indirect, localized, and indirect with varying degrees of reversibility depending on the nature of the offense and the sensitivity of the persons affected. Overall significance is deemed to be minor due to the low levels of exposed individuals around the project site. Monitoring of this indicator is key.

4.2.11 Archeological Heritage

Based on available information, no significant impact on archeology is anticipated based on knowledge of the existing resources within the project site. Notwithstanding this, implementation of the relevant measures for managing chance finds is congruent with best practice.

4.3 Evaluation of Impacts – Operational Phase

4.3.1 Water Abstraction

Water abstraction as proposed has implications for the following key receptors: riverine biodiversity, communities' livelihoods and cultural use of the river, improved water supply and human health, and other key socio-economic and development indicators.

Impacts to Beneficiary Communities: Safe drinking water is a core existential need for human development. It is a human right and is fundamental to human dignity and improving the standard of living for people across different social groups. The proposed augmentation of the water supply is predicted to improve the quality of life of the affected southeastern communities, particularly residents in water-challenged communities such as “Behind McMillan Cocoa” and Marian. An enhanced supply of water during the dry season is linked to better educational outcomes for children, due in part to reduced occurrence of water-induced school absenteeism and early closure of schools arising from water disruptions. Time savings can be achieved at the household level since less investment would be required to collect and store water. Available time could therefore be directed into more productive ventures (World Bank, 2017). Better water supply is central to poverty reduction and creates the enabling environment for socio-economic development at the household, community level, and business levels. The burden of preventable water-borne diseases such as diarrhea, which falls disproportionately on the poor and children under five, is likely to decline (OECD, 2011). A more reliable water supply is also linked to better access to water, sanitation, and hygiene (WASH) services at the educational institutions within the Les Avocats and Petite Etang supply areas. Access to WASH is every child’s right and is essential for the healthy development and growth of children, as they grow throughout adulthood (UNICEF, 2013). The proposed project

therefore supports the intent of the Convention on the Rights of the Child. Similarly, the decision to facilitate a more reliable supply of water to beneficiaries is congruent with the intent of Sustainable Development Goal (SDG) 6, the National Water Policy, the National Sustainable Development Plan 2035, and related instruments.

Impacts on the southeastern communities are predicted to be positive, localized, long-term, and of moderate magnitude. The likelihood of the predicted impacts occurring is medium. The significance of an improved supply of water to the beneficiary communities is determined to be moderate. The synergistic projects planned to promote demand reduction strategies at the household level and the expansion and/or upgrade of the Les Avocats and Petite Etang Water Supply system are predicted to generate positive cumulative effects on the beneficiary communities. These would play an instrumental role in maximizing the benefits and sustainability of the proposed Seven Sisters Water Transmission project.

Impacts on the Cultural Uses of the River: During the operational phase, approximately 72% of the minimum dry season discharge is projected to move downstream the intake as ecological flow. This is generally within acceptable limits. Proportionally, this is consistent with the abstraction and ecoflow regime that is functional at the Concord Black Bay River during the peak dry season. Throughout the English-speaking Caribbean, Dominica and Jamaica are two of the Member States with functional ecological flow frameworks. The minimum dry season ecological flow in Dominica and Jamaica are set at 70% and 60% respectively (Roberts Caribbean, 2021), slightly lower than the volume proposed for the Seven Sisters Project and the Concord Water Treatment plant. While the proposed abstraction will alter the baseline streamflow during the dry periods, it is not predicted to fundamentally change the way people connect and use the river culturally, which is very important to the affected communities. The water flow from the intake is predicted to be sufficient to support the traditional and cultural uses of the Great River by the downstream communities from Aldephi to Telescope to include bathing, swimming, fishing, recreation, and church baptism.

The proposed abstraction at the intake is predicted to negatively affect the downstream streamflow. However, impacts though detectable, are predicted to be minor in intensity, within the context of the cultural activities that are valued by community people. Impacts are further predicted to be localized within the project area, long-term, and reversible once pumping is not in effect. Importantly, the baseline status of streamflow during the wet season remains unchanged. The overall significance of impacts on the capacity of the river to support the cultural uses of the river is minor. Likelihood of impact is medium.

Impacts on Aquatic Biodiversity: Maintaining the natural flow regime in riverine systems as closely as possible during water withdrawals is central to sustaining ecological functions and services and the continued viability of life within the river (Salinas-Rodriguez et al, 2018; Arthington et al, 2006). The Nature Conservancy (n.d.) notes that the “natural, seasonal patterns of rising and falling water levels in freshwater systems shape aquatic and riparian habitats, and provide cues for migration and spawning, distribution and growth of seeds, and enables rivers, lakes, wetlands, and estuaries to function properly.” Mirroring as much as possible the natural water flow dynamics in rivers is crucial for overall ecological health and resilience. Moreover, the Brisbane Declaration concurs that freshwater and estuarine ecosystems have evolved with, and therefore depend upon, naturally variable flows of high-quality fresh water.

Little or no information is available in the literature on the ecological effects of human-induced water withdrawals on rivers within the Caribbean and other Small Island Developing States. Albeit this, consultation with water managers in select regional countries (St. Lucia and Jamaica) noted that during periods of high water abstraction from rivers, the abundance of aquatic biodiversity, in particular fish species decreases. In addition, an increased proliferation of algae in the river was observed, especially when the river was also affected by a high influx

of nutrient enrichment from adjacent lands (Roberts Caribbean, 2021). Based on the literature from developed countries, abstraction above acceptable thresholds has been linked to reduced oxygen levels, elevated pollution concentration (TNC, n.d.) and a decline in the diversity and abundance of aquatic life, with the river becoming occupied by more tolerant taxa (Dewson et al., 2007a; Scottish EPA, 2017). Recovery potential for fish and macroinvertebrate under short periods of stress, however, have been reported to be fairly high (Scottish EPA, 2017).

Within the context of the proposed abstraction in the Great River, reduced flows during the dry periods may create a stressor to aquatic life. This can be compounded by the installation of the intake across the river, which could potentially hinder species movement to areas directly upstream and downstream of the structure. This may have implications for the lifecycle dynamics of migratory fish species such as the River and the Siraji Gobies and can result in decreased abundance upstream of the intake. The overall species diversity in the river however, is not anticipated to change. Alterations to streamflow driven by water abstractions greater than 20% have been reported to result in moderate to major changes in the natural structure and ecosystem functions of riverine ecosystems, with greater risk associated with higher levels of alteration in daily flows (Ritcher et al., 2011). Considering that the proposed alterations to the baseline streamflow are around 28% coupled with the fact that the intake as a semi-barrier to movement remains permanently in the river channel, impacts to aquatic biodiversity are predicted to be adverse and of moderate intensity. Moreover, impacts are likely to be direct, localized, long-term, and reversible. The sensitivity of the receptor is medium. The likelihood of the impacts occurring is predicted to be low to medium. The overall significance of the intake on riverine lifeforms during the operational phase is determined to be moderate.

Impacts of Operation of the Intake on riverbank stability and community Safety: Installation of the proposed intake is likely to increase the turbulence and velocity of the flow downstream the intake. This can potentially increase the erosive action of the river along the downstream riverbanks close the intake. The introduction of the gabion mattress is likely to reduce the risk and occurrence of riverbank erosion. While it is not certain whether the gabion solution will be 100% effective in preventing erosion, some adverse impacts may occur. Adverse impacts if any are predicted to be minor, direct, and medium term. Overall significance likely to be minor. Monitoring changes to the riverbank during the operational phase is strongly advised. This would be important in advising appropriate changes if any to address any adverse impacts.

The installation of the intake introduces a risk to persons using the river around that area. Risks of slips, falls and injuries may occur. However, people have generally acclimatize to varying extent to traversing the river with stones along its path. Albeit this, impacts of the intake on human health and safety are predicted to be adverse are predicted to be minor, direct, and site specific. Of course, the value of the receptor, humans, is extremely high. The overall significance of impact on human health and safety is predicted to be low.

Impacts on Livelihoods: The principal livelihoods that are evaluated in this section are farming along the riverbank and the operation of the river tubing and related tours downstream of the proposed intake. Due to the contribution of these activities to community and national development, through food production and nutrition security, employment, and tourism, the water needs of both livelihood activities must be considered along with the important requirement for providing a reliable supply of water for communities.

Abstraction as proposed will reduce the volumes of water moving downstream by about 28%. While the volume of water abstracted by the farming community is not known, the proposed project is not likely to fundamentally alter farmers' utilization of the resource to support food production. It is likely that there should be sufficient water to support the irrigation needs of farmers downstream of the river. Coexistence of both needs is expected post implementation of the project. The magnitude of impacts on farmers' use of the river for irrigation are likely to

be of minor to moderate intensity depending on the growth in the farming sector along the river, the volumes of water abstracted, the impact of climate change, and the adaptation measures utilized by farmers currently and in the future to build resilience to the extreme climatic events in the dry season. Albeit this, monitoring levels of satisfaction and/or any complaints would be prudent. This is likely to be the responsibility of the soon to be commissioned Water Resource Management Unit.

The proposed abstraction of 16l/s equivalent to 28% during the dry season is within acceptable limits for water withdrawal, albeit the absence of an environmental flow framework for Grenada. This indicates that the quantity released downstream is in harmony with the safe yield calculated for the river. However, it is likely that the proposed abstraction will adversely affect the optimal functioning of the river tubing operation from January to May. While there is some uncertainty regarding the exact intensity of the impact, based on discussions with stakeholders, reduced flows will limit the volume available in the river channel and are likely to increase the challenges faced by operators to maneuver the tubes along the river. Users' experience throughout the tours can potentially decline if sufficient water is not available to involuntarily push the tubes along. This situation would likely compound the already low flows that are reportedly experienced during the peak dry season, typically between April and May, and may result in operators having to temporarily close their business during that period. If the latter occurs, this has serious implications for the sustainability of livelihoods that depend on the river, the continuance of other nature tours that are linked to river tubing, employment of rural males, and the profitability and brand of the three affected river tubing companies and the sole river rafting company. This indicates that the unique water needs of the river tubing industry require special consideration in the planning and management of the proposed project. Innovative and sustainable options for mitigating the effect of this are therefore crucial.

Impacts therefore on river tubing is predicted to be adverse, direct, moderate in intensity, localized, long term during times that water is abstracted during the dry season. Impacts are reversible once no diversion of water is facilitated (for instance during November and December based on the proposed preliminary project design). The likelihood of the occurrence and the value of the receptor is medium. The overall impact to river tubing operation is moderate. In contrast, the intensity of adverse impacts to irrigation is minor to moderate, localized, sporadically over a long term (only when water is pumped), reversible with low sensitivity to the stressor.

Overall significance of the impact to the farming community is minor.

Impacts to National Social and Economic Development: Minor

4.3.2 Unplanned Events and Natural Disasters

Leaks and Ruptures: Due to the sensitivity and high value of the site, particularly Section 3, the occurrence of adverse anthropogenic, natural, or extreme climatic events during the operational phase can potentially present considerable risks to the Grand Etang Forest Reserve. Leaks or ruptures that are not promptly and effectively managed can result in substantial soil movement with negative implications for resident vegetative communities, wildlife, and related habitats. Depending on the location of the leak or rupture, landforms within the impacted zone can be modified considerably. This is aggravated by the high pressure of water flowing through the pipes down to the Les Avocats and the remoteness and physical difficulty of workmen accessing the site. Water that flows over the forest floor for prolonged periods can result in gully erosion, landslides, toppling of vegetation, and other forms of land degradation, which contravenes national legislation, and Grenada's obligations under the United Nations Convention to Combat Desertification. Moreover, this can hinder the capacity of the forest to provide key ecosystem services that support national development.

While NAWASA is not 100% certain of the brand of pipes that would be used, a highly durable and light transmission line reduces the risks for leaks and breakage is envisioned. While there is a moderate to high uncertainty regarding the likelihood of major leaks or ruptures along the pipeline within the reserve, impacts associated with any such events are predicted to be adverse, of moderate magnitude, with impacts experienced at a regional scale (within and outside the project area depending on the magnitude of the threat). While most impacts associated with leaks and ruptures are likely to be reversible, there is some uncertainty concerning this latter prediction, since the magnitude of the event is unknown at this stage. The significance associated with unintentional leaks or ruptures is therefore predicted to be minor to moderate depending on the extent of the event, location within the reserve, and other geophysical conditions. Measures to monitor and respond to in real-time any dysfunctionality or changes within the distribution system are a top priority.

Natural Disasters and Extreme Climatic Events: Natural events, including extreme climatic occurrences, present a major risk, particularly from Option 2, above ground solutions. Evidence has shown that moderate to high catastrophic hurricanes are capable of damaging water mains and associated infrastructure. During tropical storms and hurricane conditions, the high winds combined with heavy rainfall can cause trees to sway violently. Uprooted trees can damage mains as observed in Hurricane Ivan in Grenada and Hurricane Maria in Dominica in 2018. In addition, such conditions may threaten the stability of the concrete block structures with negative implications for the water supply infrastructure. Disruption and breakage of pipes can result in the scale of degradation described previously. The need for ongoing maintenance of the water supply infrastructure through the reserve, use of the highest quality material and workmanship, and protection of soil and vegetation are pivotal.

Impacts predicted from extreme climatic events are predicted to be negative, of moderate magnitude, and localized to regional geographic extent. Impacts can be short-term to medium term depending on the magnitude. Value moderate, Significance is moderate. The risk of the earthquake is somewhat lower based on available trends. However, building with climate and earthquake resilient technology is paramount.

4.4 Summary of Impacts – Construction and Operational Phase

Table 25 outlines a summary of the impacts of the construction and operation phases.

Table 25: Summary of construction & operational impacts & significance level

Project Actions	Receptor	Predicted impacts & Direction (positive or negative +/-)	Magnitude	Geographical extent	Duration	Reversibility	Value	Likelihood	Direct/indirect or cumulative	Consequence & Significance of Impacts
Construction of intake	Water quality	<ul style="list-style-type: none"> Increase turbidity in the river (-) Possible contamination by equipment oil or fuel (-) 	Moderate	Site-specific	Short-term	Reversible	Medium	Medium	Direct	14 - Minor
	Aquatic biodiversity	<ul style="list-style-type: none"> Restricts movement of aquatic fauna at the point of impact; increased siltation affects sensitive taxa (-) 	Moderate	Site-specific	Short term	Reversible	Medium	Medium	Direct	14 - Minor
	Soils	<ul style="list-style-type: none"> Disturbs riverbed and soil along the riparian (-) 	Minor	Site-specific	Short term	Reversible	Low	Medium	Direct	6 - Minor
	Riparian vegetation	<ul style="list-style-type: none"> Damage and loss of vegetation (-) 	Minor	Site-specific	Short term	Reversible	Low	Medium	Direct	6 - Minor
	Traffic in access road	<ul style="list-style-type: none"> Slight increase in traffic; users' inconvenience - 	Minor	Site-specific	Short term	Reversible	Low	Medium	Direct	6 - Minor
	Access to intake & adjacent lands	<ul style="list-style-type: none"> Reduced access around intake (-) 	Minor	Site-specific	Short term	Reversible	Low	Medium	Direct	6 - Minor
	Construction of pumps	Resident vegetation	<ul style="list-style-type: none"> Loss and damage to vegetation (-) 	Minor	Site specific	Short term term	Reversible	Low	Medium	Direct
Water quality		<ul style="list-style-type: none"> Increase sedimentation 	Minor	Site specific	Short term	Reversible	Low	Medium	Direct	6 - Minor

Project Actions	Receptor	Predicted impacts & Direction (positive or negative +/-)	Magnitude	Geographical extent	Duration	Reversibility	Value	Likelihood	Direct/indirect or cumulative	Consequence & Significance of Impacts
		affecting riverine water quality (-)								
Upgrade of access road	Access road	<ul style="list-style-type: none"> Increase ease of vehicular movement (+) 	Minor	Regional	Long term	Reversible	Medium	Medium	Direct and cumulative	Not considered in significance determination due to positive impact
	Property values	<ul style="list-style-type: none"> Increase property values (+) 	Minor	Site specific	Long term	Reversible	Low	Medium	Indirect and Cumulative	Not considered in significance determination
	Land use	<ul style="list-style-type: none"> Possible risk of land use change from agriculture to residential or other uses (-) 	Minor	Site specific	Long term	Reversible	Low	Medium	Indirect and Cumulative	14 – Minor
Routing of pipe along Section 1 (Adelphi Intake Access)	Roadside vegetation	<ul style="list-style-type: none"> Some loss of roadside vegetation to include economic trees (-) 	Minor	Site specific	Short term	Reversible	Low	Medium	Direct	6 - minor
	Soil integrity	<ul style="list-style-type: none"> Soil disturbance, possible risk of small landslides (-) 	Minor	Site specific	Short term	Reversible	Low	Medium	Direct	6 – Minor
	Traffic flow in access road	<ul style="list-style-type: none"> Minor inconveniences for road users (-) 	Minor	Site specific	Short term	Reversible	Low	Medium	Direct	6 – Minor

Project Actions	Receptor	Predicted impacts & Direction (positive or negative +/-)	Magnitude	Geographical extent	Duration	Reversibility	Value	Likelihood	Direct/indirect or cumulative	Consequence & Significance of Impacts
	Access to real property & farms	<ul style="list-style-type: none"> Minor inconveniences (-) 	Minor	Site specific	Short term	Reversible	Low	Medium	Direct	6 – Minor
Routing of pipe along Section 2 (Grand Etang Main Road)	Roadside vegetation	<ul style="list-style-type: none"> Damage and loss of vegetation within the affected footprint of the trench (-) 	Minor	Site specific	Medium term	Reversible	Low	Medium	Direct	10 – Minor
	Soil integrity	<ul style="list-style-type: none"> Soil disturbance, possible risk of small landslides (-) 	Minor	Site specific	Short term	Reversible	Low	Medium	Direct	9 – Minor
	Traffic flow along Grand Etang Main Road	<ul style="list-style-type: none"> Traffic back up and delays (-) 	Moderate	Regional	Short term	Reversible	Medium	Medium	Direct	20 - Moderate
	Road integrity	<ul style="list-style-type: none"> Possible deterioration of affected roads due to increase movement of heavy vehicles (-) 	Minor	Site specific	Medium term	Reversible	Low	Medium	Direct	10 – Minor
	Vegetation and soil	<ul style="list-style-type: none"> Unavoidable removal and damage of vegetation and soil, loss of ecological services (-) 	Minor	Site specific	Medium term	Reversible	Low	Medium	Direct	10 – Minor
Routing of pipe along Section 3 – from 1910 southward to 300m	Vegetation and soil	<ul style="list-style-type: none"> Unavoidable removal and damage of vegetation and soil, loss of ecological services (-) 	Minor	Site specific	Medium term	Reversible	Low	Medium	Direct	10 – Minor

Project Actions	Receptor	Predicted impacts & Direction (positive or negative +/-)	Magnitude	Geographical extent	Duration	Reversibility	Value	Likelihood	Direct/indirect or cumulative	Consequence & Significance of Impacts
Routing of pipe along Section 3 (Option 1 route)	Workers' health and safety	<ul style="list-style-type: none"> Hazardous conditions increased risk of musculoskeletal and ergonomic issues. Risk higher than Option 2. Possible adverse incidents (-) 	Moderate to major	Localized (can affect households /worker family)	Short to long term	Reversible or irreversible; however, this is dependent on the nature of the occupational incident	Medium	Medium	Direct	40 – Moderate
	Forest vegetation	<ul style="list-style-type: none"> Loss and damage to biodiversity through vegetation removal. Risk of accidental and/or intentional destruction (-) 	Moderate	Local	Medium term	Reversible	High	Medium	Direct	22 - Moderate
	Wildlife	<ul style="list-style-type: none"> Disturbance to wildlife habitats; may hinder migration, foraging of wildlife species for reproduction and dispersal (-) 	Minor	Regional	Medium term	Reversible	High	Medium	Direct	24 – Minor
Routing of pipe along Section 3 (Option 1 route – cont'd)	Soil integrity	Increase exposure of soil with resultant erosion, landslides and increase runoff;	Moderate to major	Localized or regional	Medium to long term	Degree of reversible in select areas uncertain	High	Medium	Direct	48 – Moderate

Project Actions	Receptor	Predicted impacts & Direction (positive or negative +/-)	Magnitude	Geographical extent	Duration	Reversibility	Value	Likelihood	Direct/indirect or cumulative	Consequence & Significance of Impacts
		soil disturbance (-)								
	Landscape aesthetics	<ul style="list-style-type: none"> Introduction of concrete blocks and blue pipes detracts from forest naturalness Reduced recreational user experience along trail (-) 	Minor	Site specific	Medium to Long term	Reversible	Medium	Medium	Direct	30 – Moderate
Construction activities	Employment levels	<ul style="list-style-type: none"> Employment of workers, mainly men (+) 	Moderate	Regional	Short term	Reversible	Medium	Medium	Direct	Not included in significance rating
	Community and national economy	<ul style="list-style-type: none"> Multiplier effect created in the economy (+) 	Minor	Local	Short term	Reversible	Low	Medium	Direct & cumulative	Not included in significance rating
	Land tenure and rights	<ul style="list-style-type: none"> Acquisition of land tenure interests from one private land owner to install pump (+) 	-	-	-	-	-	-	-	Insignificant impact
	Community health and safety	<ul style="list-style-type: none"> Risks to community health and safety – falls and injuries (-) 	Minor	Site specific	Short to medium term	Reversible	Low	Medium	Direct	10 – Minor
Construction activities (cont'd)	Construction generated emissions	<ul style="list-style-type: none"> Increase dust, noise and related emissions 	Minor	Site specific	Short term	Reversible	Low	Medium	Direct	6 – Minor

Project Actions	Receptor	Predicted impacts & Direction (positive or negative +/-)	Magnitude	Geographical extent	Duration	Reversibility	Value	Likelihood	Direct/indirect or cumulative	Consequence & Significance of Impacts
		relative to ambient levels (-)								
	Impacts on criminal activities	<ul style="list-style-type: none"> Construction activities can increase the potential for opportunity crimes (e.g., theft) (-) 	Minor	Localized	Short term	Reversible	Low	Medium	Indirect	8 – Minor
		<ul style="list-style-type: none"> Increase risk of SEAH (-) 	Minor	Localized	Short to long term	Reversibility dependent on varying factors	Medium	Medium	Indirect	32 – Minor
	Archeological heritage	<ul style="list-style-type: none"> No major impacts foreseen little record of assets within proposed route. Medium uncertainty (-) 	Minor	Site specific	Short term	Depends on the nature of damage (could be reversible)	Medium	Low	Direct	11 – Minor
Operational impacts										
Water abstraction	Southeastern communities	<ul style="list-style-type: none"> Enhanced water supply supports national development. Linked to improve quality of life, better education outcomes, etc. (+). 	Moderate	Localized	Long term	Reversible	Medium	Medium	Direct and cumulative	Not include in calculation of project significance
	Cultural uses of river	<ul style="list-style-type: none"> Experience reduced flow 	Minor	Localized	Long term	Reversible	Medium	Medium	Direct	20 - Minor

Project Actions	Receptor	Predicted impacts & Direction (positive or negative +/-)	Magnitude	Geographical extent	Duration	Reversibility	Value	Likelihood	Direct/indirect or cumulative	Consequence & Significance of Impacts
Water abstraction (cont'd)		<ul style="list-style-type: none"> Not predicted to fundamentally affect communities use of the river (-) 								
	Aquatic biodiversity	<ul style="list-style-type: none"> Reduced flows may create a stressor to biodiversity (-) Intake can hinder species movement (-) 	Minor to moderate	Localized	Long term	Reversible	Medium	Medium	Direct	24 - Minor
	Livelihoods that depend on the river – farming	<ul style="list-style-type: none"> Some limited adverse effects Intervention not likely to fundamentally alter farmers utilization of the river (-) 	Minor	Localized	Medium to long term	Reversible	Medium	Medium	Direct	20 - Minor
	Livelihoods that depend on the river – river tubing	<ul style="list-style-type: none"> Affect optimal functioning of river tubing operation from Jan to May (-) Reduce client experience (-) May result in temporary closure in peak dry season (-) 	Moderate	Localized	Long term	Reversible	Medium	High	Direct	See rating below
Water abstraction (cont'd)	Livelihoods that depend	<ul style="list-style-type: none"> May affect sustainability of river dependent 	Moderate	Localized	Long term	Reversible	Medium	High	Direct	36 – moderate

Project Actions	Receptor	Predicted impacts & Direction (positive or negative +/-)	Magnitude	Geographical extent	Duration	Reversibility	Value	Likelihood	Direct/indirect or cumulative	Consequence & Significance of Impacts
	on the river – river tubing	livelihoods, particularly males (-) <ul style="list-style-type: none"> ▪ Profitability of river tubing businesses (-) 								
Operation of the intake	Riverbank stability	<ul style="list-style-type: none"> ▪ Increase turbulence and velocity of flow downstream the intake (-) ▪ Increase erosive potential of flow on riverbanks (-) 	Minor	Site specific	Short to medium term	Reversible	High	Medium	Direct	18 - Minor
	Riverbank stability	<ul style="list-style-type: none"> ▪ Installation of gabion mattress reduce erosion action of flow (+) 	Minor	Site specific	Medium to long term	Reversible	Medium	Medium	Direct	Not include in calculation of project significance
	Community safety	<ul style="list-style-type: none"> ▪ Risk of slips, falls, and injuries to persons using river (-) 	Minor	Site specific	Short to medium term	Reversible	High	Medium	Direct	18 - Minor
Unplanned events and natural disasters	Biodiversity and soil	<ul style="list-style-type: none"> ▪ Unmanaged leaks or ruptures can result in soil loss with adverse impacts to vegetation wildlife and habitats (-) 	Minor to moderate	Site specific to regional impacts	Medium to long term	Reversible	Medium	Medium	Direct	28 - Moderate

Project Actions	Receptor	Predicted impacts & Direction (positive or negative +/-)	Magnitude	Geographical extent	Duration	Reversibility	Value	Likelihood	Direct/indirect or cumulative	Consequence & Significance of Impacts
		<ul style="list-style-type: none"> Natural disaster can damage vegetation and concrete block structure, resulting in disruption or pipe breakage (-) 								

5 Environmental and social management plan

This section constitutes another priority component of the ESIA. It details the specific actions to be undertaken in the design, construction, and operational phases of the proposed project to avoid, limit, and manage adverse risks and impacts and enhance positive opportunities. Actions to compensate for adverse impacts are also outlined. The significance of adverse project impacts subsequent to the adoption of recommended mitigation measures is analysed. A monitoring and evaluation plan that outlines the key parameters and indicators to ascertain the extent to which the project is achieving priority targets, including lines of responsibility is also a central element of this section. A fully developed and standalone, ESMP is also available, while a C-ESMP is available for the overall G-CREWS project. Information presented in this section is still considered draft since the detailed designs for the proposed project are not yet developed.

Mitigation measures presented are guided by national policies and legislation and the applicable interim environmental and social performance standards of the GCF as listed below.

1. Labour and Working Conditions
2. Resource Efficiency and Pollution Prevention
3. Community Health, Safety, and Security
4. Land Acquisition and Involuntary Resettlement
5. Biodiversity Conservation and Sustainable Management of Living Natural Resources
6. Protection and Preservation of Cultural Heritage

5.1 Considerations for Cost Estimations

The following are guidance notes on the costs estimates for the various measures included in the Mitigation Plan below.

1. Design phase
 - The cost estimates for this element are covered as part of the existing engineering contract used to prepare the feasibility report and the detailed designs for the project.
 - Backstopping support from NAWASA and GIZ are provided through the salaries paid to the Company' staff.
2. Construction phase
 - All measures to be implemented by the Contractor are covered in the preliminaries or in the Contractor's work item rates, which are submitted to the client and the GCF for approval.
 - Measures to be implemented by all other technical staff (i.e. the Supervising Engineering Consultant, Environmental and Social Specialists etc.) will be addressed as part of the part-time contract issued by GIZ/NAWASA.
 - Input from other national entities will be facilitated through existing salary/compensation arrangements. Their time will therefore contribute to co-finance for the project.
 - Only costs estimate not referenced above are specifically included. These require further discussion with the relevant entities to ensure greater accuracy.

5.2 Design Considerations

The following measures are presented for consideration by the design team to enhance the sustainability of the draft designs.

- Design the intake to allow for the continued connectivity of aquatic organisms and abiotic factors between the upper and downstream parts of the river. This means that

the intake should only occupy a portion of the river cross section, that is the smallest area needed for its effective functioning. In addition, the intake should be designed to be low enough to facilitate migration of aquatic biodiversity that choose to traverse the upper or lower part of the stream directly over the structure. This is important to allow the movement of migratory fish and smaller benthic macroinvertebrates to access the upper and lower parts of the river to support critical lifecycle stages. Such connectivity is also paramount for fulfilling environmental functions, such as the movement of sediments and nutrients throughout the river that support key ecological functions. Moreover, limiting river fragmentation preserves as closely as possible the baseline abundance and diversity of aquatic organisms along the length of the river, necessary for maintaining ecological balance and health.

- Consider the implications of future climate change in the determination of ecological flow to account for any likely reductions in river discharge in downstream locations.
- Integrate a raw water storage facility as part of the proposed or a related project to buffer the need for continuous pumping, especially during critical low-flow periods. This is an adaptive measure that safeguards the system's capacity to reliably meet the water supply needs of the southeastern communities while sustaining the downstream socio-economic and cultural values of the river (this proposal to be discussed further with the Client).
- Upgrades to the Les Avocats and the Petite Etang Water supply network including retrofitting and expansion of the treatment plants should be implemented in tandem with the proposed project to maximize the overall benefits of the intervention. Pumping water into a substandard facility would not reap the desired outcomes and is likely to increase the overall percentage of non-revenue water loss in the system.
- Investment and promotion of RWH in the southwestern communities must become a central part of the national infrastructure for sustainable water supply production. While this is not exclusively the responsibility of the GIZ and NAWASA, the pursuit of this measure is consistent with the medium-term plan of the G-CREWS project and the climate adaptation trajectory for the water sector. Estimated Costs: US\$ 300,000.00
- Promote the adoption of RWH and climate smart agriculture among all farmers who utilize the Great River as a source of water. Taking intentional action to encourage a larger percentage of this group to benefit from the G-CREWS Agriculture Fund is strongly recommended. This is part of a larger plan to build climate resilience among the farming community with or without the proposed Seven Sisters Project. Partnership between the GIZ and the Ministry of Agriculture is relevant to advance this agenda.
- To compensate for the impacts on biodiversity within the Grand Etang Forest Reserve, it is strongly recommended that the Seven Sisters Water Transmission Project integrates a Reforestation component as part of its design. This new initiative aims to invest in the reforestation of a critical watershed as part of an overarching plan for sustainable water production and management. Alignment with the National Voluntary Targets for Land Degradation Neutrality is advised as is feasible. This can be directly funded via the Seven Project and/or through other innovative partnerships and financing modalities. The Department of Forestry should be engaged to provide leadership for the design and monitoring of this element of the proposed project. Representatives of NAWASA have reported that the leadership of the Authority has committed to prioritize watershed reforestation in collaboration with the Department of Forestry and other key stakeholders in the short to medium term in light of the importance of healthy watersheds in sustainable water production. Estimated Costs: US\$ 300,000.
- Measures for soil conservation and landslide risk reduction must be a principal element of the detailed designs for laying the pipes across Section 3 of the route, i.e., 1910 towers to Les Advocats to limit adverse effects to soil and related resources. This is a

necessary and important feature cognizant of the physical site conditions, the risk of soil movements within the Reserve, and the high sensitivity and value of the resource.

- NAWASA’s application to the Water Resource Management Unit for a license to abstract water from the Greater River and compliance with any additional requirements as set out by the competent authority.
- Although the proposed quantity of water to be abstracted is within acceptable limits, to ensure greater compliance with the Brisbane Declaration for environmental flows, and to prevent and reduce adverse impacts to the river tubing industry during the operational phase, the timing of water withdrawals is critical. This is consistent with the Brisbane Declaration which calls for environmental flows that consider the quantity, timing, and quality of water flows necessary to sustain ecology and human livelihoods and depend on these ecosystems. To ensure therefore that the project “does no harm”, three options that integrate the aspect of timing are proposed for discussion with the Client and relevant key stakeholders. This is necessary to enhance the overall sustainability of the proposed development intervention.
 - Option 1: Avoid the pumping of water unless necessary between the hours of 10:00 am and 2:00 pm during the dry season. This option maintains very closely the existing baseline conditions experienced by downstream uses, in particular river tubing operators. [option does no harm]
 - Option 2: Avoid the pumping of water from the intake between 10:00 am and 2:00 pm, to facilitate the river tubing operation during the peak dry season months. [option allows for the continued operation of river tubing businesses, and prevents abstraction-induced business closure during the peak dry months]
 - Option 3: Develop and implement a mechanism in collaboration with river tubing operators to guide the timing of water abstraction that facilitates fulfilling the water supply needs for the southeastern communities while simultaneously allowing for the effective provision of the river tubing services. [option does not harm]

The final adopted option would be elaborated as part of the mitigation measures for the operational phase. Estimated Costs: US\$1000

5.3 Mitigation Measures for the Construction Phase

5.3.1 Labour and Working Conditions

This performance standard recognizes that employment creation and income generation should be accompanied by the protection of the fundamental rights of workers. Specifically, it seeks to promote fair treatment, non-discrimination, and equal opportunity of workers; compliance with national employment and labour laws; protection of all workers; promotion of safe and healthy working conditions and the health of workers; and avoid the use of force labour (IFC, 2012).

The following general mitigation measures are elaborated to achieve the intent of this standard (Performance Standard 2).

- A labour preferential requirement should be written into the contract of the Contractor to maximize the number of workers coming from the state of Grenada. While a numerical target is not specified for local workers and women, efforts should be made to advertise jobs to attract local contractors and women across the state of Grenada to all available positions.
- Labour hiring practices must be transparent, made public, and non-discriminatory concerning gender, age or disability (ability).

- Contractors should be expected to institute work conditions that facilitate the participation of women in the project workforce, e.g., equal pay for work of equal value.
- A grievance redress mechanism should be elaborated by the Client to allow workers (inclusive of men and women) to raise workplace concerns. The Client should inform workers of the grievance mechanism at the time of recruitment and make it easily accessible to them.
- Contractor will adopt a zero-tolerance approach toward all forms of gender violence and sexual harassment in the workplace to create a hassle-free, safe, and positive environment for male and female workers, and others on the construction site or in office settings.
- During project implementation, the Contractor must ensure that:
 - All workers are made aware of these codes of conduct through orientations or sensitization training and a manual detailing them.
 - The neighbouring communities will be made aware of the codes of conduct that workers are expected to follow during consultations and discussions with community stakeholders.
- The Contractor is expected to comply with the payment of contributions for all workers as specified by the National Insurance Scheme and consistent with national legislation.

Specific measures for achieving occupational health and safety are outlined below.

- A safe and healthy work environment, that considers the inherent risks and specific classes of hazards associated with pipe laying, in particular working in steep and challenging terrain. Threats and/or risks affecting women should also be addressed. This should be congruent to NAWASA's recently launched Occupational Safety and Health Management System.
- The Client should ensure that the Contractor has in place an approved Occupational Health and Safety Plan to guide the implementation of construction activities, prior to the commencement of works. Estimated Costs: US\$ 5,000.
- The Plan should be designed to address the following aspects, which are not exhaustive (IFC, 2012).
 - Identification of potential hazards to workers, particularly those that are life-threatening.
 - Measures to prevent and protect workers from all accidents, injury, and disease arising from, associated with, or occurring in the course of work through a minimization of the causes of hazards as far as is reasonably practical. The approaches used should be consistent with good international industry practice, example, as reflected in the World Bank Group Environmental, Health, and Safety Guidelines and the Occupational Health and Safety Administration (OSHA)
 - Training of all workers, particularly vulnerable workers (e.g., young workers) on the key elements of the Health and Safety Plan, to include expectations and responsibilities. Training sessions should also address matters pertaining to safety from occupational hazards and risks, including sexual exploitation, abuse and harassment (SEAH), gender-based violence (GBV) and infection disease control; labour laws; human rights; and gender sensitivity. A workers' code of conduct should be enforced on site. Safe work procedures should be adopted consistently. A clear and appropriate (sensitive) reporting, investigation and support system should also be in place to manage SEAH issues.
 - Documentation and reporting of occupational accidents, diseases, and incidents.
 - Emergency prevention, preparedness, and response arrangements.

- Assignment of trained human resources (e.g., Health, Safety, Environment, and Quality Officer) to coordinate the full implementation of the Occupational Health and Safety Plan and ensure compliance of all workers and visitors to the site.

5.3.2 Resource Efficiency and Pollution Prevention

Performance Standard 3, Resource efficiency and pollution prevention, aims to avoid or minimize adverse impacts on human health and the environment from project generated pollution activities. It also promotes as is applicable sustainable use of resources including energy and water and reduces project related greenhouse gas (GHG) emissions (IFC, 2012).

The following mitigation measures are advanced to support compliance with Performance Standard 3.

Siltation Management and Soil Conservation

To reduce the siltation of the Great River around the intake because of earthworks to install the intake, the following measures should be undertaken:

- Where practical, land clearing and excavation should be limited to the dry season as much as possible to reduce the likelihood and volume of loose sediments entering into the river.
- Land clearing and excavation should not be done long periods in advance of when physical construction is scheduled to commence.
- Land clearing and excavation should be limited to the actual footprint of the riverbank required to access the river to construct the intake. In addition, as much as is feasible, only the area of the riverbed targeted for construction of the intake should be disturbed.
- Soil should not be used as an option for temporarily “damning” part of the river to facilitate the construction of the intake, since this can increase the introduction of sediments into the river, elevating turbidity levels. Other less hazardous materials should be utilized.
- A silt screen should be deployed along the entire length of the river where earthworks would be conducted during land preparation and construction of the intake to reduce the amount of sediment entering the water and/or to confine the resuspension of sediment to the smallest possible area. Estimated Cost: TBD
- A Soil Conservation and Landslide Risk Reduction Plan should be prepared to guide all construction activities within the Grand Etang Forest Reserve to (i) avoid and/or limit soil erosion, landslides, and other forms of human-induced land movement to a minimum. Estimated Costs: US\$ 30,000.

Prevention and Management of Spills

Although the risk of oil, fuel and related spills is low, it is important to prevent this occurrence and ensure prompt management if required.

- During the construction of the intake, a potable spill containment equipment should be available on site coupled with trained workers to facilitate its effective use, if needed.
- Any spill should be immediately contained and managed to limit introduction into sensitive receptors.

Solid Waste Management

- Best practices for solid waste management that complies with national legislation and the guidelines of the Grenada Solid Waste Management Authority should be adopted throughout the project cycle.

- A Solid Waste Management Plan should be prepared for ensuring the effective and efficient management of solid waste generated from the project, in particularly when working within the Reserve.

Noise and Dust Control and Management

- Enclose the project site/s to limit the impacts of noise and dust emissions. (would need to elaborate specific noise control measures for working in the forest depending on the final design option).
- Noise pollution resulting from heavy machinery will impact organisms such as birds and frogs that use vocalization to communicate (seeking food, mate, etc.). The endemic and critically endangered Grenada Highland Piping frog (*Pristimantis euphronides*) reproductive mating calls are done at dusk. Work along the zone of influence should be limited to 8:30 am to 4:00 pm to avoid disturbance to the Highland Piping Frog.
- Implement dust suppression techniques (e.g., wetting) as required during the implementation of works.
- Ensure that vehicles carrying loads with the potential to generate dust are appropriately sheeted.
- Situate and cover all stockpiles of spoil material away from site boundaries and sensitive receptors.
- Maintain work equipment and vehicles in good mechanical condition, guided by the manual for each machine.

5.3.3 Community Health, Safety and Security

This performance standard recognizes that project activities, equipment, and infrastructure can increase community's exposure to risks and impacts with undesirable outcomes. It is therefore important that measures are adopted to prevent and reduce the community's exposure to, and risk associated with project elements. The following mitigation measures are instructive.

- Prepare a Community Health and Safety Plan to guide the implementation of construction works. Reference to the existing C-ESMP of the G-CREWS project should be made to ensure congruence in planning. This includes but is not limited to the following (Responsible Entity – Contractor):
 - Maintenance of good housekeeping practices on all sites to prevent and limit exposure of communities to hazardous elements and risk situations. Worksite should be free of trip hazards to prevent slip and fall injuries to workers and community people at the work site. Similarly, the site should be free from all sharp objects.
 - Put in place a system that allows for the simultaneous laying of pipes with the opening and closure of trenches. This prevents trenches from being left open after a 24 hour period, thus prevent and reducing the risk of falls, slips, injuries, and other accidents.
 - Cordoned off the work zone and have spotters stationed at strategic points to monitor the movement of people and prevent entry into the work zone.
 - All visitors to the site must follow strict health and safety protocol to ensure compliance with best practices.
 - Install appropriate signage and the relevant visibility to inform that construction works are ongoing to prevent and mitigate communities from injury, illness and other incidents.
 - Monitor work site to avoid the pooling of stagnant water, which can provide additional breeding ground for vectors, such as mosquitoes.
 - To limit the occurrence of petty theft, the project site should secure and protect all valuables to reduce the risk of opportunistic crimes.

- Develop in collaboration with the Traffic Department RGPF, a Traffic Management Plan for the proposed project that incorporates measures for reducing traffic delays, congestion, and accidents along the Grand Etang Main Road. (Responsible Entities - Contractor in collaboration with the RGPF, GIZ & NAWASA)

5.3.4 Land Acquisition

To limit any adverse effects of project related land acquisition, it is important that the Client complies with national guidelines and legislation to facilitate the rental/procurement property to facilitate installation of the pump.

5.3.5 Biodiversity Conservation and Sustainable Management of Living Resources

Performance Standard 6, recognizes that protecting and conserving biodiversity, maintaining ecosystem services and sustainable management living natural resources are fundamental to sustainable development (IFC, 2012). Measures present should comply with the Convention on Biological Diversity and Grenada's National Biodiversity Strategy and Action Plan, the Revised Forest Policy, and related policy and legal instruments.

Aquatic biodiversity

- Refer to design considerations to ensure longitudinal biological connectivity along the river as indicated above.
- See also the measures for pollution prevention to limit siltation in the riverine ecosystem.

Terrestrial biodiversity

- Develop and implement a Terrestrial Biodiversity Management Plan designed to protect and conserve forest vegetation, habitats, and wildlife. Estimated Cost: US\$ 30,000.00
- The Plan should include inter alia the following measures:
 - Partnership with the Department of Forestry to finalize the on the ground route for laying the pipe through the Grand Etang Forest Reserve. This partnership should also entail elaboration of a tree removal and management plan. Consideration should be given to the following: (i) the dimensions of trees measured by DBH that are approved for cutting/disturbance, (ii) installation of flags on all trees, if any, that are approved for removal to facilitate pipe laying, (iii) monitor and supervise the land preparation and pipe laying activities during the construction phase, and any changes in the forest post construction with a focus on soil and vegetation.
 - As much as is feasible, a buffer of xx meters from the trail should be maintained when laying the pipe to limit the impact on the recreational use of the forest.
 - Engage the services of an ecologist to monitor the forest for critical life cycle activities of terrestrial animals to limit direct impact to wildlife in vulnerable life cycle periods.
 - Vegetated buffers and corridors should be preserved to limit the negative impacts of noise, edge effect and light on biodiversity. Vegetation corridors are also important to limit the impact of habitat fragmentation, thereby allowing animals to utilize these ecological corridors to move within the landscape.
 - Avoid work into hours before sunrise and nightfall within the vicinity of the Grand Etang Forest Reserve to avoid artificial light and noise from disturbing wildlife.
 - Habitat restoration is strongly recommended, through the replating of vegetation in affected areas along the pipe laying route. This is especially on slopes where vegetation damage/destroyed to allow for installation of pipes.

Restoration should be done with native vegetation including endemics, consistent with the existing ecosystem.

- Fern and fern-like (pteridophytes) species were generally abundant throughout the areas surveys. Rare ferns such as *Megalastrum subincisum*, *Hemionitis palmata* and *Diplazium striatum* should be included in the vegetation removal and management plan so as to avoid or minimize damage and destruction to these species. Additional consideration must be given to avoid modification of the vegetation around areas that show large clusters of rare ferns so as to prevent changes in microclimatic conditions (humidity, temperature and soil moisture) that can adversely affect these plants.

A vegetation removal plan should be developed before the commencement of land preparation to avoid the unnecessary removal of trees. Mature trees with a DBH of twelve (12) inches and greater should be preserved where possible (to be reviewed and approved by forestry). Vegetation only within the 'footprint of the project should be destroyed.

5.3.6 Protection and Preservation of Cultural Heritage

This performance standard seeks to protect physical infrastructure and cultural heritage from the adverse impacts of project activities and support its preservation (IFC, 2012).

- Take every action to limit adverse effects to the infrastructure of utility companies both situated both underground and above ground. NAWASA has excellent experience in this regard, risks are anticipated to be minimal.
- During project implementation, protocols should be in place for chance encounters of archaeological remains (as legally required). If construction activities expose historic/prehistoric artifacts, the following is the recommended procedure:
 - All activity that may cause further disturbance to the area must cease and the area should be immediately cordoned off.
 - The findings should not be touched, moved, or further disturbed -- they must remain in place because their relative position(s) and context are important for understanding the discovery.
 - However, any documentation (including photos, videos, or written statements) would be helpful later on.
 - An authorized representative of the Contractor should report the find to one of two authorities (police or Grenada National Museum - GNM) in the most expeditious manner possible who would advise on next steps.
- Take every precaution to limit the impact of vibrations on the structural integrity of buildings with the project site. It is advisable that the contractor take a detailed record of pictures before and after works to establish a baseline. Communication to property owners is also important prior to and at the start of works.

5.4 Mitigation Measures for Operational Phase

5.4.1 Emergency Preparedness and Response

- The Client should have in place an Emergency Preparedness and Responses Plan in collaboration with appropriate third parties to address the likely hazards that can affect the water supply system, particularly within the Grand Etang Forest Reserve. The plan should at a minimum identify the main hazards of concern for the water infrastructure, methods for monitoring functioning of the system, preparedness action to be taken prior to a predictable hazardous event, and response protocols and mechanisms for recovery. A robust governance arrangement that details roles and responsibilities at all

stages is key. Similarly, training of all staff members to underpin the effective roll out of the plan, including testing the capacity of key players to roll out the Plan in normal times is an imperative. Estimated Costs: US\$ 10,000.

- Assignment of a trained dedicated team to timely address any issues with the pipe network within the forest. Their prompt response should be underscored as a pivotal risk reduction measure.
- Implementation of remote monitoring and control (SCADA) system consistent with the thrust of the G-CREWS project to monitor system functioning, including the prompt identification of leaks, ruptures etc.

5.5 Summary mitigation measures

Impact Category	Mitigation Measures	Phase	Estimated Cost
Labour and Working Conditions	<ul style="list-style-type: none"> - Maximize local workforce involvement, with emphasis on gender equality and fair treatment. - Implement transparent, non-discriminatory hiring practices. - Ensure a grievance redress mechanism for workers. 	Construction	Not specified
Resource Efficiency and Pollution Prevention	<ul style="list-style-type: none"> - Limit land clearing and excavation to dry season to reduce siltation. - Use silt screens along the river to prevent sediment entering water. 	Construction	TBD
Community Health, Safety, and Security	<ul style="list-style-type: none"> - Develop a Community Health and Safety Plan to guide works. - Ensure the worksite is free of hazards and secure from community access. - Implement traffic management plans. 	Construction	Not specified
Biodiversity Conservation	<ul style="list-style-type: none"> - Reforest disturbed areas with native species, particularly on slopes. - Avoid night-time work near Grand Etang Forest Reserve to reduce light/noise disturbance to wildlife. 	Construction	US\$ 300,000 for reforestation
Cultural Heritage Preservation	<ul style="list-style-type: none"> - Establish protocols for archaeological finds. - Record and communicate potential impacts on nearby historical sites. 	Construction	Not specified
Soil Conservation and Landslide Prevention	<ul style="list-style-type: none"> - Develop a Soil Conservation and Landslide Risk Reduction Plan to minimize erosion, especially in the Grand Etang Forest Reserve. 	Construction	US\$ 30,000
Emergency Preparedness	<ul style="list-style-type: none"> - Implement an Emergency Preparedness and Response Plan in collaboration with third parties to address hazards affecting the water supply system in the forest. 	Operational	US\$ 10,000

Impact Category	Mitigation Measures	Phase	Estimated Cost
Water Abstraction Impact on River	- Avoid water abstraction during peak hours of river tubing business (10:00 am - 2:00 pm during dry season).	Operational	US\$ 1,000

5.6 Monitoring and Evaluation

Table 26 outlines the monitoring and evaluation plan for the proposed project to track progress and overall success.

Table 26: Monitoring and Evaluation Plan

Parameter/study	Frequency	Responsible & Collaborating entities	Estimated cost/US\$	Indicators of success
1. Complaints and/or levels of satisfaction from downstream river users (farmers, river tubers, community people/other users).	During dry season	WRMU & NAWASA	US\$ 15,000 annually (to monitor levels of satisfaction); complaints be via the normal day to day systems of the agencies	Percent (%) reduction in customer complaints
2. Vegetation regrowth at the project site and areas targeted for reforestation.	Monthly post construction	Department of Forestry or private sector entity (if preferred)		% vegetation coverage along affected transect & DBH
3. Occurrence of soil movement activity along the pipe alignment route along Section 3				
4. Aquatic biodiversity around the intake	During and during operation phase	WRMU & NAWASA (with support from private Environmentalist)	US\$15,000 - \$20,000 per ecological assessment	# and diversity of fish and macroinvertebrate taxonomic groups in the River; significant changes post intake implementation
5. Water quality around the intake	Monthly	NAWASA	Internalized costs	Within acceptable thresholds for recreational water
6. Reliability of customers water supply.	Ongoing up to 3-5 years	NAWASA	Internalized costs	% customers in the southeastern communities receiving a reliable supply – Level of service in the Les Avocats & Petite Etang System

5.7 Stakeholder Engagement Plan and Grievance Redressal Mechanism

It is important that a stakeholder engagement plan and grievance redressal mechanism be in place to support the construction phase of the project. An additional chapter for the Seven Sisters Project can be added into the existing Stakeholder Engagement Plan for the G-CREWS project. In addition, the project will adopt the existing GRM procedures operationalized by the GIZ for all its projects. A summary of the GRM prepared by the GIZ is outlined below (G-REWS, n.d.).

What is the GRM?

A formal process to manage complaints and minimize social risk linked to the G-CREWS project.

The GRM Accounts for the Following Matters:

- Any complaints regarding the implementation of the overall project and its activities.
- Persons affected by land acquisition and temporary land occupation.
- Persons affected by construction nuisances which is to be managed by NAWASA and Ministry of Finance.
- Grievance of construction workers which is to be managed by the Ministry of Finance.

1st Tier of Redressal

Stakeholders submit their complaint through the available grievance channels. The project manager registers and documents the complaint using a standard template. The complaint is then investigated. The concerned individual/people are contacted to redress the grievances within 14 working days. If not remedied within 14-21 working days, it is moved onto tier 2, except where the complainant agrees to an extension of the timeline.

2nd Tier of Redressal

The project manager coordinates the conveying of the meeting with the Grievance Redressal Committee (GRC) and will brief them on the deliberations of the first level of redressal along with the views of both parties. The GRC will host the necessary meetings with the affected persons to find a solution acceptable at all levels. If not redressed within 60 working days, it is moved onto tier 3.

3rd Tier of Redressal

If the affected party/complainant does not agree for the resolution of the 2nd level, or there is a time delay of more than 60 working days in solving the issue, the complainant can opt to consider taking it to the courts.

Complaint Guidelines

- Must be in English.
- Can be submitted written, verbal via telephone, fax, text message or Project's Facebook page GCREW473.
- Must include the name, location, nature of activity caused or may cause adverse impacts.
- Must include a brief explanation as to how the complainants has been or may be adversely affected by the G-CREWS Project.

Contact

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The full document (20 pages) can be accessed via the project website at <https://climatefinance.gov.gd/embedded-pdf/grievance-mechanism-climate-resilient-water-sector-in-grenada-g-crews/>.

6 Stakeholder analysis and engagement

Stakeholder engagement is central to the development process and is central to good governance and environmental justice. It ensures the credibility and usefulness of decisions and is highly likely to result in the sustainability of outcomes (CANARI, 2021). Stakeholder involvement throughout the planning and implementation cycles builds local ownership, strengthens project integrity and design, and helps to create foundational relationships that may contribute to constructive problem-solving (UNDP, 2020, p.8). Experience has shown that failure to incorporate the interests and perceptions of target populations, including that of men and women can result in poor project performance. The impact and sustainability of development interventions are likely to be enhanced when all project stakeholders have a sense that decisions affecting their lives have been transparently made (CDB, N.D). Informed by the principles of participatory development, a stakeholder engagement strategy was developed and implemented as part of the ESIA process.

6.1 Methodology Employed

Guided by tools developed by the UNDP, IDB, CANARI²¹, and other development agencies, a stakeholder engagement strategy was prepared. This was informed by an analysis of stakeholders likely to be affected and/or interested in the proposed project. Stakeholders were identified based on three broad categories: (i) Core decision makers, (ii) affected groups and individuals, and (iii) others with interest or influence. Table 27 outlines the results of the stakeholder mapping exercise.

Table 27: Stakeholder analysis

Stakeholder group	Stakeholder interest	Perception of the problem	Resources/influence
Core decision makers - Entities who are directly responsible for the approval processes and/or represent the implementing agency and its direct associates			
NAWASA	Responsible for potable water production and supply.	Projected future demand of the southeastern communities, necessitates identification and utilization of alternative water sources.	Has access to technical resources and reputable strategic partners. Legal framework outlines a lead role for water provision.
GIZ	Lead executing agency for the G-CREWS project with a strong stake in the proposed project		Technical assistance and leadership for project design & implementation. Mobilize finances for project roll-out.
Ministry of Health	Responsible for ensuring compliance of potable water with acceptable standards for human and ecosystem health.	Addressing water supply gaps to curb preventable waterborne illnesses and related human health issues.	Can provide advice on water quality issues and occupational health and safety.
Planning and Development Authority	Lead entity responsible for regulating development.	Sustainable solutions are required to meet the emerging water needs of the south.	Critical to the approval process for physical development.

²¹ UNDP – United Nations Development Programme; IDB – Inter-American Development Bank; and CANARI - Caribbean Natural Resources Institute.

Stakeholder group	Stakeholder interest	Perception of the problem	Resources/influence
Stakeholder group	Stakeholder interest	Perception of the problem	Resources/influence
Department of Forestry - Ministry of Agriculture, Lands and Cooperatives	Leads the management of forest resources to ensure optimal water production and provision of other ecological services.	Adoption of appropriate safeguards to support the effective management of resources within the Grand Etang Forest Reserve.	Can offer technical support and advice during the design, construction, and operational phases of the proposed project.
Ministry Climate Resilience, the Environment, and Renewable Energy	Lead public sector entity responsible for the coordination of environmental and natural resource management.	Recognizes the need for addressing the water supply needs of the island. However, this must be done in a way that respects natural systems.	Technical staff can advise on project design to ensure conformity with good practice.
Ministry with responsible for Infrastructure and Physical Development	Provides overarching leadership and oversight for implementation of infrastructural projects.	The need to improve capacities for enhanced water supply with supporting infrastructure.	Can offer advice on design and implementation to ensure compliance with national agenda and best practice.
Others with interest or influence - This group of stakeholders may include other agencies or institution contributing to the project, community leaders, civil society groups, academia and research organizations, organized interest groups, and relevant private sector companies operating in the area			
Tourism, within the Ministry of Economic Development, Planning, Tourism, ICT, Creative Economy	Manages the tourism related infrastructure and processes within the Grand Etang Forest Reserve.	Recognizes the importance of meeting the water needs of the population, including to support the development of the tourism sector.	Strategically position to provide invaluable information on matters pertaining to tourism protocol and activities within the Grand Etang Forest Reserve.
Ministry of Social Development, Housing & Community Empowerment	Provides leadership for mainstreaming gender equality in projects and programmes and advocating for vulnerable groups.	Inadequate management of the construction phase can result in adverse impacts, which can worsen the challenges faced by vulnerable groups.	Technical staff can advise on stakeholder engagement, social and gender related matters.
Ministry of Legal Affairs, Labour and Consumer Affairs	Leading entity responsible for the protection of workers.	N/A	Staff can provide advice on best practices for employment related matters, ensuring compliance with national policies and laws.
Grenada Bureau Of Standards	Offers a range of services to support the national quality infrastructure, including construction material testing.	N/A	Technical staff is placed to provide information on standards that are applicable to the proposed project.
Inter-Agency Group of Development Organizations (IADGO)	Advocates that the ESIA follows best practices and provides adequate opportunities for stakeholder engagement.	The issue of providing sustainable water supply to the nation requires solutions that incorporate appropriate environmental and social	Public pressure and political influence. Offers unique insights for consideration in the ESIA process.

Stakeholder group	Stakeholder interest	Perception of the problem	Resources/influence
		safeguards and best practices.	
Stakeholder group	Stakeholder interest	Perception of the problem	Resources/influence
Grenada Hotel and Tourism Association (GHTA)	Shares the goals of the project for expansion of the potable water supply to include hotel and tourism sector.	Continued need for reliable supply of water meet the needs of the tourism sector that considers environmental and social dimensions.	Public pressure and political influence.
Grenada Fund for Conservation	Lead entity that mobilized financing & implementation of 1910 to Apres Toute Trail.	N/A	Knowledge of the trail system and associated ecosystem. Advice for ensuring harmony between project and trail.
Tour Operators	Interest in ensuring continued use of the resources within the Forest Reserve and Great River.	N/A	Knowledge of the tourism industry.
Faith and Community Based Organizations (CBOs/FBOs) & churches in the community	Interest in advancement of the resident community generally or in some specific area.		Local community knowledge; excellent resource to support the mobilization of target groups; and capability to influence select community stakeholders.
Affected groups and intended beneficiaries - These are directly affected positively or negatively by the proposed project			
Beneficiaries in the southeastern communities	Share the goal of the project – improved water supply to the southeastern communities.	Unreliable water supply particularly in the dry season inadequate water quality due to high turbidity after heavy rains.	Can provide an excellent baseline of existing water supply issues and views on proposed solutions.
Communities downstream the proposed intake (e.g., Adelphi, Birchgrove, Castigne, Balthazar)	Proposed intake is along the Great River, a natural resource that is culturally, socially, and economically important to adjacent communities.	While communities noted that there could be a water supply challenge in the southeastern areas, the proposed solution does not appear most suitable due to likely negative implications on downstream river flow and related uses.	Excellent local knowledge of the river, uses, and related issues. Can contribute invaluable perspectives on the proposed solution.
River tubing companies downstream intake	Operate nature-based enterprises that depend on the downstream flow in the Greater River.	Continued adequate downstream flow in the Great River to support their river tubing businesses.	Local knowledge about the river and general area. Can potentially impose public pressure if proposed project hinders operation of business.
Farmers downstream intake	Uses river for irrigation purposes.	No major issues reported. Somewhat concerned about likely reduce flow of water.	Local knowledge about the River and general area.

Stakeholder group	Stakeholder interest	Perception of the problem	Resources/influence
Stakeholder group	Stakeholder interest	Perception of the problem	Resources/influence
Utility companies (Grenada Electricity Services & Flow)	Utility lines run along part of the route for transmission lines. Communication infrastructure situated at 1910.	Delayed communication from NAWASA about the scheduled start of the construction phase can affect the company's efficiency in responding to requests for easements and/or changes to existing infrastructure.	Utility companies are available to provide the technical support needed to advance the project.
Micro and small business owners & operators at Grand Etang	The tourism activities within the Grand Etang Reserve provides source of livelihood.	N/A	Local knowledge about the tourism activities in the Reserve, likely impacts on operations, and possible mitigation measures.
Grenville-St. George's Bus Association	Hassle free transportation of passengers to and from Grenville and St. George's on a daily basis.	N/A.	Knowledge of likely impacts on the public transportation sector and possible measures to limit adverse impacts.

The following strategies were used to engage stakeholders informed by the foregoing analysis.

1. Preliminary stakeholder consultation and scoping exercise. This session occurred towards the commencement of the assessment. It was designed to (i) sensitive stakeholders of the proposed project, (ii) identify any critical issues to be addressed in the ESIA, (iii) discuss important information about the project site that can be useful to the assessment, and (iv) listen to stakeholder views, including the likely benefits and concerns, as part of a commitment to inclusion. This was achieved through consultation with key stakeholders within the Government's service, non-governmental organizations (NGO), community leaders, and key private sector agencies. Twenty stakeholders participated in this activity – four representing the NGO community, 14 representing the public sector, one statutory body, and one international agency. One NGO whose representative was unavoidably absent from the consultation submitted written comments expressing views on the proposed intervention (see a summary of the feedback received in Appendix 10). The feedback received from this scoping and initial consultation was used by the ESIA Team to refine the research methodology and inform the mitigation measures articulated.
2. Community-based meetings. Three (3) community meetings targeting stakeholders downstream of the proposed intake and beneficiaries within the southeastern areas were organized. These sessions aimed to better understand the economic, social, and household uses of the Great River downstream the intake, knowledge of the general project's study area, and stakeholders' views on likely project effects.
3. Key informant interviews. Targeted interviews were undertaken with (i) farmers and landowners along the access road leading to the intake, (ii) gatekeepers within the communities around the Great River, (iii) owners and employees associated with the river tubing companies, and (iv) small and microbusiness owners and operators at Grand Etang.

As shown in Table below, a total of 101 stakeholders, 59 males and 41 females were consulted during the period August 31st to October 18, 2023. This involved discussions with representatives from Government Ministries (16), statutory bodies (1), private sector

companies/individuals (12), NGOs (5), farmers (6), community members (58), and landowners close the intake (3). Table 28 summarizes the stakeholders consulted.

Table 28: Summary of stakeholders consulted

Type of stakeholder	Male	Female	Total
Ministries or divisions of Government	11	5	16
Statutory bodies	1	0	1
Private sector companies/individuals	4	8	12
Farmers	4	2	6
NGOs	2	3	5
Community members	35	23	58
Landowners along access road to intake	3	1	3
Total	59	42	101

6.2 Issues Identified as Important for Inclusion in the Assessment Process

As part of the scoping exercise to inform the methodological approach to guide the conduct of the ESIA, the following were recommended by key stakeholders as important issues to be considered.

1. Occupational health and safety of workers and the adjacent communities during the construction phase.
2. The extent to which preparedness and response planning is required during the operational phase of the proposed project.
3. The impact of the proposed abstraction on downstream communities.
4. Determination of the activities, if any, within the watershed that are likely to affect water quality around the point of abstraction.
5. Conduct of a baseline terrestrial ecology assessment to document the biodiversity within zone of influence within the Grand Etang Forest Reserve, including any rare, threatened, or endangered species of high ecological significance.
6. Determination of the likely impact of projected reduced precipitation within the context of climate change on the ecological flow and downstream uses of the river after the point of abstraction.
7. Land tenure issues along the proposed route for the transmission line.
8. The rationale for the increased demand for water in the southeastern communities.

The imperative of engaging stakeholders from the start of the design process, rather than only at the latter stages.

6.3 Perspectives on the Proposed Project

To better understand stakeholders' perspectives on the proposed project, the following beliefs and/or attitudes to water, management of water catchment areas, and the national infrastructure managed by NAWASA's are particularly important.

- Various stakeholders across all groups were not completely convinced about the suitability of the proposed solution. They did not view diverting water from the Great River to Les Avocats as the most suitable and sustainable solution to address the identified problem due to the distance involved in routing the pipeline. This could be linked to the limited information that was available at this preliminary stage in the impact assessment process since the findings of the ESIA were not yet shared with stakeholders.
- Further, stakeholders located in the Birchgrove, Adelphi, Castigne, Balthazar, and surrounding areas, and to a lesser extent Perdmontemps questioned NAWASA's perceived low investment in upgrading existing infrastructure, enhancing storage infrastructure, and construction of new dams. This is within the context of the ongoing deterioration of the water infrastructure and the increased water needs of the populace, particularly in the south of mainland Grenada.
- Many stakeholders also reported an observed substantial reduction in the streamflow within the Great River over the last three or more decades. This they believe has implications for the resultant downstream ecological flow that is likely to occur during the project's operation. One community member notes:

"I think the people [NAWSA] also need to know that the Great River is not great anymore. The Great River was named because of the volume of water, but right now it isn't great anymore. If you ask people probably 60+ about their experience with the volume of water they would tell you it is much lower even in the rainy season although the bridge may still overflow from time to time. It is not great anymore and it is not getting better, they need to know that' [Adult Female, Balthazar Community].

"All of the bigger basins in the river no longer exist, in those days the river was wide and deep, the volume of water in my forty years was cut by half and it continues to go down because climate change is affecting everything and maybe in the next ten to twenty years the river might just be trickling. So yes, while we understand that the people need water and we have to find solutions I still have my doubts about that project" [Adult Male, Balthazar]"

- Ongoing concern about the perceived limited investment in measures to promote sustainable water production, particularly through improved management of water catchment areas. This sentiment was shared largely by the NGO representatives.

6.3.1 Benefits

Five (5) main benefits were identified by the stakeholders consulted.

1. Stakeholders within the beneficiary areas, particularly women, viewed the proposed project as a good one that would directly benefit the southeastern communities and reduce workplace absenteeism due to water issues. Stakeholders confirmed that water shortage within their respective communities has sometimes affected their ability to attend work during periods of prolonged water disruption due to inadequate water available to support the conduct of basic household chores (e.g., wash clothes, clean). The proposed project is therefore likely to reduce this occurrence indirectly through a more consistent water supply during the dry season.
2. The representative from the Environmental Health Division, Ministry of Health indicated that the benefits of the proposed project outweigh the risk from a health standpoint. Citizen's access to an improved water supply will positively impact personal hygiene and sanitation, reducing the incidence of waterborne infectious diseases such as diarrhea.
3. The overall positive impact of water infrastructural projects on human health and well-being of the beneficiary communities was well noted, including among government

officials and stakeholders that use and/or depend on the river. This was echoed due to the intrinsic importance of a safe and reliable water supply to human existence. However, many stakeholders viewed the proposed project as only directly beneficial to the communities within the Les Avocats and Petite Etang supply area with little or no benefits to the communities and users of the downstream part of the Great River. Community stakeholders commented:

“If it is possible to get it [the project] done in a way that benefits them [southeastern communities] since we know it is a necessity but does not affect us significantly, that will be good, but we don't have any benefit to that project” [Adult Male, Balthazar].

“Really and truly, there is nothing in that for us. Well, the people in St. David's will benefit from the water but there is no benefit for us” [Adult Male, Balthazar Community].

4. Most stakeholders along the great river reported that based on their perspectives, there were no direct benefits of the proposed project to downstream communities, except for the provision of temporary short term employment opportunities. This points to the need for more focused consultation with stakeholders about the proposed project.
5. Improved quality of the access road leading to the intake and the likely appreciation of property values. This was shared by landowners within that general area.

6.3.2 Concerns

Concerns were articulated by all stakeholder groups consulted. While there were similarities in some instances, there were issues that were unique to each group of stakeholders. A summary of the main issues communicated is presented below.

Government

- The Department of Forestry noted that although the project is a worthy one for improving water availability, the increasing introduction of built infrastructure within the reserve is of concern. Specifically, the Department representative raised concerns about the likely adverse effects of the blue water pipes on the natural integrity of the forest. This they believe could reduce the “naturalness” of the reserve and potentially alter the visual aesthetics with a possible reduced experience for hikers using the 1910 to Apres Toute trail. Ensuring discreteness in any infrastructure installed was deemed a priority for the Department.
- A few government stakeholders raised concern about the impacts of pipe breakage and/or leaks on soil and the implications for soil movement and loss (e.g. erosion and landslides) during the operational phase. As such, they raised concern about the extent to which measures would be in place to prevent and address such adverse events.
- A representative from the RGPF registered support for the proposed project with respect to its focus on meeting the water needs of communities. However, the official was concerned about the likely effects of reduced water flow on downstream communities in St. Andrew's

NGO

- The potential over-abstraction of water from the river resulting in adverse environmental outcomes such as degradation of the riparian habitat was raised by an NGO representative. Linked to this concern was the potential challenges of finding suitable water sources to meet any future water supply issues affecting the people along the Great River.
- NGO representatives were interested in ascertaining the actions that are taken to protect the existing national water stock and questioned the need for diverting water from one source area to another region.

- A few stakeholders cautioned against using the most affordable solution and forgoing more robust, higher cost interventions which could potentially create sustainability challenges in the medium to long term.
- An official from the Agency for Rural Transformation noted that the proposed there was no mention of the transmission line from 7 sisters to Les Avocats in the G-CREWS project document and the existing ESMP. She added that it is unclear how the proposed action could be considered an action to support a climate resilient water sector in the absence of any hydrological and other data²².

Communities

- The most significant and frequently voiced concern among communities and users of the downstream part of the Great River is the compounded effect of abstraction on the already reduced streamflow in the dry season, and the impacts on river ecology and the cultural and socioeconomic uses of the resource. This was vehemently expressed by men, women, and young people. In fact, a few stakeholders in the beneficiary communities (i.e., Perdmontemps, etc.) reported some degree of concern about the likely impact of the project on socioeconomic activities in the eastern communities, notwithstanding the need to improve the existing water supply in the southeast.
- Some stakeholders were concerned that “NAWASA was killing the goose that laid the golden egg.” This was within the context of the pivotal role that the Great River plays in supporting food production within the parish, food and nutrition security at the national level, and in supporting cultural and economic activities. One community stakeholder noted: “Birchgrove is the food basket of St. Andrew. Why move the water to somewhere else, and why was Birchgrove targeted?” [Female adult, Birchgrove].
- Communities were concerned about the already reduced precipitation even in the traditional wet season. They therefore wondered whether or not the impact of climate change on precipitation and river volumes was considered during the identification of the proposed intake site.
- Downstream communities wondered why is it that NAWASA could not tap the rain that is falling in the wet season to meet the water needs in the southeast and “leave us alone”. Why is there a need to “stress the communities along the river that has no problem with water to satisfy people who have problems with water” [Female community member, Birchgrove].
- One community member pointed out that sometimes during the planning phase of capital projects, all adverse effects are not foreseen, rather, manifest during the operational phase of the project. For instance, the stakeholder noted that the rehabilitation of the Balthazar Bridge blocked the migratory movement of the “Sad Fish” from the downstream parts of the river to the upper areas. As such none of this species of riverine fish is observed upstream the bridge. According to local people, this impact was not anticipated during the design or the construction phase. This points to the need for robust impact prediction and focused monitoring during construction and operation to address any unlikely effects not anticipated in the design phase.
- A few male community members reported some levels of distrust with the proposed plans to transfer water from the Great River to Les Avocats. They were of the opinion that the main drivers of the project are not to fulfil the water needs of communities in the southeast. Rather it is principally designed to (i) meet the water needs of two major hotels in the southeastern area: the Six Sense and Intercontinental hotels, (ii) supplement the Annandale Water Treatment Plant during extreme dry periods. Consultation with NAWASA official revealed that these assumptions are not accurate.

²² Note : while this is correct the project’s Annual Progress reports published on the GCF Website make already mention of the proposed 7 sister project since 2022 <https://www.greenclimate.fund/sites/default/files/document/fp059-annual-performance-report-cy2022-v.pdf> ; this ESIA/ ESMP document on the 7 sister project complements the GCREWS ESMP after finalisation

Moreover, the referenced hotels located in the parish of St. David's are not served by the Les Avocats and Petite Etang water supply system, rather, via the Laura and Petite Esperance Tanks, which are on a different system²³.

- Very few persons, primarily females identified traffic delays and congestion along Grand Etang road as a possible concern during construction.
- Consistent with a point raised by an NGO representative, a local woman from the St. Andrew's communities was concerned about the impact of the proposed project on accessing alternative water resources to meet the future water supply deficiencies of the downstream communities. This is within the context of the impact of a changing climate on streamflow.

"Where does that leave us when it comes to water supply in the next 10 years because am looking at it and wondering now with the diminishing rainfall we are having, when you take water and send it elsewhere, eventually Birch Grove and the other areas would not have enough water in the river to meet our needs in the future" [female resident, Birchgrove].

- Stakeholders in the beneficiary communities were concern about the cost and difficulty to transfer the water from Grand Etang to St David's. They questioned whether putting in more storage tanks or other solutions would not be a better option to address the deficit in the dry season.
- The focus on new solutions with limited investment in maintaining and upgrading existing infrastructure such as dams and treatment plants was identified as a concern among male stakeholders in the southeastern areas This was viewed by beneficiary stakeholders as a deficiency in the current management of water supply. The need to also ensure that the quality issues currently experienced are addressed via this project. See quote below.
- A few stakeholders from both the beneficiary and affected communities were of the viewpoint that the consultations were merely to "check a box" and not for genuine engagement that can influence decisions about the project. They purported that the client has already made the final decision about moving forward with the proposed project, and this engagement is really a "rubber stamp" activity. Such viewpoints should be addressed to reduce the impact on this and future consultative processes to support development planning. This viewpoint could be based on stakeholders experience with prior development projects, and not exclusively link to the proposed Seven Sisters intervention.
- The lack of research on the possible health impacts of consuming treated potable water produced by NAWASA. This was deemed an actionable item by a local woman in the beneficiary communities.
- One male did not support the diversion of water from one region to another and viewed this as contrary to natural laws established by God.

River Tubing Companies

- The most substantial concern of all river tubing companies is the likely diminished downstream flow associated with abstraction and the potentially severe effects on the functionality of their business. This concern was shared by other stakeholders including community people and the public sector. Representatives of the river tubing companies noted that the proposed abstraction is likely to compound the challenges already faced in the dry season, particularly during the peak months of April and May, and under prolonged periods of no or little precipitation in the wet periods (e.g., as occurred from August to October 2023). Moreover, owners and operators stated that during the dry

²³ Source of water for the Laura Tank (Bailles Bacolet pump) and for the Petite Esperance tank (Mama Cannes Treatment Plant). These two networks feed the areas between Ft. Jeudy to Corinth and Redgate to Corinth respectively.

season, the water levels are already low. Any further reduction can result in the ceasing of all operations in the peak dry season with major negative consequences for livelihoods, employment, and the rural economy. Closing operations in these dry months can also create challenges with clients within the tourism sector, such as Sandals who promote river tubing tours internationally in advance of the season's commencement. One business owner summarizes the foreseeable business impacts:

"I have seen the struggles with the guys on the river during the driest part of the year. It's very tough for them especially when they have a guest on the heavier side and they literally pulling them along. It will mean stopping that tour [river tubing] for that period; I cannot see anyway else out of it if we are taking water from an already limited water supply ... we need at least a basic water level in the river to do a river tubing tours, we will be below the acceptable level of water during the driest part of the dry season. This is a cause for concern" [Female business owner, River Tubing Company].

- For one business, river tubing is paired with several other ecotours largely because it generates a lot of interest among clients. Moreover, 2024 bookings for these tours have already commenced. If river tubing tours are suspended for part of the cruise season due to low levels of water in the river channel, this can negatively affect the combo tours, the quality of services offered by local businesses, and the brand integrity of partnering agencies who also market these recreational services (e.g., Huggins and Sandals).
- Reduced tours can therefore result in a reduction of business revenue and income for employees²⁴, with a multiplier socio-economic effect experienced at the community level.
- Business owners and workers are therefore interested in the mitigation measures that would be implemented to limit such adverse impacts, thus supporting the continued sustainability of the river tubing tours.
- All the river tubing companies were therefore interested in understanding how the proposed project, in particular, abstraction in the Great River would affect the flow of water downstream and the magnitude of impact on their businesses. Similarly, a knowledge of the mitigation measures to ensure the continued sustainability of the river tubing tours was a high priority item for this stakeholder group.

Owners of lands along the intake to Adelphi Main Road

Most owners did not report any major concerns with the proposed project. The undermentioned emanated as the main concerns shared by this group.

- The Motorability of the access road leading to the intake during the construction and post-construction phase. This was identified as important to land users and farmers who own or rent land in that area.
- Potential for landslides along private lands located in boundary with the riparian zone/river bank during the installation of the intake.
- Obstruction to landowners desirous of crossing the river to access lands on the other side created by the installation of the intake.
- The extent to which withdrawal of water from the river will (i) prevent the livelihood of the people who operate sports businesses downstream and (ii) farmers who need to irrigate their lands during the dry season.

²⁴ Staff are paid for the tours conducted in some instances; therefore, the less tours conducted is linked to a reduced income for workers.

Grand Etang Businesses

- The likelihood that the project can reduce the flow of traffic around the Grand Etang visitor center and potential negative effects on business, particularly in the peak tourist season.

6.3.3 Suggested Stakeholder Recommendations

- NGO/Govt - Public awareness and education aimed at promoting the adoption of RWH technologies in the southeastern communities and around Grenada generally in light of the climate change risks to the water sector. This was confirmed by the GIZ as an action which has commenced implementation under the G-CREWS project.
- Department of Forestry recommended the integration of a reforestation element of the proposed project to compensate for any damaged vegetation during the laying of the pipes within the reserve. This can be implemented within the area of project work and/or in another area that can benefit from this intervention. This was supported by community stakeholders within the Great River. Representatives from NASAWA reported that in its conceptual stages of development, the current leadership of the Authority has identified investment in watershed management and forest restoration as a strategic priority going forward.
- Stakeholders suggested other options for addressing the water deficiency in the southeast to including increased storage of raw and treated water, construction of desalination plants, and greater investment in RWH at the household level. Construct dam in St. David's.

Storage of water during the wet season (Female, Balthazar).

- Development and implementation of legislation that mandates integration of RWH technology during the construction of new homes or other buildings. This is a measure that is pursued by the GIZ currently.
- Address the water quality issues currently experienced with the Les Avocats and Petite Etang Service area as part of the proposed project.
- Explore the options for groundwater from suitable aquifers located within the southeastern belt. The GIZ noted that this recommendation is also part of the actions planned for implementation under the G-CREWS project.
- Need for research on the link between water and health conditions.
- I have another suggestion, encourage each household in that particular area to have a tank in the southeast area so that they would not be severely affected. Then again would NAWASA increase their labor force, even during the rainy season they have to work overtime, sometimes night time taking them up in the forest trying to rectify certain situations just to give us water, so what about this new one again would they be increasing their workforce to take care of this additional situation. So just encourage people to do what they have to do (Female Balthazar).
- One river tubing company recommended investment in solutions to augment rainwater harvesting and storage technologies at the household level. Such an initiative should be supported by NAWASA. Moreover, the stakeholder noted that NAWASA or related partners can provide support to householders and property owners who were unable to purchase or construct the relevant storage tanks. This they believe could reduce the need for the Seven sisters and such projects or the volume of water needed to be abstracted. Some elements of this recommendations are already implemented through the G-CREWS project via the Tourism and Farmers Challenge Fund.

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Annexes

Appendix 1 : Location of vegetative transects

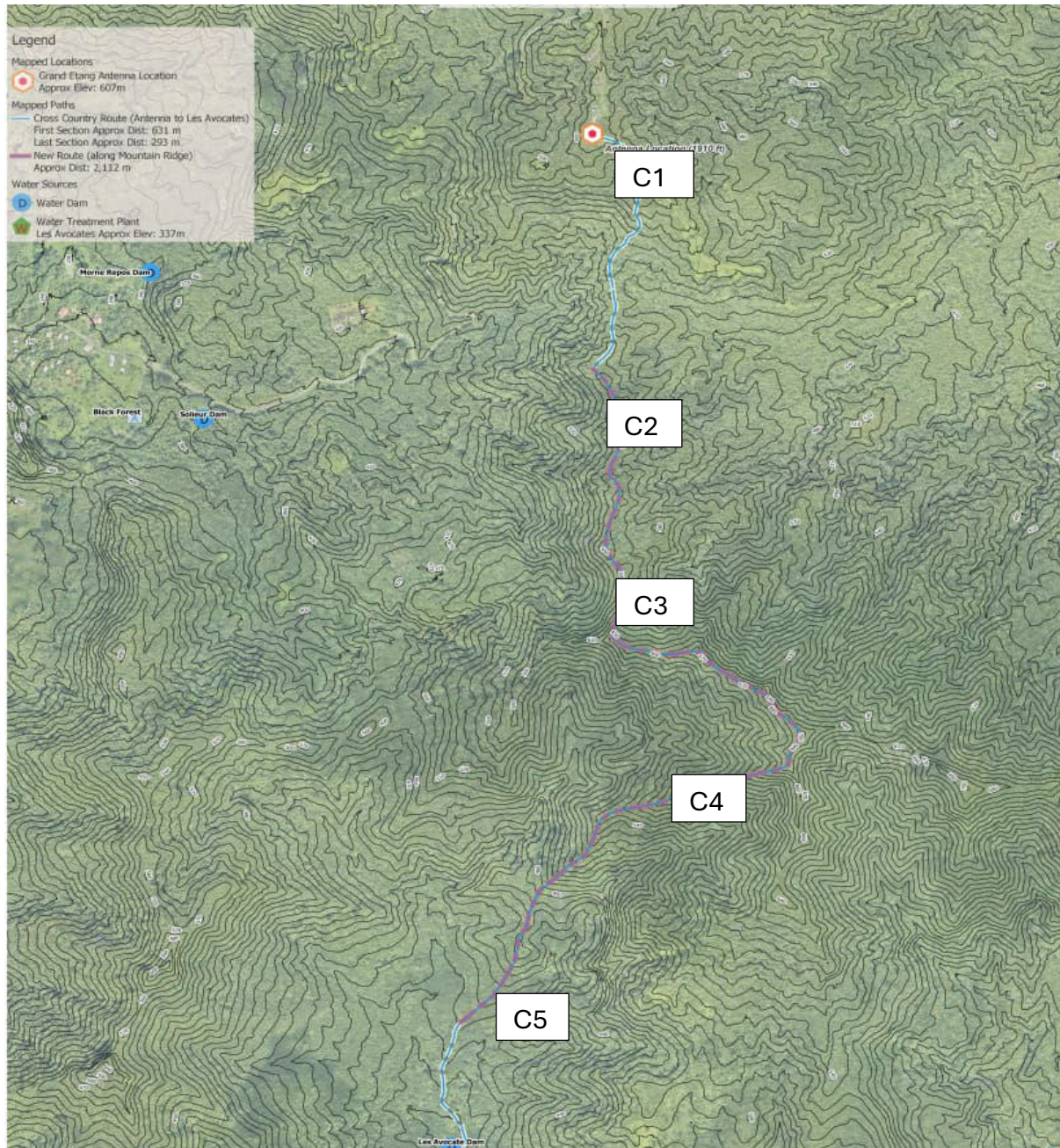


Figure 1: Location of Vegetation Transect C5 =Les Avocat site 1, C4=Les Avocat site 2, C1=Grand Etang site 3, C2= Grand Etang site 4, C3=Grand Etang site 5

Appendix 2: Plants along the riparian at intake, Adelphi

Source: Hawthorne, 2004, Grenada's National Red List of Threatened Species, 2014 and IUCN, 2019

Family	Botanical name	Common names	Status		Notes
			Local	International	
Malvaceae	Theobroma Cacao	Cocoa	Not listed	Not listed	Commercially cultivated for fruit which is used to make chocolate and other cocoa products such as cocoa tea.
Bombacaceae	Pachira insignis	Wild Breadnut / Cacao Sauvage	Not listed	Not listed	Bark is used as bait for cocoa beetles and as a fever treatment. Edible seeds can be eaten raw or roasted.
Lauraceae	Persea americana	Avocado	Not listed	Not listed	Edible fruit.
Areraceae	Cocos nucifera	Coconut	Not listed	Not listed	Variety of uses including consumption (coconut water, jelly, milk, copra, oil etc.); fibrous husks used for 'coir' mats and shredded for use in gardening; jewellery, shack-shacks (i.e. maracas) etc. from the
Fabaceae	Inga Ingoides	Pwa Doux/Kakoli	-	Least concern	Edible beans. Eaten of the mona monkey.
Heliconiaceae	Heliconia sp	Heliconia/ Balizyé	Not listed	Not listed	Leaves used in other Caribbean countries as thatch, liners for basket and to cover bread during baking. Used as ornamental.
Acanthaceae	Justicia secunda	Brazilian Plume	Not listed	Not listed	
Fabaceae	Leucaena leucocephala	Wild Tamarind	Not listed	Not listed	Rapid growing trees. Early succession vegetation of disturbed forest.
Fabaceae	Albizia niopoides var. niopoides	Dandycayo	-	Least concern	
Moraceae	Ficus sp	Ficus/Fijé	-	Least concern	Common nesting and foraging site for many species of birds e.g. scaley-naped pigeon.

Family	Botanical name	Common names	Status		Notes
			Local	International	
Costaceae	Costus speciosus	Wild ginger	Not listed	Not listed	Ornamental species.
Urticaceae	Cecropia peltata	Bois canot	-	Least concern	Tea is used for cold and hypertension.
Piperaceae	Piper dusii	Mal lestomak	Not listed	Not listed	Used a fodder.
Lauraceae	Cassytha filiformis	Love vine	Not listed	Not listed	Considered an invasive species
Convolvulaceae	Ipomoea obscura	Seasonal/Rabbit Vine	Not listed	Not listed	Tubers are edible. Leaves are used as fodder.
Rubiaceae	Gonzalagunia sp		Not listed	Not listed	

Appendix 3: Plants recorded at along the zone of influence (Grand etang to Les Avocat)

Source: Hawthorne, 2004, Grenada's National Red List of Threatened Species, 2014 and IUCN, 2019

Family	Common Name	Scientific Name	Form	Transect					Status		Notes
				C5	C4	C3	C2	C1	National	International	
ANACARDIACEAE	Mango	Mangifera indica	Tree	✓					Not Listed	Not Listed	Cultivated for its edible fruit. Extracts from the leaves and bark can be used to relieve toothaches and sore gums.
ARACEAE	Swiss Cheese Plant	Monstera adansonii	Vine		✓	✓	✓	✓	Not Listed	Not Listed	Has value as an ornamental. Ripe fruit is edible.
	-	Anthurium acuale or Anthurium hookeri		✓	✓	✓	✓	✓	Not listed	Not listed	-
ARECACEAE	Coconut	Cocos nucifera	Palm	✓					Not Listed	Not Listed	Variety of uses including: consumption (coconut water, jelly, milk, copra, oil etc.); fibrous husks used for 'coir' mats and shredded for use in gardening; jewellery, shack-shacks (i.e. maracas) etc. from the shells; leaflets made into mats, belts, cocoyea brooms etc.
	Mountain Cabbage	Euterpe dominicana	Palm		✓	✓	✓	✓	Endemic – found on the mountains of Grenada, Dominica and St Vincent.	Not Listed	Has value as an ornamental. Palm heart / 'cabbage' (i.e. young shoots and leaves) are eaten; this results in the loss of the entire tree.

Family	Common Name	Scientific Name	Form	Transect					Status		Notes
				C5	C4	C3	C2	C1	National	International	
									Almost Endangered		
	Mountain Palm	<i>Prestoea acuminata</i> var. <i>montana</i>	Palm		✓	✓	✓	✓	Not Listed	Not Listed	Shoots and young leaves are edible.
ANNONACEAE	-	<i>Gutierrezia caribaea</i>	Tree		✓				Not listed	Not listed	West Indian endemic
AQUIFOLIACEAE	-	<i>Ilex dioica</i>	Tree		✓				Not listed	Data deficient	-
	-	<i>Ilex sideroxyloides</i>	Tree		✓				Not listed	Least concern	West Indian endemic
BROMELIACEAE	-	<i>Guzmania lingulata</i>	Herb		✓	✓	✓	✓	Not listed	Not listed	Indigenous epiphytic herb
BURSERACEAE	Mountain Gommier	<i>Dacryodes excelsa</i>	Tree		✓	✓	✓	✓	Not listed	Not listed	West Indian endemic. Used to build canoes. Sap is used in religious ceremonies and the start fire.
URTICACEAE	Bois Canot / Trumpet Plant	<i>Cecropia schreberiana</i>	Tree	✓	✓	✓	✓	✓	Not Listed	Not Listed	Young buds are edible. Tea is used for cold and hypertension.
CONVOLVULACEAE	Wild Potato Vine	<i>Ipomoea tiliacea</i>	Vine	✓	✓	✓	✓		Not Listed	Not Listed	Tubers are edible.
COSTACEAE	Wild Ginger	<i>Costus speciosus</i>	Herb	✓	✓	✓			Not Listed	Not Listed	Ornamental species. Used elsewhere to treat cough, asthma, dysmenorrhea, skin issues and intestinal parasites.

Family	Common Name	Scientific Name	Form	Transect					Status		Notes
				C5	C4	C3	C2	C1	National	International	
CYATHEACEAE	Tree Fern	Cyathea tenera	Fern		✓	✓	✓	✓	Not Listed	Not Listed	-
CYCLANTHACEAE	-	Asplundia insignis	Herb	✓	✓	✓	✓	✓	Not listed	Not listed	Lesser Antillean endemic
	-	Asplundia rigida	Herb	✓	✓	✓	✓	✓	Not listed	Not listed	West Indian endemic
	-	Cyclanthus bipartitus	Herb			✓	✓	✓	Not listed	Not listed	-
CYPERACEAE	Razor grass	Scleria secans	Herb	✓	✓	✓	✓	✓	Not listed	Least concern	
DILLENIACEAE	Water Vine	Dolioscarpus sp.	Vine		✓	✓			Not Listed	Not Listed	Used as a source of water by persons (e.g. hikers) in the forest. In the other places, this sap is used as an anti-inflammatory.
Elaeocarpaceae	Chatannyé	Sloanea caribaea	Tree		✓		✓		Not listed	Not Listed	-
EUPHORBIACEAE	Gripe Weed / Egg Woman / Seed-under-leaf	Phyllanthus amarus	Herb	✓		✓			Not Listed	Not Listed	-
	Bois d'Amande / Tapana	Hyeronima laxiflora	Tree		✓	✓	✓		Not Listed	Not Listed	Commercial hardwood.
	-	Sapium glandulosum	Tree	✓		✓			Not listed	Least concern	Lesser Antillean endemic

Family	Common Name	Scientific Name	Form	Transect					Status		Notes
				C5	C4	C3	C2	C1	National	International	
Fabaceae	Donkey eye	Dioclea megacarpa	Vine	✓	✓				Not listed	Not Listed	Used in art and craft
-	Dandykayo	Albizia niopoides var. niopoides	Tree	✓	✓	✓	✓		Not listed	Least concern	-
-	-	Adenanthera pavonina	Tree			✓			Not listed	Least concern	-
-	-	Pithecellobium jupunba	Tree			✓			Not Listed	Not Listed	-
Gesneriaceae	-	Besleria lutea	Shrub	✓	✓	✓	✓	✓	Not Listed	Not Listed	-
Gesneriaceae	-	Nautilocalyx melittifolius	Herb	✓	✓	✓	✓	✓	Not Listed	Not Listed	-
HELICONIACEAE	Balisier	Heliconia caribaea	Herb	✓	✓	✓	✓	✓	Not Listed	Not Listed	Leaves used in other Caribbean countries as thatch, liners for basket and to cover bread during baking.
	Heliconia	Heliconia psittacorum	Herb	✓	✓	✓	✓	✓	Not Listed	Not Listed	Used as an Is ornamental species.
LAURACEAE	Laurier	Ocotea sp.	Tree		✓	✓			Not Listed	Not Listed	Hardwood species used for timber.
	-	Cinnamomum elongatum	Tree	✓	✓	✓	✓	✓	Not listed	Not listed	-

Family	Common Name	Scientific Name	Form	Transect					Status		Notes	
				C5	C4	C3	C2	C1	National	International		
	-	Cinnamomum montanum	Tree		✓	✓	✓	✓		Not listed	Not listed	-
LEGUMINOSAE	Cacoley	Inga laurina	Tree	✓	✓	✓	✓			Not Listed	Not Threatened (Catalogue of Life)	Fruit is edible; once sold in Grenadian markets.
	Sweethearts / Coeur de Valeur	Desmodium incanum	Herb	✓	✓	✓	✓			Not Listed	Not Threatened (Catalogue of Life)	Treatment for diarrhoea in children.
	Sensitive Plant	Mimosa pudica	Shrublet	✓		✓				Not Listed	Least Concern (IUCN)	Used to treat colds, coughs, venereal diseases, toothache and to induce vomiting and urination.
MALVACEAE	Blue Mahoe	Talipariti elatum	Tree	✓		✓				Not Listed	Least Concern (IUCN)	Introduced for reforestation after Hurricane Janet in 1955. Used in woodwork.
	Wire Weed / Sweet Broom	Sida acuta	Shrublet	✓		✓				Not Listed	Not Listed	Stems and roots used as poultice on sprains and strains.
	-	Pachira insignis	Tree	✓	✓					Not listed	Least concern	-
	Swizzle stick	Quararibea turbinata	Tree	✓						Not listed	Not listed	-
	Bois Flot / Balsa	Ochroma pyramidale	Tree	✓	✓					Not listed	Not listed	One of the lightest weight commercial woods.

Family	Common Name	Scientific Name	Form	Transect					Status		Notes
				C5	C4	C3	C2	C1	National	International	
MALPIGHIACEAE	Seawet	Byrsonima spicata	Tree	✓					Not listed	Least concern	-
	-	Byrsonima trinitensis	Tree		✓	✓			Not listed	Not listed	-
MARANTACEAE	Arouma / Terite	Ischnosiphon arouma	Herb		✓	✓	✓	✓	Not Listed	Not Listed	Used in other places to make baskets.
MELASTOMATACEAE	Kak Mel	Clidemia hirta	Shrub	✓			✓	✓	Not Listed	Not Listed	Leaves are crushed with lard and applied to treat hernias. Can also be used for healthy skin.
		Miconia racemosa	Shrub		✓	✓	✓	✓	Not listed	Least concern	-
		Conostegia icosandra	Shrub	✓	✓	✓	✓	✓	Not listed	Not Listed	-
		Charianthus alpinus	Shrub	✓	✓	✓	✓	✓	Not listed	Not listed	-
Meliaceae		Trichilia sp	Tree		✓				-	-	-
Meliaceae	Bois rouge	Guarea macrophylla	Tree		✓	✓	✓	✓	Not listed	Least concern	-
Meliaceae		Guarea glabra	Tree	✓					Not listed	Least concern	-
MORACEAE	Figuier	Ficus guianensis	Tree		✓	✓			Not Listed	Not Listed	Used as a shade plant. Latex is applied to decaying tooth to

Family	Common Name	Scientific Name	Form	Transect					Status		Notes
				C5	C4	C3	C2	C1	National	International	
											relieve pain and results in tooth falling out 1-2 days later.
	White Fig	<i>Ficus americana</i>	Tree	✓					Not Listed	Least Concern (IUCN)	Has value as a slope stabilizing species.
MYRTACEAE	-	<i>Marliera guildingiana</i>	Tree			✓	✓		Not listed	Not listed	-
	-	<i>Myrcia cf. platyclada</i>	Tree			✓	✓		Not listed	Not listed	-
	-	<i>Eugenia sp.</i>	Tree	✓					-	-	-
Phyllanthaceae	-	<i>Hieronyma alchorneoides</i>	Tree		✓	✓			Not listed	Least concern	-
	-	<i>Richeria grandis</i>	Tree			✓	✓	✓	Not listed	Not listed	-
PIPERACEAE	Mal lestomak	<i>Piper dusii</i>	Shrub	✓	✓		✓	✓	Not Listed	Not Listed	Leaves may be used as fodder.
	-	<i>Peperomia sp</i>	Herb	✓	✓	✓	✓	✓	-	-	Some species are listed as endanger nationally
POACEAE	Bamboo	<i>Bambusa vulgaris</i>	Grass	✓	✓	✓	✓		Not Listed	Not Listed	Used for construction, water pipes and in basket-making. Leaves are used to relive fever and reduce blood sugar. Used to increase sex-drive in both animals and humans. Shoots are edible.

Family	Common Name	Scientific Name	Form	Transect					Status		Notes
				C5	C4	C3	C2	C1	National	International	
	-	<i>Oplismenus hirtellus</i>	Grass	✓		✓			Not Listed	Not Listed	
RHAMNACEAE	Chew-stick	<i>Gouania lupuloides</i>	Vine	✓			✓		Not Listed	Not Listed	Chewed to clean teeth. Used to make a medicinal tea and used as a hops substitute in ginger-beer.
RUBIACEAE	Broom Weed	<i>Spermacoce latifolia</i>	Herb	✓					Not Listed	Not Listed	-
		<i>Psychotria berteriana</i>	Shrub	✓	✓	✓			Not listed	Not listed	-
SAPOTACEAE	Penny Piece	<i>Pouteria multiflora</i>	Tree	✓					Not Listed	Not Listed	Fruits is edible.
	Wild balata	<i>Microphalis guyanensis</i>	Tree			✓	✓	✓	Not Listed	Not Listed	-
		<i>Meliosma herbertii</i>	Tree						Least concern	Least concern	-
Simaroubaceae	Maruba	<i>Simarouba amara</i>	Tree		✓	✓	✓		Least concern	Least concern	-
Urticaceae	-	<i>Pilea sp.</i>	Herb		✓	✓	✓		Not Listed	Not Listed	Many species in this genus are cultivated as ornamentals.
	-	<i>Phenax sonneratii</i>	Herb	✓			✓		Not Listed	Not Listed	-

Family	Common Name	Scientific Name	Form	Transect					Status		Notes
				C5	C4	C3	C2	C1	National	International	
VERBENACEAE	Ven-ven / Vervain	Stachytarpheta sp	Herb	✓		✓			Not Listed	Not Listed	Leaves are used in a 'cooling' herbal tea for nursing women, for fevers and in poultices for wounds.

Appendix 4: Observed Pteridophytes and Lycopodiophytes

Source: Hawthorne, 2004; Grenada National Red List of Threatened Species, 2014; and IUCN, 2019

Family	Botanical Name	Common Name	Transect					Status	Notes
			C1	C2	C3	C4	C5		
Lycopodiaceae	<i>Lycopodiella cernua</i>		✓					Indigenous	Abundant in most parts
Athyriaceae	<i>Diplazium striatum</i>		✓	✓	✓	✓		Indigenous	rare
Blechnaceae	<i>Blechnum occidentale</i>			✓	✓	✓	✓	Indigenous	Abundant in most parts
Blechnaceae	<i>Blechnum polypodioides</i>			✓		✓	✓		
Cyatheaceae	<i>Cyathea tenera</i>			✓	✓	✓	✓	Indigenous	Abundant in most parts
Cyatheaceae	<i>Cyathea arborea</i>			✓	✓	✓	✓	Indigenous	Abundant in most parts
Cyatheaceae	<i>Cyathea grandifolia</i>			✓		✓		Lesser Antillean endemic	Abundant in most parts
Dryopteridaceae	<i>Elaphoglossum crinitum</i>					✓	✓	Indigenous	Rare
Dryopteridaceae	<i>Elaphoglossum latifolium</i>			✓		✓	✓	Indigenous	Abundant in most parts
Dryopteridaceae	<i>Elaphoglossum petiolatum</i>			✓			✓	Indigenous	Abundant in most parts
Dryopteridaceae	<i>Megalastrum subincisum</i>			✓				Indigenous	Rare
Gleicheniaceae	<i>Gleichenella pectinata</i>	Kalmere/Fern	✓	✓	✓	✓	✓	Indigenous	Abundant in most parts

Family	Botanical Name	Common Name	Transect					Status	Notes
			C1	C2	C3	C4	C5		
Gleicheniaceae	Sticherus bifidus			✓	✓	✓	✓	Indigenous	Abundant in most parts
Lindsaeaceae	Lindsaea lancea			✓			✓	Indigenous	Abundant in most parts
Lindsaeaceae	Lonchitis hirsuta						✓	Indigenous	Rare
Lindsaeaceae	Lindsaea lancea			✓	✓		✓	Indigenous	Abundant in most parts
Polypodiaceae	Microgramma lycopodioides					✓	✓	Indigenous	Abundant in most parts
Pteridaceae	Ananthacorus angustifolius					✓		Indigenous	
Pteridaceae	Hemionitis palmata					✓	✓	Indigenous	Rare
Pteridaceae	Polytaenium feei			✓		✓	✓	Indigenous	Abundant in most parts
Selaginellaceae	Selaginella flabellata		✓	✓	✓	✓	✓	Indigenous	Abundant in most parts
Hymenophyllaceae	Didymoglossum sp					✓		Indigenous	
Hymenophyllaceae	Trichomones sp						✓	Indigenous	
Marattiaceae	Danaea antillensis					✓	✓	Lesser Antillean endemic	Abundant in most parts

Appendix 5a: Birds sighted heard and likely to be found in locality - 1910-Les Avocats

Common Name	Scientific Name	Zone/Location	Occurrence
Sighted or heard			
Scaly-Naped Pigeon Ramier	<i>Columba squamosa</i>	1,2,3	COMMON
Banana Quit	<i>Coereba flaveola</i>	2	COMMON
Lesser Antillean Tanager	<i>Tangara cucullata</i>	1,2,3	COMMON
Green -Throated Carib Humming Bird	<i>Eulampis holosericeus</i>	2,3	COMMON
Black- Whiskered Vireo	<i>Vireo altiloquus</i>	2,3	COMMON
Gray –Rumped Swift	<i>Streptoprocne zonaris</i>	3,4	COMMON
Likely to inhabit the area			
Broad-Winged Hawk	<i>Buteo platyterus</i>	1,2,3,4	COMMON
Hook-Billed Kite	<i>Chondrohierax uncinatus mirus</i>	1,2	RARE
Gray Kingbird	<i>Tyrannus dominicensis</i>	1	COMMON
Grenada Flycatcher [endemic]	<i>Myiarchus nugator</i>	1	RARE
Rufous- Breasted Hermit Humming Bird	<i>Glaucis hirsuta</i>	2,3,4	COMMON
Antillean Created Humming Bird	<i>Orthorhyncus cristatus</i>	2,3	COMMON
Bare-Eyed Robin	<i>Turdus nudigenis</i>	2,3	RARE
Cocoa Thrush	<i>Turdus fumigatus</i>	2,3	COMMON
Black Swift	<i>Cypselodes niger</i>	3,4	RARE

Appendix 5b: Wildlife sighted and likely to be found in locality - 1910-Les Avocats

REPTILES

Local /Common Name	Scientific Name
Common Anole or Wall Lizard	Anolis aeneus
Tree Lizard	Anolis richandi
Wood slave or House Gecko	Thecadactylus rapicauda
Mabouya or Spinous Gecko	Hemidactylus mabouya
Tree Boa	Corallus endyris
Boddaert's Tree Snake	Mastigodryas bruesi

MAMMALS

Local /Common Name	Scientific Name
Mona Monkey	Ceropithecus mona
Greater Chapman's Murine Oposum Marmosa	robinsoni chapmani
Lesser Chapman's Murine Oposum	Marmosa fuscatacarri
Nine -Banded Armadillo/Tatoo (sighted)	Dasypus novemcinctus
Mongoose	Herpestes auropunctatus
Bats	Aritbeus jamaicensis
	Glossophgaga longirostris
	Aritbeus lituratus

Appendix 6: Water quality results assessed for standards for human health

pH - pH of water can influence its taste and odor which are often useful indicators of water quality (low pH: metallic taste, high pH: soda taste). The pH readings obtained were well within the USEPA's acceptable limit of 5 to 9, thus indicating that the water sampled is of desired taste and odor

Total Dissolved Solids (mg/L) - Total dissolved solids (TDS) in drinking water have an aesthetic target of ≤ 500 mg/L. Higher concentrations may result in unpalatability. On the other hand, TDS helps make water more palatable at low concentrations (Government of Canada, 2009). The levels obtained (60 mg/L and 48 mg/L) are therefore lower than the guideline value set by the Gov't of Canada. This therefore suggests that the water tested was of desirable taste.

Salinity (‰) - Typically, drinking water contains very little salt (20 mg/L), which is thought to contribute very little to the daily consumption. As a result, the WHO has an aesthetic recommended value of 200 mg/L rather than a health-based criterion.

Nonetheless, a number of research investigations have found a link between high levels of salinity in drinking water and a higher risk of hypertension. The risk of gestational hypertension and pre-eclampsia has also been associated with drinking salinized water. A 200 mg/L aesthetic guideline value has also been linked to reports of newborn mortality, cholera epidemics, and skin and diarrheal illnesses (Chakraborty et al., 2019). The salinity readings obtained were 0.06 ‰ and 0.05 ‰, these readings are therefore above the WHO's aesthetic guideline of 0.02 ‰ and may expose consumers to the aforementioned health impacts if consumed.

Conductivity ($\mu\text{S}/\text{cm}$) - The conductivity readings obtained were 125.7 $\mu\text{S}/\text{cm}$ and 101.5 $\mu\text{S}/\text{cm}$.

Alkalinity (mg/L as CaCO_3) - Human health is not severely affected by alkalinity (Illinois Dept of Public Health, 2023). The alkalinity readings obtained were 31 mg/L as CaCO_3 and 23 mg/L as CaCO_3 .

Chloride (mg/L, Cl^-) - Except in cases where it is present at high proportions, chloride in drinking water is usually not hazardous to human health. Heart and kidney sufferers may be adversely affected by the high concentration. Taste standards set the limit on the amount of chloride allowed in drinkable water (Pooja, 2017). The chloride readings obtained were both 11mg/L, Cl^- which are within the acceptable standard (250 mg/L, Cl^-) set by British Columbia. This suggests that the water sampled was of desirable taste.

Hardness (total) (mg/L as CaCO_3) - The amount of dissolved calcium and magnesium in the water determines its water hardness. Hard water may be advantageous in contributing calcium and magnesium to the diet (USGS, 2018). The readings obtained for hardness were 39 mg/L as CaCO_3 and 27 mg/L as CaCO_3 . Nonetheless the World Health Organization (2010), states that "there is insufficient data to suggest either minimum or maximum concentrations of minerals at this time, and so no guideline values are proposed."

Nitrate (mg/L, NO_3^-) - Nitrates are natural compounds of nitrogen and oxygen. By altering the blood's ability to carry oxygen, nitrates—even in low concentrations—can harm pregnant women and infants six months of age or younger (Pooja, 2017). The nitrate concentration obtained were 1.3 mg/L, NO_3^- and 1.6 mg/L, NO_3^- which are within the USEPA's limit of 10 mg/L, NO_3^- . This suggests that human health effects are unlikely to occur from the nitrate concentrations obtained.

Sulphate (mg/L, SO_4^{2-}) - The USEPA categorizes sulphate as a secondary pollutant.

Secondary standards are voluntary guidelines designed to help public water system providers reduce these pollutants to levels that are not likely to be noticed by most consumers. Even though the water from their public water system is safe to drink, a significant proportion of

individuals may cease utilizing it if secondary pollutants are detectable (by taste or smell). The water system supplier would thus be free to decide whether to conduct additional tests and treatments for consumer satisfaction.

At the secondary maximum contaminant levels (SMCL), these pollutants do not pose harm to human health but are assessed for aesthetic considerations such as odor and taste (USEPA, 2023c). The two readings obtained for sulphate were <2 mg/L, SO₄²⁻ which are lower than the USEPA's guideline value of 250 mg/L, SO₄²⁻, thus indicating that the water sampled is of desirable taste and odor.

Phosphate (mg/L PO₄²⁻) - The phosphate levels obtained were both 0.10 mg/L PO₄³⁻.

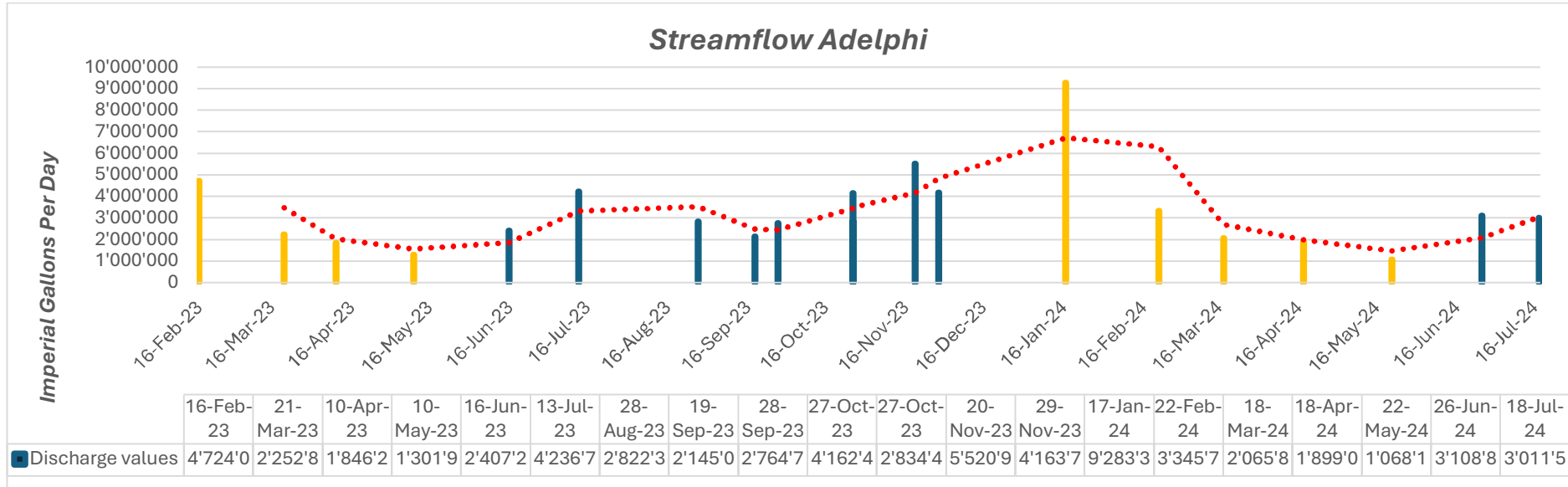
Iron (total) (mg/L, Fe) - The USEPA categories iron as a secondary pollutant. At the SMCL, these pollutants do not pose harm to health but are assessed for aesthetic considerations such as odor, taste, and color (USEPA, 2023c). The iron levels obtained were 0.04 mg/L, Fe and 0.06 mg/L, Fe which are lower than the USEPA limit of 0.3 mg/L, Fe, thus indicating that the water sampled is of desirable taste, odor, and color.

Total Organic Carbon (mg/L, C) - Reducing organic carbon in drinking water is primarily done to prevent the unpleasant color that results from high levels of humic and fulvic acids, as well as to lessen the formation of trihalomethanes (THMs) after chlorination, which may be harmful to humans. The total organic carbon concentrations obtained were 2.0 mg/L, C and 1.6 mg/L, C which are below the 4 mg/L, C limit set by British Columbia. This therefore indicates that the water sampled is not likely to pose a threat to human health.

Sample Date	Analysis Date	Sample Point	Time	pH (Temp' Corr.)	TDS (mg/L)	Salinity (‰)	Cond (µS/cm)	Turbidity (NTU)	Alkalinity (mg/L)	Cl ⁻ (mg/L)	Hard Ca (mg/L)	Hard Mg (mg/L)	Hard Total (mg/L)	Al (mg/L)	NO ₃ ⁻ (mg/L)	NO ₂ ⁻ (mg/L)	NH ₃ (mg/L)	SO ₄ ²⁻ (mg/L)	S ²⁻ (µg/L)	PO ₄ ³⁻ (mg/L)	Fe (mg/L)	Mn (mg/L)	Silica (mg/L)	Cu (mg/L)	TOC (mg/L)	THMs (ppb as CHCl ₃)
20. Feb 24	20. Feb 24	River At Adelphi		7.69	58	0.06	123	0.95	48				47	< 0.008	1.3	0.009	< 0.02	< 2	< 5	0.18	0.09	0.013	28.4	<0.04	< 0.3	
18. Apr 24	18. Apr 24	River At Adelphi	09:30	7.82	59.8	0.06	126.5	0.69	36				72	0.013	1.2	0.012	< 0.02	< 2	< 5	0.12	0.006	0.007	31.8	< 0.04	1.2	
22. Mai 24	22. Mai 24	River At Adelphi	10:01	7.91	61.7	0.06	134.1	0.47	31.7	11	20	16	36	0.019	2.9	0.008		< 2		0.13	0.07		31.8	0.06	1.6	
26. Jun 24	27. Jun 24	River At Adelphi	10:09	7.64	42.8	0.04	82.5	3.43	18	1	12	10	22	0.012	1.2	0.013		< 2	< 5	0.08	0.09	0.010	21.0	< 0.04	1.0	
15. Aug 24	16. Aug 24	River At Adelphi	10:30	7.89	42.2	0.04	92	2.28	18.4	9	13	10	23	0.014	1.6	0.008		< 2	< 5	0.10	0.32	0.011	20.5	< 0.04	3.2	< 10

Appendix 7 -Streamflow data

Date	Station	Discharge values	Unit
16-Feb-23	Adelphi	4'724'060	Imp. Gal. per day
21-Mar-23	Adelphi	2'252'800	Imp. Gal. per day
10-Apr-23	Adelphi	1'846'240	Imp. Gal. per day
10-May-23	Adelphi	1'301'960	Imp. Gal. per day
16-Jun-23	Adelphi	2'407'240	Imp. Gal. per day
13-Jul-23	Adelphi	4'236'760	Imp. Gal. per day
28-Aug-23	Adelphi	2'822'380	Imp. Gal. per day
19-Sep-23	Adelphi	2'145'000	Imp. Gal. per day
28-Sep-23	Adelphi	2'764'740	Imp. Gal. per day
27-Oct-23	Adelphi	4'162'400	Imp. Gal. per day
27-Oct-23	Adelphi	2'834'480	Imp. Gal. per day
20-Nov-23	Adelphi	5'520'900	Imp. Gal. per day
29-Nov-23	Adelphi	4'163'720	Imp. Gal. per day
17-Jan-24	Adelphi	9'283'340	Imp. Gal. per day
22-Feb-24	Adelphi	3'345'760	Imp. Gal. per day
18-Mar-24	Adelphi	2'065'800	Imp. Gal. per day
18-Apr-24	Adelphi	1'899'040	Imp. Gal. per day
22-May-24	Adelphi	1'068'100	Imp. Gal. per day
26-Jun-24	Adelphi	3'108'820	Imp. Gal. per day
18-Jul-24	Adelphi	3'011'580	Imp. Gal. per day
<i>The highlighted rows are measurements taken during the dry season</i>			



Appendix 8 - Images of macroinvertebrate specimen collected in the study area around intake, Great River, Adelphi, St Andrew's



Image 2: Psephenidae



Image 2: Atyidae



Image 3: Oligochaeta



Image 4: Lepthoplebiidae



Image 51: Hydropsychidae

Appendix 9: Parcels of land along the access road leading to the intake

ID	Parcel size and location along roadside		Sex of listed owner
	Left (western end)	Right (eastern end)	
29	6 acres 2 roods	-	Male
40	1 acre 3 roods	-	Female
30	4 acres 35 poles	-	Male
31	1 acre	-	Female
27	2 acres, 1 rod, 27 poles	-	Male
32	2.2 acres	-	Male
33	2.71 acres	-	Female
34	2 roods	-	Male
23	1 acre, 2 roods	-	Female
22	24 poles	-	Female
21	6.5 acres	-	Male & female
1	-	2 acres, 3 roods, 2 poles	Male & female
2	-	5.6 acres	Male
3	-	3.75 acres	Male
4	-	8 acres, 2 roods & 35 poles	Female
5	-	5 acres, 1 rood	Male & female
7	-	2 acres, 2 roods and 10 poles	Male
8	-	33.5 acres	Male
9	-	1 acre, 9 poles	Male

Source: Valuation Department

Appendix 10: Impact prediction associated with Option 3, Horizontal Directional Drilling

Impacts on Biodiversity and Soil: The creation of a motorized road to allow access of the drilling machine into the forest is not considered a viable option for the Forestry Option since this goes against the value and sensitivity of the Reserve. Construction of any motorable road will result in considerable damage to resident biodiversity and soils based on the Department of Forestry's assessment. This is an important consideration in ascertaining the practicality of this option.

Based on the information provided by the design engineers, the existing accessway towards the start of the 1910-Apres Tout trail will be used to gain entry to the point of drilling. The proposed designs for horizontal directional drilling (HDD) do not anticipate the creation of additional motorable roads into the forest to enable the implementation of Option 3. This is congruent with the Department of Forestry's recommendation. The technology intends to address the main risks associated with Option 2 by bypassing the critical peaks that are likely to (i) generate soil movements and loss or damage of biodiversity, and (ii) occupational health and safety impacts and risks associated with the installation of the pipes at the upper elevation. It therefore can potentially result in a reduction in soil and biodiversity damage and loss in approximately 40% of the affected area compared to Option 2. Trenchless technology as utilized via HDD is fundamentally designed to provide a less invasive form of method for laying the pipes that prevents disturbance of the vegetation, topsoil, and above ground wildlife habitats. It is touted as a viable and appropriate option for working in environmentally sensitive areas such as protected areas compared to the traditional open-cut construction methods. The fundamental intent of horizontal directional drilling (sentence seems incomplete).

More information, however, would be required to ascertain the exact area that would benefit from the HDD in light of the proposed start point for drilling. In theory, if it is feasible to utilize the HDD technology within the context of the project site, this can translate into the protection of a considerable proportion of the biodiversity and soils within the affected part of the Reserve due to the need for substantially less above ground excavation. Minimum ecological footprint useful in sensitive areas (sentence incomplete).

Impact Determination: Preliminary impact prediction suggests that the overall impact of Option 3 would remain adverse due to the need for above ground pipe laying throughout an estimated 50% of the site. However, overall, the magnitude of impacts on vegetation, wildlife, and soil is likely to be reduced. The level of change to key receptors can potentially be more acceptable among segments of the population. In addition, this option also reduces the visual effect of the pipes and concrete blocks along part of the trail with positive implications for user experience. Further, the timeframe required for the construction process may also be shortened with reduced occupational and human health risks for workers.

Information Gaps: Albeit the benefits of the HDD technology, there are some information gaps that limit a full evaluation of this option. No information is available on the nature of the subsurface geology of the mountain range to ascertain the impacts if any on related assets. Therefore, while this option more closely complies with national legislation and provides the opportunity to reduce impacts on critical biodiversity and natural resources within the project site, an understanding of the nature of the subsurface geology along the prospective pipe route is advised. This would be important in ascertaining the presence of any significant obstruction, natural resources, or other features along the proposed underground route, which will ultimately guide the preferred route for utilization of the HDD technology. Therefore, before a full evaluation of the impacts of Option 3 is carried out, the relevant geological investigation should be undertaken to determine the preferred route, management methods for addressing potential impacts and risks, and the practicality within the context of the site layout. The United Kingdom Society for Trenchless Technology, a registered charity involved in the development

of such technologies notes that for new installations using trenchless technology the ground condition and locations of existing services are essential to establish a clear path to follow the installation (UKSTT, n.d.). Other authors advised that a thorough site and subsurface investigation is important (Najafi, 2020 and Bennet and Ariaratnam as cited in Norizam et al., 2017). This is also important due to the limited experience of this technology by NAWASA.

The impact of the drilling fluid requires further analysis in this report.

After future investigation, Option 3 was deemed impractical by the design engineers.

Appendix 11: Stakeholder consultation (Q&A matrix)

<p>→</p> <p>March-15, 2024 Roberts-Caribbean Ltd. ¶</p> <p>Farmers: Practices Along the Great River Questionnaire ¶</p> <p>The National Water and Sewerage Authority (NAWASA) and the German Development Corporation (GIZ) proposes to build a water transfer line from the Great River in St. Andrew's to the Les Avocats Water Treatment Plant in St. David's to address the water challenges facing communities in these areas. About 300,000 gallons of water would be pump every 24 hours during the dry season when there is a shortfall. We would like to better understand your farming practices and your views about the proposed project. Would you be willing to answer a few questions? It will take about six minutes. ¶</p>	<p>→</p> <p>March-15, 2024 Roberts-Caribbean Ltd. ¶</p>
<p>1. → Name of farmer: { } ¶</p> <p>2. → Record participant sex: Male Female ¶</p> <p>3. → Which of the following best represents your age? ¶</p> <ul style="list-style-type: none"> → 15-24 years ¶ → 25-34 years ¶ → 35-44 years ¶ → 45-54 years ¶ → 55-64 years ¶ → 65+ ¶ <p>4. → What is the highest level of education completed? ¶</p> <ul style="list-style-type: none"> → Primary ¶ → Secondary ¶ → College /Voc training ¶ → University ¶ → Other (specify) ¶ <p>5. → State the location of your farm along the river OR in which community is your farm located along the Great River? ¶</p> <ul style="list-style-type: none"> → Adelphi ¶ → Birchgrove ¶ → Castine ¶ → Balhazar ¶ → St. Clouds ¶ → Grand Bras ¶ → Ford ¶ → Paradise ¶ → Telescope ¶ <p>6. → How many plots of land do you farm along the Great River? ¶</p> <ul style="list-style-type: none"> → 1 plot ¶ → 2 plots ¶ → 3 plots ¶ → More than 4 plots ¶ <p>7. → What is the total size of your farm in acres? ¶</p> <ul style="list-style-type: none"> → Less than 1 acre ¶ <p>¶ Would not be integrated into the analysis --- responses would be decoded during the analysis. ¶</p>	<ul style="list-style-type: none"> → 1-2 acres ¶ → 3-4 acres ¶ → 5-6 acres ¶ → 7-8 acres ¶ → 9-10 acres ¶ → More than 10 acres (if more than 10 state acreage) ¶ <p>8. → Are you a part time or full-time farmer? ¶</p> <ul style="list-style-type: none"> → Part time ¶ → Full time ¶ <p>9. → Do you use water from the Great River to irrigate your crops? ¶</p> <ul style="list-style-type: none"> → Yes ¶ → No ¶ <p>10. If yes, when do you use the river for irrigation? ¶</p> <ul style="list-style-type: none"> → Dry season only ¶ → During dry season and dry periods in the wet season ¶ → Both dry season and dry periods during wet season ¶ <p>11. How often in the dry season do you use the water in the river to irrigate? ¶</p> <ul style="list-style-type: none"> → Daily ¶ → Once a week ¶ → 1-3 times per week ¶ → Once a month ¶ → Only as needed ¶ <p>12. → Could you estimate the amount of water you pump from the river in gallons at each pumping event in the dry season? _____ ¶</p> <p>13. → What type of farming are you involved in OR what type of crops do you plant? ¶</p> <p>14. → Do you rear livestock on this farm? ¶</p> <ul style="list-style-type: none"> → Yes ¶ → No ¶ <p>15. If yes, what type of animals do you rear and the total number of livestock _____ ¶</p> <p>16. → Do you use water from the river during the dry season to water your animals? ¶</p> <ul style="list-style-type: none"> → Yes ¶ → No ¶ <p>17. → What are your views on the proposed project? ¶</p> <ul style="list-style-type: none"> → Likely Benefits ¶ → Do you have concerns ¶

Questionnaire for the farmers elaborated by Dianne Roberts

Feedback from Grenada Land Actors and regional colleagues re the ESIA for the planned 7 Sisters water management plan.

Comments	Action taken or answer
<p>The ecological section needs clearer outcomes regarding the project's findings and recommendations for the next steps. These recommendations should be strictly from an applied science perspective, free from bias, and then shaped in a participatory space with the communities involved.</p>	
<p>The relative abundances of species across different taxonomic groups needs to be examined. This information is crucial for decision-making, particularly in protecting fragile habitats and endemic species on the island. (Little to no information collection on endemic endangered species such as the Grenada Piping Frog). It can also aid in developing conservation strategies that involve and benefit local communities, rather than imposing restrictions on traditional practices. Habitat and ecological restoration across various altitudinal gradients are essential for maintaining a healthy water cycle and ensuring a consistent water supply.</p>	
<p>The socioeconomic and cultural sections seem to rely heavily on secondary information rather than deep surveys and participatory exercises within the project's influence and buffer areas. The descriptions feel deterministic and overly focused on tourism, overlooking the activities of local farmers. There is little to no data or understanding of how they abstract water or otherwise rely on the Great River. The final impact score for farming stakeholder is listed as low, this is again based on</p>	<p>I think this was rectified with the input from Ministry of Agriculture. Also this was addresses in the consultation and I trust that we have now more information. However, it has to be said that the farmers will most likely not be impacted as the minimum ecological flow will have to be observed; also the farmers do not use immense quantities from the river beyond</p>

Comments	Action taken or answer
<p>almost no data and is not likely to be credible at all. Lack of consultation with farmers has reduced the emphasis that this ESIA places on them and their livelihoods. It appears that the much smaller river tubing business has received a much greater emphasis than stakeholders who depend on the river for food security, and have done so for a much longer period of time (river tubing is said to have only started around 2005). The farming community depending on the Great River is extensive, leading all the way down to the Telescope area. These stakeholders have played no part in the decision making process under this project. Where is the cultural richness of Grenada? How does the project add value in terms of preserving Grenada's traditional values and cultural heritage? Where is the data supporting these statements?</p>	<p>that. Maybe this needs to be clearer in the report.</p>
<p>There does not appear to be any monitoring over the extreme drought conditions that Grenada just went through – a missed opportunity (“the study was nonetheless constrained by an inability to monitor the impact of the proposed water abstraction on downstream socioeconomic and ecological parameters during the dry season - the report preparation period”).</p>	<p>The project follows a do no harm approach. While this is of course desirable, the project unfortunately has no means to invest in increased cultural heritage. However, we could explore ideas to create a water information campaign and support a recreational space that would allow for cultural heritage information to be displayed; could be proposed as a mitigation measure</p>
<p>Risks to workers on the 1910 to Les Avocets trail appears to be of major concern. This may be exacerbated by the passage of Hurricane Beryl which has damaged some of the surrounding forest areas. As mentioned before this trail also intersects with a landslide prone area. It is likely that damage to the trail area and surrounding forest has taken place – meaning that work on the trail could be even more dangerous than predicted. Loss of trees due to the storm could also mean higher runoff and also higher potential for land slippage. Additional studies should be done in this area as the trail from 1910 to Les Avocets is located in a landslide prone area – this could have major implications for the future sustainability and maintenance of pipes installed in this area (see Landslide Susceptibility Map Due to the nature of the terrain, the trail cannot sustain the concrete structures necessary to maintain the proposed metal pipeline. There are several narrow ledges with drops of over 100 feet and very steep slopes that extend for several hundred feet. It is inconceivable to see how the construction materials and workers would be brought to those dangerous areas. As stated the area is prone to landslides and construction in that area would definitely generate some. If polyurethane pipes were used, it is possible that a natural landslide would damage the pipeline and generate more landslides from water leakages to the detriment of the forest. Most of the mature trees in this area were destroyed during Hurricane Ivan and the emerging forest (less than 20 years) needs to stabilize and create an environment on the forest floor to absorb more rainfall in a critical water catchment area.</p>	<p>The project is indeed challenging. All the risks have been identified and assessed during the option analysis. All 3 options have been evaluated based on technical, financial, social and environmental criteria. One option (option 3 : Horizontal drilling through the mountain) was withdrawn mainly due to the high cost implication but also to the technical challenge of drilling). Both remaining options presents very challenging points. Option 1 has a very critical path length of approx. 500 m and option 2 has a very critical path length of approx. 700 m. These are the very challenging points which will take time and where special provisions should be allocated (time, financial resources but also very strong health and safety considerations. Considering that these very critical parts represent only 6% of the total length (option 1) and 8% of the total length (option 2) and given the strategical importance of the project. It was suggested to mitigate these risks by a clear identification and recommendation how to proceed as well as a strong monitoring and work supervision. It is expected that before starting the work, during construction and after finishing work all efforts shall be made to ensure a safe lying of the pipe under consideration of all safety and security aspects. Option 1 was chosen for many reasons:</p> <ul style="list-style-type: none"> • Length of the critical paths is shorter (comparing to option 2) • Total length of the line is shorter (comparing to option 2) , cost saving

Comments	Action taken or answer
	<p>and saving of material and reduction of environmental impacts</p> <ul style="list-style-type: none"> • The topography of option 1 is more favorable (no need of an addition booster and associated risks , like water hammer etc.) • Finally the work for option 1 at the critical paths is across the ridge (instead of along the ridge at option 2) which is more safer while having a wider working area • The use of HDPE pipes and electrofusion welding will increase the longitudinal restraint and the resistance in case of slope slidings • All pipes will be buried (even if the depth will not be very important in certain areas) also to increase the protection against rock or stone chutes
<p>This intervention is taking place within a protected forest reserve and the highest standards for environmental studies and consideration of flora and fauna, including amphibian species should be upheld. International best practices for conducting work in areas and forest reserves should be followed. There appears to have been no specific surveys to look at the potential impact of this project on the Grenada Piping Frog, as was done under previous projects proposing to conduct work in the Grand Etang Forest Reserve.</p>	<p>Correct, we should involve Forestry and define mitigation action. It would be good to get an estimate on the number of frog population along the construction area. My assumption is that the intervention would only be temporarily affecting a limited number of frogs. Any interventions in the mating period should be avoided</p>
<p>No documentation provided to accompany this ESIA in terms of alternatives which were mentioned, including building of dams and other storage capacity. No transparency around cost implications. Multiple mentions made that this intervention was selected due to budgetary and time constraints. This gives the impression that this project is being conducted in a rushed manner without the necessary due diligence.</p>	<p>The aim the G-Crews project is to provide a modest support in the improvement of the water sector in Grenada. The limited funds in this project do not allow the financing of very important infrastructure but rather trying to support optimization measures to reduce the deficit of water supply in the country. A preliminary assessment of important and cost intensive infrastructure like desalination plant or the building of additional dams and water treatment plant have been withdrawn mainly due to the financial capacity of the project. The Main objective was therefore to identify a realistic, short term and reasonable solution to tackle the water deficit for GE catchment area. A flexible but sustainable solution which could be implemented also very quickly minimizing the environmental impact and bringing a very fast relief to the problematic on site. Very quickly the Seven sister's waterfall was identified as the intake source. Various options have been discussed including the building of a transmission line along the main road to St Georges and to connect this line to the existing supply system. Due to the heavy losses and non-revenue water in the system this solution was considered as too risky to tackle the deficit. This solution was also not the</p>

Comments	Action taken or answer
	best one from financial point of view as the road to St George would be longer as a crossing to the natural reserve. Also the topography and curvy road is a technical challenge. This has led to consider a crossing of water transmission line through the GE reserve to les Avocats
It was mentioned that unsatisfactory water quality is also an issue for the beneficiary communities. If water quality issues persist then it is possible that more water will be abstracted from the river to make up for this. No consideration given to persons who extract raw water from springs in areas close to Birchgrove and potentially other areas for the purpose of drinking (supposedly a common practice by some locals, including by Rastafarians who do not rely on treated water). Any impacts on the river caused by the installation of the weir such as heavy sedimentation or even oil spillage may thereby affect a person's health downstream.	Again, this is not part of the 7 sister project, but the WRM. The ESMP should however recommend for the WRMU to regularly test the water quality in that area. This could be part of the GCREWS ESMP (but for WRM)
Water pollution due to intense human activities at the Seven Sisters waterfalls which are up-river from the proposed source and the pipeline along the Petit Etang/Grand Etang trail.	This is not related to the project
Multiple areas of the ESIA appear incomplete, including information on farmers and their usage of the river, little information on informal livelihoods, including catching of crayfish and other species (including titiree downstream). In many places in the document blank spaces are left where information is assumedly not available e.g. the design period of the intervention.	I assume this would be now addressed with the additional information and contacts from MoAL
Calculation of minimum streamflow appears to reference standards in the UK where the amount of abstraction is based on the type and classification of river – which results in more sensitive parts of the river such as upstream and steep sections, as well as first and second order streams being given a more sensitive status and a lower amount of abstraction therefore being allowed in these areas. No such classification has been presented which have guided the abstraction rate of 28% recommended in this ESIA.	
Little studies have been done on the aquatic life downstream and how anadromous species may be affected despite the ESIA mentioning that previous smaller interventions have blocked certain species from migrating upstream.	
It was mentioned that the Adelphi waterfall would not be affected, however it seems that the surrounding Adelphi community / ecosystems downstream may be affected. These areas appear to have been excluded from the study.	Is it affected? How?
Based on the water quality analysis – phosphate levels put forward by the ESIA seem to indicate that “this system may be subjected to the impacts of eutrophication which includes the presence of algae blooms”. Further analysis should be done on this as well as potential sources of pollution affecting the river.	We could include this in the ESMP and engage the limnologist about this that is already contracted within the support to the WRMU within the GCREWS project.
New tourist sites are mentioned as part of the rationalization for future population increases - this is concerning - what	This is a political decision and the GCREWS project cannot answer this. NAWASA has to

Comments	Action taken or answer
<p>percentage of water from this initiative is going to tourist infrastructure and not local communities which seems to be the original impetus for this project? New census data should have been used – older census data now over 10 years old.</p>	<p>serve every connection. We would suggest to address this to the Government</p>
<p>Local people have reported that during periods of heavy rain, large volumes of runoff flow from the higher embankment and enter the land area that is proposed for installing Pump #1. What is the mitigation for this – as this could lead to potential damage to the infrastructure?</p>	<p>See detailed design A rain and stormwater drainage system have been designed to drain run off flow from the higher embankment to the side arm of the creek. This side arm will also be re-modelled and rein-forced by a crossing culvert to canalise the rainwater into the main creek bed of seven sisters.</p>

MEMO

To: Terrence Smith (Mr.), General manager (Ag.)

From: Ms. D. Burris- Legal Counsel

Date: October 28, 2024

Re: **An opinion on whether sections 22(1) of the Physical Planning and Development Control Act (Act 23 of 2016) applies to the Environmental Impact Assessment conducted Kocks Engineering in cooperation with Roberts Engineering**

The Government of Grenada through The National Water and Sewerage Authority (NAWASA) in partnership with the German Development Corporation (GIZ) proposes to build a water transfer line from the Great River in St. Andrew to the Les Avocats Water Treatment Plant located in St. David to address the future water challenges in the southeastern part of the island ("the Transmission Line Project").

The Transmission Line Project comprises three (3) key components:

- (i) An intake downstream the Seven Sisters Waterfall;
- (ii) A pumping station after the intake; and
- (iii) Routing of the pipeline from the intake across three sections: From intake to Grand Etang Main Road (Section 1), from Grand Etang Main Road to Antenna 1910 (Section2); and from Antenna 1910 to Les Avocats (Section 3).

Kocks Engineers, in cooperation with Roberts Caribbean were engaged by NAWASA to conduct an Environmental Social Impact and Assessment ("ESIA") designed primarily to determine the minimum ecological flow required at the Great River downstream the intake and the impact of the pipeline route. The methodology employed complied with the approach required by section 22(1) of the Physical Planning and Development Control Act (Act 23 of 2016) ("the PDA Act") for the ESIA process.

The Physical Planning and Development Control Act (Act 23 of 2016)

The long title to Physical Planning and Development Control Act provides background on the intention of the parliament of Grenada, giving some insight, into the problem statement the PDA Act is intended to address or make provisions for.

The long title is in the following terms:

***“An Act to make provision for the orderly and progressive development of land and to preserve and improve the amenities thereof; for the grant of permission to develop land and for other powers of control over the use of land; for the regulation of the construction of buildings and other related matters; to confer additional powers in respect of the acquisition and development of land for planning; to protect the natural and cultural heritage, to repeal and replace the Physical Planning and Control Act, Cap 241A.*”**

Throughout the PDA Act, the stated objective of providing for the progressive development of land is achieved by general and specific provisions. Of critical importance is the interpretation given to “Development” which is gated as follows;

“Development in relation to land, means the carrying out of building, engineering, mining or other operations in, or, under land, the making of any material change in the use of land or buildings or the subdivision of land.”

It was determined that “Engineering” must also be gated and it thus defined as

***“Engineering Operations includes the laying out, construction and maintenance of roads, drains, culverts, bridges and retention structures, the preparation of land for carrying out any development, the clearing and grubbing of land, earthworks, dredging, land-filling and land reclamation.*”**

Parliament also provided guidance, by reducing to section 3(2) of the PDA Act the directive that the implementing, applying and interpretation of the Act shall have regard to, and use best efforts to further and give a broad and purposive interpretations to the matters set forth in the subsection one (1) of the PDA Act.

Benion on Statutory Interpretation¹ has noted that a purposive interpretation of statute is one which gives effect to the legislative purpose by following and applying the literal meaning of an enactment where the meaning is in accordance with the legislative purpose, **or**, applying a strained meaning where the literal meaning is not in accordance with the legislative purpose.

This writer is asked to render an opinion on whether the ESIA conducted by Kocks Engineers in cooperation with Roberts Caribbean must be submitted to the Physical Planning Authority pursuant to section 22(1) of the PDA Act. This query is contingent on whether the larger project, namely, the Transmission Line Project requires planning approval for development of land within the meaning of the PDA Act.

The requirement for an environmental impact assessment within the meaning of section 22(1) of the PDA Act is not a freestanding provision but contingent on an application for planning approval for the development of land. It is therefore necessary to examine the definition sections highlighted above to ascertain whether a planning application in relation to the Transmission Line Project is necessary before considering section 22(1) of the PDA Act.

In addition to the above provisions, consideration must be given to section 17(1)(c) of the PDA Act allows the following exception:

17(1)(c) (1) *The following operations on or uses of land shall not be deemed for the purposes of this Act, to involve the development of land-*

(c.) The carrying out by or on behalf of the Government or any statutory body of any works for the purpose of inspecting, repairing or renewing any sewers, water mains, pipes, cables or other apparatus, including the breaking open of any road or other land for that purpose or other land for that purpose.

A purposive interpretation of section 17(1)(c) will suggest that the laying of the water transmission lines is an exemption under the PDA Act in keeping with the general intent to exclude as development of land, the inspecting, repairing or renewing water mains; the purposive interpretation of the section as required by parliament will include or read into the section, the exclusion of the laying of new water mains. One may further argue, that the laying of pipeline infrastructure by NAWASA is not development of land as no benefit accrues to the land but that the land value may actually diminish as a result of the existence of water mains on the land.

¹ Benion on Statutory Interpretation part XX section 304

A deeper appreciation of the components of the Transmission Line project can segment the implementation thereof into its respective components; the only component which would fall clearly within the meaning of "Development" under the PDA Act is component two (2) of the Transmission Line project.

Section 22(1) of the PDA Act provides that:

The Authority may require an Environmental Impact Assessment to be carried out in respect of any application for permission to develop land, including an application for approval in principle, if the proposed development could significantly affect the environment.

The Interpretation and General Provisions Act, Cap 153 of the 2010 Continuous Revised laws of Grenada prescribes that ***"In every written law, except where the contrary intention appears, the word "may" shall be construed as being directory or empowering and the word "shall" or "must" shall be construed as mandatory or imperative."***² There is no mandatory requirement for an ESIA to be a part of the application process for permission to develop land in relation to component two (2) of the Transmission Line Project; the requirement for the provision of said ESIA is discretionary and within the purview of the PDA.

Having due regard to the definition of "Development" and "Engineering Works" with further consideration of section 17(1)(c) against the backdrop that parliament mandated that the interpretation of the PDA Act be purposive, I am of the opinion that in the totality of the circumstances, the Water Transmission Line Project would not require submission to the PDA the Environmental Impact Assessment conducted by Kocks Engineers in cooperation with Roberts Caribbean for the following reasons;

1. The extraction and transmission aspects of the project are excluded under section 17(1) (c.) of the PDA Act;
2. The PDA Act defines development of land and engineering works which exclude abstraction of water and running of water mains;
3. The PDA Act prescribes a purposive interpretation; and
4. The component of the Transmission Line Project which may require ESIA is not such which would significantly impact the environment and there is no mandatory requirement for such ESIA.

² Section 3(3) of the Interpretation and General Provisions Act, Cap 153 of the 2010 Continuous Revised laws of Grenada

At this juncture, I note that the PDA is a statutory body with whom NAWASA has cooperated on past projects. Whilst there appears to be no social and environmental factors requiring the submission of an ESIA in relation to component two (2) of the Transmission Line Project, through the establishment of letter requesting unofficial comments on the document, NAWASA may submit the document to the PDA for their comments. This route will circumvent the lengthy administrative process inherent in section 22(1) of the PDA Act and satisfy any lingering doubt as to the requirement for approval of the ESIA by the PDA.