Caribbean Development Bank

Grenada Wastewater Treatment and Recycling Project Outline

Implementing Country: Grenada

Lead Agency: Windward Islands Research and Education Foundation (WINDREF)

Core Collaborating Agencies: National Water and Sewage Authority (NAWASA), Ministry of Health, Caribbean Development Bank

Support Institutions: Ministry of Social Development, Basic Needs Trust Fund (Grenada), TP Engineering (Grenada), Global Water Partnership-Caribbean, Akwatix Water Resources Management (Barbados), Ministry of Implementation and Infrastructure Development, Ministry of Climate Change Resilience, Department of Public Health and Preventive Medicine, St. George's University (SGU), Grenada Chamber of Industry and Commerce, Clean Water Wave, GCRF network members

Primary Beneficiaries: Residents, farmers, and students in Mirabeau community, health workers and patients at Princess Alice Hospital

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Context and Rational

Grenada is a tri-island State in the south eastern Caribbean. The island has a population of approximately 110,000 and was ranked upper-middle income by the World Bank. Traditionally, as in many other Caribbean countries, the local economy was highly dependent on agriculture. In the last two decades, the tourism sector has progressively emerged to surpass the GDP contributions from the agriculture sector. Despite this development, agriculture is still significant for the rural economy in Grenada particularly in terms of employment and contribution to low income households. Contributions from the construction industry and financial and education services are also significant to the GDP. The country's infrastructure is relatively well developed to serve the basic needs of the population although, in some aspects, rural communities lag in the quantity and quality of infrastructure and available services. Prior to 2000, there was steady growth in the Grenadian economy. The passages of hurricanes Ivan and Emily in 2004 and 2005, respectively, followed by the global economic downturn in 2008, have, however, led to declines in the local economy. The 2020 COVID-19 pandemic is expected to further challenge the economic growth trajectory. Firstly, due to its impact on the tourism sector and reduction in revenues and foreign exchange income. Secondly, the resultant public health and health care systems demand for much higher expenditures to control the impacts of the spread of the coronavirus. In the 2021 budget speech, the Government of Grenada stated its commitment to recovery programs and to strengthen sectoral resilience against economic and environmental threats.

Grenada's *National Sustainable Development Plan (NSDP) 2020-2035* includes the development of the productive sectors and infrastructure. The plan also highlights the need to harvest and manage local resources to support national development. In the *2017 Technology Needs Assessment Adaptation Report* conducted by the Ministry of Agriculture, Lands, Forestry, Fisheries and the Environment in collaboration with the Climate Technology Centre & Network (CTCN), United Nations Environment Program and the Technical University of Denmark (UNEP-DTU), several strategies were outlined to address climate change impacts on the local water sector. The reclamation of wastewater was featured as a climate change adaptation measure that is particularly suited for and beneficial to tourism, education, and agriculture activities.

Grenada has seasonal dry and wet weather. The country regularly experiences a shortfall between supply and demand in the dry season resulting in constrained consumption. In recent years, the frequency of extended harsh dry weather has increased, forcing many communities to seek alternative sources of water. Climate change has contributed to temperature and precipitation anomalies. Extreme weather is disruptive to many sectors affecting livelihoods, trade, transportation, social and cultural activities and many other activities of societies. The agriculture sector has been particularly hard hit both by drought and heavy rainfall. Because agriculture is more prominent in rural areas, the rural economy has also been disproportionately affected by climate change related events. Rainwater harvesting is not a common practice to augment supplies for agriculture production in Grenada. Technologies, to capture and treat wastewater generated by agricultural, domestic, and industrial activities, are

limited. In the 2017 technology assessment report, it was cited that wastewater reclamation and reuse was practiced in four small hotels on the island for landscaping purposes only. The report further stated that there was no mechanical system in Grenada for tertiary treatment of wastewater.

According to the United Nations University (2019), high-income countries treat about 70% of generated wastewater, upper-middle-income countries treat about 38%, lower-middle-income countries treat about 28%, and low-income countries treat about 8% of wastewater (1). Few Caribbean countries also reported on wastewater treatment and recycling activities. Among the countries in Latin America and the Caribbean that reported up to 2012, Cuba and the Dominican Republic were among those that reported treating the highest volume of wastewater (21.7 and 30.7%, respectively). Data was not available for Grenada. A study on the global use of recycled water shows the livelihood of millions of small agriculture farmers can benefit from recycled water in irrigation systems (2). Wastewater treatment and recycling was also shown to be benefit industrial and recreational activities (2). In some Caribbean countries, wastewater treatment and recycling is practiced on a limited scale and the potential returns to sectors have not been measured. In a Work Bank report titled *From Waste to Resource: Shifting Paradigms for Smarter Wastewater Interventions in Latin America and the Caribbean,* the development of wastewater initiatives and related policy framework and financing was promoted address the mounting challenge of water shortage. This deficiency has been recognized through the Global Environment Facility - Caribbean Regional Fund for Wastewater Management[1] project which found that 85% of wastewater remains untreated and only 17% of households are connected to acceptable collection and treatment systems.

This project seeks to work in partnership with national and international experts, national authorities and rural communities to obtain an understanding of the importance, reliability, and safety of utilizing wastewater, following its treatment. Given that there are few previous examples of the utilization of wastewater throughout the Caribbean, the cultural acceptance of utilizing this resource will be an important component in the project. Current technologies will be applied to transform wastewater to a usable, safe, and high standard of purity in a community. The treated water will be distributed for community-based agriculture production and possibly other non-potable activities. The project aims to have a positive impact on environmental protection and food security through reducing soil, air and ground water pollution. The lessons from this project regarding the efficiency and safety of this initiative will be important to inform possible future climate change adaptation action in Grenada and the wider Caribbean.

The Global Challenges Research Fund One Health Project

The Global Challenges Research Fund (GCRF)-One Health network aims to reduce health problems related to water and soil pollution in climate–stressed, rural and deprived urban

[1] https://www.gefcrew.org/

communities. The network includes participants in four countries are targeted in the project: Kenya (administrative lead), Jamaica, Grenada, and Scotland. The approach of the network is to support the exchange of knowledge, experience, ideas and capacity building amongst academic and non-academic stakeholders and develop solutions on how to achieve the triple health and environmental co-benefits of access to clean water, a basic human right, healthy and productive soils and delivery of safe, nutritious foods. Across the network, the One Health approach is adopted in developing solutions on how to achieve the triple health and environmental co-benefits of access to clean water, a basic human right, healthy and productive soils and delivery of safe, nutritious foods.

As a first step, country teams identified key issues and the geographic focus in the respective jurisdictions. The country teams are represented by community members and experts, including from civil societies, businesses, government and academic institutions. Each program is comprised of innovative, interconnected activities and "big-tent" events designed to develop collective interdisciplinary skills and capacities, to solve health problems related to environmental pollution. The project will build country-based knowledge networks, through the organization and delivery of roundtable discussions, workshops and co-laboratories, demonstration activities and outreach events.

Across the global network, partners will be building online Communities of Practice, offering training seminars, e-learning courses and topic conferences, and hopefully hold an in-person and digital international conference in 2021 at the Eden Centre in the UK. In addition to designing country-based projects, the teams are also involved in global academic and research roundtables with a focus on gender, community, and business. Through the roundtables, the GCRF will gather views on the project and country issues, identify key stakeholders through a mapping exercise and co-design the national and global programs for development and implementation. The link to the project website is https://gcrfonehealth.org

Scope and Objectives

The Wastewater Treatment and Recycling Project will be implemented as a pilot at the site of the Princess Alice Hospital in St. Andrew (see map below). The AFM technology will be introduced in Grenada and will be utilized in the Mirabeau community to transform wastewater from the hospital to a usable, safe, and high standard of purity for reuse to support agriculture production. The treated water will be distributed to nearby farms to support community-based agriculture production and possibly to community facilities for other non-potable uses. This project is expected ultimately benefit the livelihood of community members, protection of the environment, and climate change adaptation to improve water security. The specific outcomes to be achieved are:

1. Increased agriculture production by men and women beneficiary farmers by 15% during each dry season;

2. Increased income from agriculture production by men and women beneficiary farmers by 5% annually;
3. Increased treatment of wastewater from the Princess Alice Hospital by 75%
4. Increased number to 15 community properties utilizing treated recycled water by Year 3
The AFM Technology

The Wastewater Treatment, Recycling and Water Enhancement Project involves the application of Activated Filtration Media (AFM) technology to treat wastewater. AFM builds on conventional approaches to wastewater treatment that have been used for decades but that the innovation introduces advances in the filtration media. AFM technology, developed by Dryden Aqua in Scotland, is a highly engineered filtration media manufactured from green and brown container glass as a raw material[2]. The AFM technology will be introduced to transform wastewater into a usable state (potentially up to a potable standard, depending on the quality of the input water) for use in crop cultivation. AFM® is the only glass filter media certified for pools (NSF50) and drinking water (NSF61) (Appendix 1 AFM A4 8 pager English). Forty-eight U.S. states have legislation, regulations or policies requiring drinking water system components to comply with, or be certified to, NSF/ANSI/CAN 61 (https://www.nsf.org/testing/water/municipal-water-systems/nsf-ansi-can-61). Unique benefits of AFM include: prevention of the transmission of pathogens including the protozoan zoonoses *Cryptosporidium* spp, *Giardia* spp and *Entamobia* spp, which are the most common waterborne pathogens prevalent in Grenada, filters all particles to a 1 micron level; eliminates odour due to disinfectants or chlorine; saves backwash water and chemicals; and requires little maintenance and does not use a sand filter. Results of the performance test of AFM in 2019 is shown in Appendices 2-3 (2019 AFTS Report AFM-EN & DA_WT_AFM_2018-Def-imperial)

Clean Water Wave (CWW) manufactures containerized water treatment system - Clean Aqua for Everyone (CAFE) - that incorporates the AFM technology. CAFE was designed specifically for rural community, peri-urban or micro-network water treatment. The concept for CAFE was initially developed by Dr. Howard Dryden as part of a European Commission FP7 research project in collaboration with Tyndall Research Institute Ireland, Adelphi Germany, Copenhagen University, DST Department of Science and Technology India and Jadavpur University Kolkata.

[2] 1. AFM® performed the best in tests, more than twice as good as sand or any of the crushed glass products. It is easy to remove large particles but it is the sub 5 micron that are difficult to remove and in this particle size range AFM® excelled (see graph 1 & table page 2)
2. None of the glass products tested backwashed within 6 minutes, the best still retained 8 % of solids, and the worst retained 20 %. This translates to a significantly higher water requirement for backwashing and a higher chlorine demand resulting from retained organic matter (see graph 3)
3. The chemistry of the glass, the particle shape and especially the activation process give AFM® the important properties to clearly outperform sand and glass sand filter media. The large surface of AFM® has a strong negative charge to adsorb heavy metals and small particles. The surface of AFM® ng has a neutral charge (hydrophobic surface) to adsorb fine particles, organics and microplastics. The surface also has metal oxide catalysts which produce free radicals and thus a high redox potential. Therefore AFM® is self-sterilising. AFM® prevents bacteria from settling to make it a unique, bio-resistant filter material (source: IFTS Independent Performance Test Results, October 2019, conducted by IFTS: www.ifts-sls.com (see attached).

The initial project's objective was to try and develop a system that could remove arsenic from ground water and that would have the capacity treat water as polluted as the River Ganga to deliver clean drinking water in compliance to European Commission standards. The system is used in several countries, requires uses low energy, low maintenance, and allows for a decentralized treatment system that can be powered by renewable energy sources. Appendices 4 - 5 show a schematic and details about the CWW system which incorporate AFM technology (Grenada drawings compressed & Clean Water Wave Precis -1).

Project Site

The Princess Alice Hospital, located in Mirabeau, St. Andrew on the eastern side of Grenada, was selected for the implementation of the pilot project. This assessment was conducted in September, 2020 by an SGU Master of Public Health student. The scores awarded against the criteria and summary of the findings at the Princess Alice Hospital site are shown in the table below.

Table 1. Summary of Findings from the Assessment of Princess Alice Hospital, Mirabeau, St. Andrew

	Criterion	Summary of Findings/Site Characteristics	Score (1-5)
1	***Focus on poor communities***	The Country Poverty Assessment 2007/2008, states 44.9% of residents in St. Andrew were poor. The poverty rate for the respective community was not available. The parish poverty rate may indicate that a large proportion of the residents in communities are also poor.	**3**
2	***Focus on rural communities***	Princess Alice Hospital is located in Mirabeau, a rural community in the parish of St. Andrew. St. Andrew is on the eastern side of Grenada.	**5**
3	***Potential to empower communities***	The project will provide an opportunity for farmers in the rural community to augment water supply for agriculture production through collaboration with the Ministry of Health, NAWASA, and other institutions. The community will be empowered to cultivate produce throughout the dry season when, typically, production is significantly reduced. Through the collaboration, the farmers will also be facilitated to provide produce for the hospital kitchen.	**4**
4	***Experience with project implementation/management (financial and operational)***	Princess Alice Hospital is part of the PAHO SMART Hospital initiative in Grenada. The staff of the hospital is trained to deliver activities that are focused on improvements in 3 areas – save water, save electricity, and overall safety. The hospital SAMRTing project requires staff to be aware of and understand activities to achieve the targets. This water reclamation project is directly aligned with water saving through recycling; electricity saving through the use of solar energy to fuel the water treatment operations; and safety of the workers and patients through reducing the emission of polluted water in the environment of the hospital. The prior experience of the hospital staff is an asset to understanding the value of the project and to make contributions in the implementation.	**5**
5	***Promotes social equity, gender sensitivity***	The project aims to facilitate men and women farmers in a rural community to engage in their livelihood activity throughout the year. The farmers have an opportunity to eliminate the disadvantages that	**4**

		arise from disruptions in their work and earning. While agriculture is predominantly done by men, the women, youth and children in the household can benefit greatly from the returns and financial security of the household. As many as 7 households in the community can be involved and supported by the project. Women are directly involved in farming on 3 plots in the immediate vicinity of the project site. The treated water can also be a valuable resource for the rural TAMCC campus scholastic activities of students attending the nearby TAMCC rural agriculture program. Overall, the project will contribute a resource to improve the conditions of men and women in rural communities to be more comparable to those in other communities.	
6	***Sustainable livelihood***	As in many other communities in Grenada, the farmers frequently experienced water shortages during dry season. Water shortages affect production and livelihood of the residents. The project will contribute to sustaining year-round production for the men and women farmers.	**5**
7	***Promotes environmentally sustainable development***	The project contributes to climate change resilience through adaptation in the agriculture sector. Wastewater, that will otherwise be disposed into the environment, will be collected and recycled to boost agricultural production for food and trade. The project has low energy and maintenance demands. The direct emission of wastewater from the Princess Alice Hospital into the surrounding agriculture lands will be controlled to enhance environmental protection and food safety.	**5**
8	***Community-driven***	The Princess Alice Hospital administrators and farmers made suggestions early in the project that were also incorporated in planning. To show support for the project at the time of the initial site assessment, the Hospital Services Administrator (former) stated, "We want a project like this at the hospital, having a sustainable garden is important to us; it will reduce our bills." NAWASA is the authority for water collection, treatment and public distribution in Grenada. The community is not permitted to participate in the technical and operational activities of the project.	**4**
9	***Dovetails into National Sustainable Development Plan (2020-2035) priorities***	Grenada's National Sustainable Development Plan (NSDP) 2020-2035 includes plans for the development of the productive sectors and supporting infrastructure. The Plan also highlights the need to utilize local resources for national development. The project will contribute to improve the efficiency in the use of water to increase the supply for agriculture production. The project also dovetails into the climate change mitigation strategy through the use of solar power to reduce green hour gas emissions and also reduce. Pollution reduction is also aligned to the NSDP environmental sustainability focus.	**5**
10	***Dovetails into the National Climate Change Policy (2017-2021)***	This project directly addresses climate change. The national policy encourages adaptation and mitigation strategies. Water recycling is an adaptation strategy while harvesting solar energy is a mitigation strategy, eliminating the use of fossil fuel and carbon generation.	**5**
11	***Dovetails into the Caribbean Action Plan on Health and Climate Change (2019-2030)***	The project will involve collaboration with development partners to address climate change and health. Strategic Action #3 will be specifically addressed. This Action is focused on *preparedness for climate risks, building climate-resilient health systems and health-promoting mitigation policies.* The alignment of the project is summarized in #4, 9, 10 above.	**5**

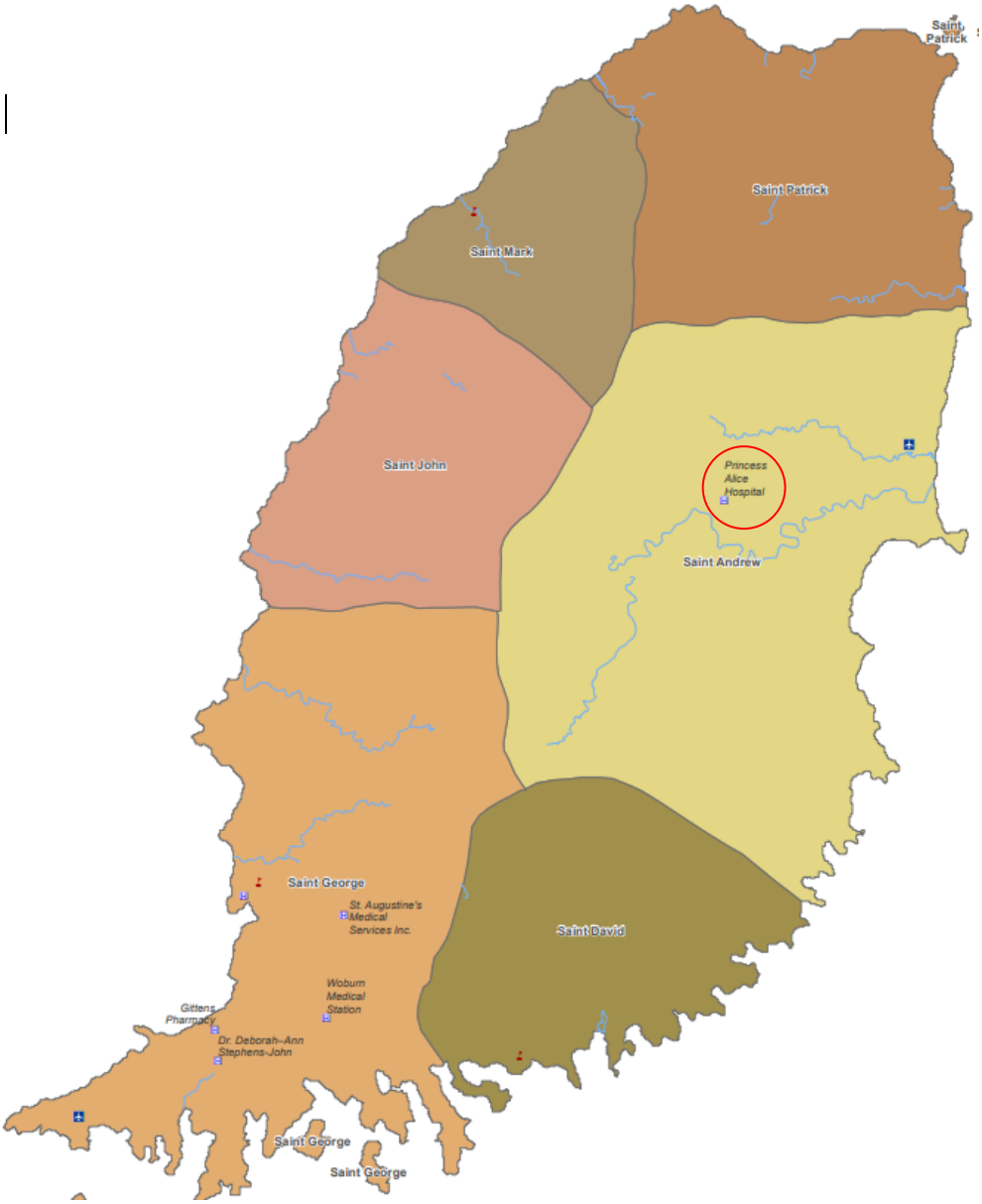
12	***Adequate community capacity***	Approximately 15 farmers cultivate lands on lower elevation to the project site. NAWASA will install multiple connection points to facilitate connection by several downstream farms and facilities and, therefore, access will require minimal inputs by farmers to reach their plots. The downward incline of the area and existing irrigation systems on some farm lands will also facilitate transmission to farmlands and facilities.	**4**
13	***Site ownership and accessibility***	The hospital property (including surrounding lands) in owned by the Government of Grenada. The Ministry of Health is supportive of the project and is the Government's entity through which arrangements will be made for the allocation of lands for the project. The project will not disrupt the activities of the farmers, residents, hospital, or other operations in the community.	**5**
14	***Reuse potential***	The wastewater will be treated to be usable for agriculture production. Farming is common in the Mirabeau community, allowing many of the community residents to benefit from the project.	**5**
15	***Sufficient volume of wastewater***	The hospital water consumption is approximately 2009 imperial gallons/day. The volume of wastewater generated is sufficient for efficient implementation of the project .	**5**
16	***Current wastewater impactful on health, soil, water, environment***	Blackwater and greywater currently flow onto farm lands in the vicinity of the hospital. The effluent pollutes the soil, water and air. Human, animal and plant health can be negatively affected from exposure to polluted environments.	**5**
17	***Technical feasibility***	A suitable area is available for the placement and operation of the equipment. The land elevation will allow for gravity flow to the farms and other beneficiary facilities. The hospital wastewater outlets are in the immediate vicinity of the facility and can be readily accessed for connection.	**5**
Total			**79**

In summary, the Princess Alice Hospital site was selected based on the following evaluation by the assessor and included in the assessment report:

> *The Princess Alice Hospital at Mirabeau scored excellent in most criteria. It is in a rural part of the parish, St. Andrew, which is 26.8% of Grenada's population. The hospital is surrounded by productive farmlands owned by the hospital with portions leased to local farmers for cultivation. The Hospital relies on the produce for consumption and offsetting its operation budget. Both men and women farm the available lands as a source of income. The facility consumes large quantities of water; most of it is used in the sluice. The grey water flows into open concrete drains travelling through agricultural plots. This wastewater contains detergents, some bio-hazardous waste and pharmaceuticals. Its sewerage system is currently malfunctioning; black water is leaking into nearby agricultural lands creating a possible source of mosquitoes and pathogenic microorganisms. The negative impacts on soil health and human health is present at this site. There is suitable space to place the equipment and redirecting grey*

water sources into the system is possible. This site is recommended because of the positive outcomes to the health and economy of the community. Equity among groups such a women and young people can be achieved by empowering them with the means for sustainable livelihoods.

Figure 1. Project Site in Grenada



From the 2011 Census, the Central Statistics Office in Grenada reports Mirabeau population at 543 (289 males, 254 females).

Among the resident who reported on occupation, the number reported employment in agriculture, forestry and fisheries (23 males, 10 females).

The majority of residents reported income at 2000-3999 (10 males, 15 females) and 1200-1999 (22 males, 11 females).

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Figure 1: Farming lands adjacent to the hospital
Figure 2: Wastewater drains and settles close to the hospital
Figure 3: Permanent Secretary, farmers and WINDREF staff view hospital wastewater drain
Figure 4: Hospital wastewater drains onto a nearby cultivated farm
Figure 5: Princess Alice Hospital identified as a SMART Hospital
Figure 6: Cross section of hospital administrators, farmers, business representatives, and GCRF team members participating in a meeting to discuss the project on
Figure 7: Chief Environmental Health Officer and colleague view hospital wastewater drain
Figure 8: WINDREF and Ministry of Health officials at a project consultation meeting in 2020

Components and Activities

The project activities will be delivered in four components:

Component 1: Site Selection and Baseline Study

The first component includes two activities: (1) assessment and selection of the project site and (2) baseline data collection. A criterion was developed as the reference against which suggested sites were evaluated. The areas of assessment cover potential contributions to national development, empowerment and participation; economic development, social/ gender equity, environmental protection, climate change mitigation/adaptation, availability of resources, and technical feasibility (see Table 1). Relevant institutions and individuals were consulted to suggest possible sites for this project. The institutions were NAWASA, Ministry of Implementation and Infrastructure Development, Ministry of Agriculture, WINDREF, Ministry of Climate Change Resilience, Ministry of Social Development, and GIZ. Nine possible sites were suggested. Onsite assessment was done at four locations. Desk reviews and key informants provided information for assessing the remaining five locations which were found to not be suitable for the project. An example is the Point Saline sewer outfall. Although liquid waste can be extracted from the sewer, the technical requirements would have been extensive, costly and complicated to undertake in a pilot project. The site assessments were conducted by an SGU Master of Public Health (MPH) student. The Princess Alice Hospital, located in Mirabeau, St. Andrew, on the eastern side of the island, was selected with the highest scores against the criteria. The assessment was done in September, 2020. The equipment will be installed on lands owned by the Government of Grenada, adjacent to the Princess Alice Hospital. The operations will not lead to the disruption of intrusion on any current activities of the hospital, farmers or other activities in the area.

The second part of Component 1 is the collection of baseline data on the current environmental situation relating to each indicator in Table 2. A consultancy will be awarded for the collection and reporting of the data. The baseline data will be used as the reference point in the process and summative evaluations to determine how well the project is on track to achieving the expected outcomes and performance against the other success indicators. The TOR for consultancy will be developed by the oversight committee. WINDREF will have primary responsibility for managing the selection of the consultant and supervising the consultancy.

Component 2: Education and Awareness Campaign

Given that there are few previous examples of the utilization of wastewater throughout the Caribbean, the cultural acceptance of utilizing this resource will be an important component at the start of this initiative. The education and awareness campaign will be used to bolster support for and participation in the project. A campaign will be launched to (1) build community knowledge of the value of healthy soils, clean water, and the impact on health, animal, and plant health; (2) show the linkages between the project and national priorities; (3)

demonstrate climate change adaptation through the project activities; and (4) discuss safety measures of the project. Other topics may be included based on the interest and needs of the beneficiary population and other interest groups. The modes of delivery will include virtual, media (radio and television), and face to face. The deliveries will include presentations, panel discussions, testimonials, and round table meetings. The oversight committee or WINDREF will decide which approaches are most appropriate to deliver information to an audience and the mobilization strategy. Influential local community persons will also be consulted, as necessary, to make contributions towards identifying suitable methodologies. As much as possible, activities will target the entire population to build national awareness about the potential for wastewater reclamation and recycling. At least one activity will be delivered each quarter. Access to the project site for demonstration must be done with the approval of NAWASA and under its supervision.

Component 3*: *Procurement and Installation of CAFÉ System

The third component of the project will involve the procuring, shipping, and installing the equipment and materials. The description and specifications of the equipment are shown in Appendix 6. Based on current estimates, approximately 2000 gallons (imperial) per day is expected to be processed at the site (equates to ca 10,000L/day, flow rate 420L/hr). The equipment will be assembled and shipped from CWW in Scotland to Grenada for installation on the property of Princess Alice Hospital. NAWASA, in collaboration with the Ministry of Health, will be responsible for preparation of the project site to place the equipment. Technical personnel from CWW and Dryden will travel to Grenada to conduct a site assessment that will inform the final assembling of the equipment. A technical team will also travel to Grenada to install the equipment. A technician will make a final trip to review and assess the performance of the equipment following its initial usage to make any necessary adjustment. WINDREF will be responsible for making arrangements and payments for equipment and materials, shipping and installation. Procurement guidelines of the Caribbean Development Bank will be applied. Clean Water Wave will coordinate with NAWASA for the installation of the equipment and to train NAWASA personnel to operate and maintain the system. The system will be solar powered with the necessary equipment included with the equipment. Community residents will not be trained or employed in the management of the system.

The farmers and community residents are expected to utilize the treated water primarily for agricultural purposes. Vegetables, peas, beans, and water melon are cultivated on the farms in the area. Beneficiaries will be required to apply for connection which will be approved by NAWASA. Connections will be approved based on supply capacity and NAWASA will maintain a distribution schedule. Users will be responsible for installing lines from their private properties to the central connection point. NAWASA will install multiple connection points to facilitate connection by several downstream farms and facilities.

NAWASA will have full responsibility for ensuring the water is of a usable state, distribution to beneficiaries, and developing and maintaining a quality monitoring scheduling. Equipment for 24-7 water quality monitoring will be installed at the outlet. This system will be controlled by

NAWASA. Quality information will be provided to beneficiaries based on request. NAWASA will also provide information promptly if the state of the water is unfit for use and precautionary measures. During the rainy season, depending on supply capacity, the treated water can also be distributed to users for other non-potable activities. Although minimal maintenance is expected, NAWASA will perform any required services, with support from Clean Water Wave. Maintenance work and materials will be paid for by the project during the 3 years.

Component 4: ***Maintenance, Monitoring and Evaluation***

WINDREF and NAWASA will have primary responsibilities for oversight of the project. A management committee will be formed to provide guidance and review the project processes. Process evaluation will be conducted bi-annually to allow for review of the project performance of remedy as necessary. A summative evaluation will be done at the end of the third year. A consultancy will be awarded through WINDREF to conduct an independent assessment of the process and summative evaluations. The evaluations will measure performance against stated outcomes and other success targets. The reports will be submitted to the oversight committee, through WINDREF, for review and to make recommendations. Copies of all evaluation reports will be made available to NAWASA, Ministry of Health, and the Caribbean Development Bank. The TOR for the consultancy will be developed by the oversight committee. WINDREF will have primary responsibility for managing the selection of the consultant and supervising the consultancy. The project will be terminated and handed over to NAWASA for its full management after Year 3.

Development and Management

The Grenada project team was constituted by WINDREF in June, 2020 at the start of the GCRF-One Health project. The team includes knowledgeable and experienced representatives of local institutions and the community, which is expedient for this project, given its complexity and relative newness in Grenada and in the Caribbean region. The country team conceptualized and designed the project in consultation with the core and supporting organizations, equipment manufacturing company, Caribbean Development Bank, and water quality and management experts. The Ministry of Health and NAWASA also supported the development of the project. There is strong collaboration between the local team and the international team (Scotland, Kenya and Jamaica) which provides various forms of administrative and technical support. Meetings are held bi-weekly for the network members across the four countries. The following persons constitute the Grenada core project team, which generally meets on a quarterly basis, with regular email contact between meetings:

- Dr. Calum Macpherson – *Windward Islands Research and Education Foundation (WINDREF)*
- Dr. Lindonne Glasgow – *WINDREF & Department of Public Health and Preventive Medicine, St. George's University*

- Dr. Satesh Bidaisee –*WINDREF & Department of Public Health and Preventive Medicine, St. George's University*
- Mr. Allan Neptune - *National Water and Sewage Authority (Grenada)*
- Dr. Adrian Cashman - *AKWATIX: Water Resources Management, Barbados*
- Mr. Terrance Smith - *TP Engineering, Grenada*
- Ms. Kizzy Ann Abraham - *Basic Needs Trust Fund/CDB/GOG, Grenada*
- Ms. Simone Lewis - *Global Water Partnership-Caribbean*
- Mrs. Elaine Henry McQueen - *Ministry of Social Development, Gender Division*
- Dr. Guido Marcelle - *Botanist/chemist (private consultant and community representative)*

WINDREF is the lead organization through which the project is coordinated. WINDREF is a registered NGO in the state of Grenada. The project has broad-based support from local institutions as well as regional and international partners. Three local other organizations will collaborate with WINDREF to lead this pilot project: the National Water and Sewage Authority (NAWASA), Ministry of Health, and the Caribbean Development Bank. The other organizations that support the development Representatives of the project are: Ministry of Social Development, Basic Needs Trust Fund (Grenada), TP Engineering (Grenada), Global Water Partnership-Caribbean, Akwatix Water Resources Management (Barbados), Ministry of Implementation and Infrastructure Development, Ministry of Climate Change Resilience, Department of Public Health and Preventive Medicine, St. George's University (SGU), Grenada Chamber of Industry and Commerce, Clean Water Wave, GCRF network members. This partnership is strategic to guide the project and will be valuable for success. A steady working relationship has been established between the organizations. Residents, farmers, and students in the Mirabeau Community will be primary beneficiaries of the water resource. The health workers and patients at Princess Alice Hospital will also beneficiate from the cleaner immediate environment.

The installation of the equipment is expected to be completed within 6 months of the start of the project. The life span of the project is 3 years. The containerized equipment is protected from weather elements and is shown to be durable and requiring minimal maintenance. The operations can last for several years. As the project rolls out, the operations will be reviewed by a management committee that will also make recommendations to improve the project delivery. Evaluations will be conducted each year to measure the project performance.

NAWASA and WINDREF (project team) will have joint responsibility for the management and oversight of the project. All administrative and financial activities will be managed by WINDREF, guided by its policies, where appropriate. Procurement guidelines of the Caribbean Development Bank will also apply. WINDRREF will manage the procurement of all goods and services for the project. A program coordinator and secretary/financial manager roles can be filled through allocated level of effort by existing WINDREF/SGU personnel. A stipend will be provided for administrative services.

NAWASA will be responsible for all technical and water quality monitoring services, with support from Clean Water Wave, as necessary. Maintenance work and materials will be funded through this project over the three years. Clean Water Wave will coordinate with NAWASA to install the system and train NAWASA personnel to operate and maintain the equipment. Community residents will not be trained or employed in the management of the water treatment and distribution system. NAWASA will determine whether a minimal fee can be charged for the treated water.

A management committee will be constituted to provide oversight for the project. This committee will comprise the existing country project team plus one representative of each of the core collaborating agencies - National Water and Sewage Authority (NAWASA), Ministry of Health, Caribbean Development Bank – and one farmer representative, totaling 13 members. The committee will be chaired by WINDREF Director or a designate. A secretary or a designate will be appointed for documenting, disseminating, and filing Minutes. A stipend of USD $50 will be provided for attendance at each management committee meeting. The meeting would be held quarterly with a maximum of six meetings per year.

The process evaluation reports will be submitted to the management team, through WINDREF, for review and to make recommendations for the effective delivery of the project. The summative evaluation report will be final with a determination of the outcomes of the project. Copies of all evaluation reports will be available to NAWASA, Ministry of Health, and the Caribbean Development Bank. The project will be terminated and handed over to NAWASA for its full management after Year 3.

Success Indicators

Table 2 shows the success indicators and narrative. The project will be evaluated to determine how well the project is achieving the success targets. These targets are intermediary to achieving the overall outcomes.

Table 2: Success Indicators

	Indicator	Summary Narrative
	National Development	
1	Dovetails into National Sustainable Development Plan (2020-2035) priorities	Project supports national development priorities
2	Dovetails into the National Climate Change Policy (2017-2021)	Project is aligned with local climate change adaptation/mitigation strategies
3	Dovetails into the Caribbean Action Plan on Health and Climate Change (2019-2030)	Project is aligned with Caribbean climate change adaptation/mitigation strategies
	Community Development and Participation	

4	Focus on rural and poor communities	Project implemented in a rural/ poor community, identified in the Census/CPA/Survey of Living Conditions/Poverty Index
5	Potential to empower communities	Project outputs and outcomes contribute to improve the social and economic conditions of the beneficiary groups in the community
6	Experience with project implementation/management (financial and operations)	Project incorporates community participation and draws on the community experiences, capacity, leadership, resources to support the project
7	Community-driven	There is drive and commitment for the project by individuals/groups in the community
	Economic Development	
8	Sustainable livelihood	Potential for project to support sustainable livelihood of poor/vulnerable community/groups
9	Promotes environmental sustainable development	High probability that outputs and outcomes will result in improvements to soil, water and health in specific communities/groups
	Social and Gender Equity	
10	Promotes social equity	Project outputs and outcomes contribute to equitable development of the community groups (women, men, youth), i.e. ensuring people that are in a less advantageous position receive more benefits than other groups.
	Environmental Protection	
11	Reduce wastewater impact health, soil, water, environment	Project contributes to reduction of soil and water pollution and protects human health
	Climate Change Mitigation/Adaptation	
12	Climate change adaptation/mitigation	Project requires low energy demand, has low emissions, increases resilience of built environment
	Technical Feasibility	
13	Site ownership and accessibility	Site ownership determined and accessible during implementation period
14	Reuse potential	Wastewater reuse by community
15	Sufficient volume of wastewater	Sufficient volume of wastewater produced at site for farm operations
16	Practicality	Equipment placed at higher elevation to user community

Timelines

		Year 1				Y2				Y 3			
		Q1	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**
Component 1													
Site assessments and selection													
Formation of Oversight Committee													
Baseline study and reporting													
Component 2													
Education and awareness (presentations, panel													

discussions, testimonials, and round table meetings)													
Component 3													
Procurement													
Installation													
Training (NAWASA personnel)													
Application and approval (preparation of distribution schedule)													
Distribution													
Water quality monitoring													
Component 4													
Process evaluation													
Summative evaluation													
Termination and hand over to NAWASA													

Note:
Project year commences at the receipt of funding from the Caribbean Development Bank

Expected Benefits

Water scarcity is one impact of climate change that is experienced in many countries across the globe. Many Caribbean countries are being forced to seek alternative water sources. The agriculture sector is one of the hardest hit by the impact of climate change. In the United Nations University (2019) global study, four specific benefits were found regarding the use of wastewater in the agriculture sector: (1) the source can be available throughout the year (2) the need to use chemicals to fertilize soil was reduced (3) lower energy cost for production and (4) enables year round production of high value vegetables for sale (2). The agriculture sector in Grenada is expected to benefit in similar ways from the implementation of the project. The project is a climate change adaptation measure with the purpose of increasing the availability of water for crop production, especially during the dry season. Livelihoods can be sustained year round, with income for men and women in rural households. The project can also contribute to reducing expensive agricultural imports, whilst enhancing food security and potentially providing better nutrition and thereby a direct health impact. The partnership between the Ministry of Health and the farmers for the supply of produce to the hospital in exchange for farmers' leasing of the lands is valuable to reduce the food bill for patients at the

hospital. Increased production will allow farmers to both supply larger quantities of produce to the hospital and to markets. Another potential benefit is building partnerships with food-based development programs such as the FAO's Zero Hunger Initiative. The community economy can be impacted significantly with the high production during the dry season which typically last for six months each year.

Currently, the untreated wastewater is discharged into the environment, polluting soils, air, and ground water. This practice can be hazardous to humans, plants, and animals. The nearby river basin is also a community resource to be protected from leached polluted wastewater. The Great River is well patronized as a primary water source for recreational activities, washing, bathing and fishing. Water from the Princess Alice Hospital will be collected, treated and distributed to farmers in the Mirabeau community. This project reduces the potential for public health problems from exposure to polluted soils, water, air, and contaminated foods. Environmental health problems can be costly to treat and exert high burden on individuals and household members and the health care system.

Social equity can be realized as the project aims to support year-round employment of the men and women farmers in the community. The rural farmers will have an opportunity to work and earn income consistently as other farmers that have resources to install irrigation and other technologies to support year-round production. TAMCC agricultural campus is also located in the area and farm school training activities can be supported through accessing water for demonstration and production activities. The agricultural propagating station is also located in the area. Seedlings require a consistent supply of water and the facility can benefit from the year round source of water which may be supplied at a lower cost than potable water.

Water recycling is a mitigation strategy to sustain and augment useable water supplies. Harvesting solar energy to power the system is a mitigation strategy, eliminating the use of fossil fuel and the emission of carbon and other green house gases. The project also supports the regional and national health sector mitigation program. The hospital is designated as a SMART facility with focus on finding solutions to save water and electricity and enhancing workers and patients' safety. This project supports the saving water through recycling; saving electricity through the use of solar energy in the CAFÉ water treatment system; and promoting workers safety through reducing potential exposure to contaminated soils and air. Improving the efficiency of the hospital operations, including waste disposal, has benefits for overall national development, productivity and is cost-cutting. The savings can be redirected to other areas of development.

Sustainability and Scale Up

The project involves the introduction of new technologies for the water sector in Grenada. This implementation is a pilot to determine how effective the AFM technology is to improve water treatment in Grenada, the practicality and feasibility of undertaking wastewater

management on a large scale in Grenada and the environmental and socio-economical impacts of the project. In the three years of the project, WINDREF will have responsibility for management and oversight of the project with technical support from NAWASA, Dryden and CWW. After 3 years, the project will be handed over to NAWASA for ongoing management and monitoring. If the AFM technology is found to be effective in wastewater treatment, it can be replicated at several sites. If the outcomes are achieved, the private sector may become highly interested in facilitating scale up in Grenada and across the Caribbean region. The AFM can replace sand filtration and there is scope for NAWASA to partner with the business sector to pilot this application and subsequently replicate the technology and produce materials for new establishments. The AFM technology was proven to be an effective filter media in test in other countries. NAWASA operates 30 treatment plants across the island which are potential sites for scale up. As a relatively new technology the region, the innovation can be shared across the Caribbean to also benefit other countries.

Budget

The budget is attached in Appendix 7. The total budget is USD$360945.37

Project Duration

The lifetime of the project is 3 years from the date of receipt of finances from the donor agency.

Risks Management

- Lands ownership not determined or land not available - The Land Registry holds information on land ownership and can be consulted. This will allow the project to enter into negotiations if land is in private hands. Other options include utilizing land that the government either owns or leases that is proximate to the proposed site, it is then a question of obtaining the requisite permissions and formalizing agreements between the government department and NAWASA. In extremis Government has powers that would allow access but negotiation is the default option.
- Landscape not suitable for project operations - Suitability may be affected by a variety of factors such as proximity to other facilities, topography etc. The solution will depend on the nature of the suitability and there will in most cases be reasonable solutions though these may increase costs. In the vicinity of the location there are other suitable sites.
- Lack of community support and participation - The community has already benefited from a number of development projects particularly targeting support for agricultural

development. They have therefore been sensitized and their positive experiences can be harnessed to engender support. Community engagement and participation is a key feature of the work and NAWASA has a good track record of community outreach and engagement as well.

- Equipment not suitable for Grenada/community landscape - The equipment has been utilized in other more challenging environments and on treating water qualities that are much poorer than those from the hospital so this falls within the design specification. The plant has been designed with these sorts of operational conditions in mind and has been tried and tested in a variety of other conditions. As such questions of equipment suitability should not arise.
- Project management/oversight not functional - NAWASA and members of the project team are experienced project managers who have worked on similar projects. The project is able to harness this expertise.

References

1. Wastewater Treatment Status by Countries and Economies – UNU-INWEH [Internet]. [cited 2020 Jul 7]. Available from: https://inweh.unu.edu/wastewater-treatment-status-by-countries-and-economies/
2. Toshio Satoa, Manzoor Qadirb, Sadahiro Yamamotoe, Tsuneyoshi Endoe AZ. Global,regional,and country level need for data on wastewater generation, treatment, and use. Agric Water Manag [Internet]. 2013;130:1–13. Available from: https://inweh.unu.edu/wp-content/uploads/2019/03/2013-AGWAT_Sato-et-al_Global-Wastewater-Data.pdf