UNIVERSIDAD PARA LA COOPERACION INTERNACIONAL
(UCI)

PROJECT MANAGEMENT PLAN FOR THE IMPLEMENTATION OF A WASTEWATER TREATMENT SYSTEM FOR THE ISLAND OF CAYE CAULKER, BELIZE.

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FINAL GRADUATION PROJECT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE
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DEDICATION

This work is dedicated to my family for their unconditional love and support throughout this process.

ACKNOWLEDGMENTS

Thanks to all the professors and classmates for your dedication and professionalism over this past year. The knowledge gained from you all is priceless.

ABSTRACT

The objective of this document is to develop a project management plan to implement the installation and commissioning of a wastewater treatment system in Caye Caulker, Belize, considering the socio-economic needs of the island as a top tourist destination. As one of the top tourist destinations in Belize, the implementation of this wastewater infrastructure project for the island of Caye Caulker is expected to enhance the tourism product which Belize heavily depends on for revenue earnings. Another benefit of this project is the safeguarding of the environment and public health, in addition to complying with SDG6: increased access to water and sanitation.

The final product of this FGP consists of the development of a Project Management Plan which will provide the framework for successfully implementing the project. This includes the following knowledge areas: cost, schedule, quality, resources, communication, procurement, risk, and stakeholder engagement. To accomplish this, an analytical methodology is used to develop the project management plan.

As a result of the project, it is identified that it is possible to develop an integrated Project Management Plan to implement the installation and commissioning of a wastewater treatment system in Caye Caulker, Belize, that is also sustainable and regenerative.

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ABBREVIATIONS AND ACRONYMS

AWWA	American Water & Wastewater Association
BWS	Belize Water Services
DD	Detailed Design
FGP	Final Graduation Project
FS	Feasibility Study
GDP	Gross Domestic Product
GOB	Government of Belize
PMBOK	Project Management Book of Knowledge
PMI	Project Management Institute
PUC	Public Utilities Commission
SDG	Sustainable Development Goal
SIB	Statistical Institute of Belize
SIDS	Small Island Developing States
USD	United States Dollar
WASA	Water and Sewerage Authority
WBS	Works Breakdown Structure

EXECUTIVE SUMMARY

Belize Water Services Limited (BWS) is the National Water and Sewerage Utility that owns, manage, and operates thirteen disparate systems across the country. It currently operates and maintains sewerage systems in three municipalities namely Belmopan, Belize City and San Pedro Town. None of the municipalities served by these sewerage systems enjoy 100% coverage (BWS, 2023)

The village of Caye Caulker is located on a small limestone coral island located approximately 20 miles north-northeast of Belize City and is one of BWS' thirteen service areas. In recent years, the island has become a popular tourist destination for both foreign and local visitors. Presently about 1,000 tourists visit the island daily during the peak season including festive holidays such as Easter and Lobster Fest SIB, 2023).

The island of Caye Caulker currently has no centralized wastewater treatment system, with the general population depending on individualized septic systems with leach fields (SIB, 2023). The potential for groundwater contamination is very likely due to the high-water table, soil conditions, and linkages to the Caribbean Sea, which can also pose a great threat to public health (SSN, 2023).

Due to the complex nature of implementing a wastewater treatment system, an adequate Project Management Plan was required to guide the project team in all project management knowledge areas. The main purpose of this FGP, therefore, was to improve the likelihood of success of this project by developing a Project Management Plan which provided the framework for successfully implementing the project.

The general objective of this FGP was to develop a Project Management Plan to implement the installation and commissioning of a wastewater treatment system in Caye Caulker, Belize, considering the socio-economic needs of the island as a top tourist destination. The specific objectives were to develop a project charter and to formally authorize the project and provide the project manager with the authority to utilize resources for project completion; to develop the Scope Management Plan to outline the tasks required for successful installation and commissioning of the wastewater treatment system.; to develop the Schedule Management Plan to define the timeframe for completion of the project, including the identification of project milestones; to develop a Cost Management Plan in order to properly budget the project funds and prevent cost overruns; to develop a Quality Management Plan to define the quality controls required for successful implementation of the project; to develop a Resource Management Plan to define how the project resources will be obtained and deployed as required for all phases of the project; to develop a Communication Management Plan to allow for successful information exchange and dissemination; to develop a Risk Management Plan to assist in the identification and mitigation of potential risks throughout the project lifecycle; to develop a Procurement Management Plan to determine the manner in which goods and services will be purchased and contracted; to develop a Stakeholder Management Plan to define engagement protocols and ensure the involvement of stakeholders in all phases of the project; and to develop a Sustainable Development Plan to align the project objectives with sustainable and regenerative outcomes.

The methodology of this research was the analytical method. This FGP used available data from this wastewater project along with the principles from PMBOK to develop a comprehensive project management plan. These plans included Feasibility Studies and a Detailed Design Report.

Upon completion of the FGP, it was concluded that an integrated Project Management Plan could greatly assist the implementation of a wastewater treatment system for the island of Caye Caulker by utilizing the PMI standards. All PMI knowledge areas were considered, including Scope, Schedule, Cost, Quality, Resource, Communication, Risk, Procurement, Stakeholder, and Sustainable Development Management. The project management plan provides the framework to successfully plan, execute and monitor the proposed works for both the wastewater treatment and collection system for Caye Caulker. To achieve this, it is recommended that the plan be properly executed, in line with PMI best practices to ensure project success.

1 INTRODUCTION

Wastewater management, and the lack thereof, continues to be a growing problem for small developing islands that are highly dependent on tourism (SSN, 2023). Wastewater treatment systems, while considered basic infrastructure in developed countries, is only just becoming a priority for small island communities, with only about 32% of all Small Island Developing States (SIDS) currently connected to a wastewater treatment system (UNEP, 2019).

The government of Belize and Belize Water Services is committed to expanding its water and wastewater services throughout the country, including in areas that have been prioritized due to rapid economic growth and environmental vulnerability. For this reason, this FGP will focus on developing an integrated Project Management Plan to implement an adequate wastewater treatment system for the small island of Caye Caulker, Belize, considering its strong tourism linkages and close proximity to the Mesoamerican Barrier Reef. The Project Management Plan will cover the ten knowledge areas of project management as explained within the Project Management Body of Knowledge (PMI, 2017) and will serve as a guide for successful implementation of this national project.

1.1. Background

Belize Water Services Limited (BWS) is the National Water and Sewerage Utility that owns, manage, and operates thirteen disparate systems across the country. It is a regulated utility – the regulatory controls include a statutory regulator, the Public Utilities Commission (PUC), the Water Industry Act (2001), an operating license issued by the PUC and a periodically updated Codes of Practice which is agreed on by the Regulator and

BWS. Belize Water Services currently operates and maintains sewerage systems in three municipalities namely Belmopan, Belize City and San Pedro Town. None of the municipalities served by these sewerage systems enjoy 100% coverage (BWS, 2023)

The village of Caye Caulker is located on a small limestone coral island located approximately 20 miles north-northeast of Belize City and is one of BWS' thirteen service areas. The island of Caye Caulker measures about 5 miles (north to south) by 1 mile (east to west) and it is divided in two (North and South Caye Caulker) by a natural split. Caye Caulker has a population of approximately 2,000 inhabitants with most residing in the southern portion. In recent years, the island has become a popular tourist destination for both foreign and local visitors. Presently about 1,000 tourists visit the island daily during the peak season including festive holidays such as Easter and Lobster Fest. There are over 50 hotels and several restaurants and shops that provide service to the public in general (SIB, 2023).

1.2. Statement of the problem

The island of Caye Caulker currently has no centralized wastewater treatment system, with the general population depending on individualized septic systems with leach fields (SIB, 2023). The potential for groundwater contamination is very likely due to the high-water table, soil conditions, and linkages to the Caribbean Sea, which can also pose a great threat to public health (SSN, 2023). In addition, its close proximity to the Caribbean Sea adds to the concerns for the reef's ecosystem and marine environs which are very vulnerable to high nutrient loading from untreated wastewater, potentially leading to algal blooms and coral bleaching.

Due to the complex nature of implementing a wastewater treatment system, an adequate Project Management Plan is required to guide the project team in all project management knowledge areas. There is currently no implementation framework available for this purpose and so this will serve as an opportunity to develop a specific plan which can meet the expectations of all stakeholders.

1.3. Purpose

As one of the top tourist destinations in Belize, the implementation of this wastewater infrastructure project for the island of Caye Caulker is expected to enhance the tourism product which Belize heavily depends on for revenue earnings. In 2020, Belize generated over 487,000,000 USD from tourism which equates to 29.76% of the country's GDP (SIB, 2023).

Another benefit of this project is the safeguarding of the environment and public health, in addition to complying with SDG6: increased access to water and sanitation. Other benefits include the protection of the Belize Barrier reef system and the marine environment.

Therefore, the main purpose of this FGP is to improve the likelihood of success of this project by developing a Project Management Plan which will provide the framework for successfully implementing the project, while also considering the socio-economic needs of the island of Caye Caulker as a tourist destination.

1.4. General objective

To develop a Project Management Plan to implement the installation and commissioning of a wastewater treatment system in Caye Caulker, Belize, considering the socio-economic needs of the island as a top tourist destination.

1.5. Specific objectives

1. To develop the project charter to formally authorize the project and provide the project manager with the authority to utilize resources for project completion.
2. To develop the Scope Management Plan to outline the tasks required for successful installation and commissioning of the wastewater treatment system.
3. To develop the Schedule Management Plan to define the timeframe for completion of the project, including the identification of project milestones.
4. To develop a Cost Management Plan in order to properly budget the project funds and prevent cost overruns.
5. To develop a Quality Management Plan to define the quality controls required for successful implementation of the project.
6. To develop a Resource Management Plan to define how the project resources will be obtained and deployed as required for all phases of the project.
7. To develop a Communication Management Plan to allow for successful information exchange and dissemination.
8. To develop a Risk Management Plan to assist in the identification and mitigation of potential risks throughout the project lifecycle.

9. To develop a Procurement Management Plan to determine the manner in which goods and services will be purchased and contracted.
10. To develop a Stakeholder Management Plan to define engagement protocols and ensure the involvement of stakeholders in all phases of the project.
11. To develop a Sustainable Development Plan to align the project objectives with sustainable and regenerative outcomes.

2 THEORETICAL FRAMEWORK

2.1 Company/Enterprise framework

2.1.1 Company/Enterprise background

Belize Water Services Limited (BWS) is the national water and sewerage utility that was vested with the Assets and Liabilities of the Water and Sewerage Authority (WASA) in March 2001. The company has issued share capital of forty million (40,000,000) shares with the Government of Belize (GOB), the majority shareholder, owning approximately 82.6% of the total shares; the Belize Social Security Board holds 10% and minority shareholders the remainder. BWS is a regulated utility – the regulatory controls include a statutory regulator, the Public Utilities Commission (PUC), the Water Industry Act (2001), an operating license issued by the PUC and a Codes of Practice which is agreed by the Regulator and BWS and updated periodically.

BWS operates in licensed service areas, serving all the municipalities of the country as well as some 44 villages. As at March 2019, BWS serves over 60,000 connections or approximately 257,000 consumers, with a total average water demand of approximately 225 million US gallons per month.

BWS operates and maintains sewerage systems in three municipalities namely Belmopan, Belize City and San Pedro Town. None of the municipalities served by these sewerage systems enjoy 100% coverage. The systems came into operation in 1970, 1980 and 1996 respectively.

2.1.2 Mission and vision statements

Mission:

To improve the lives of consumers by delivering cost-effective and sustainable supply of high quality water and wastewater services, in an environmentally and socially responsible manner, promoting employee excellence and providing a fair return to our shareholders (BWS, 2025).

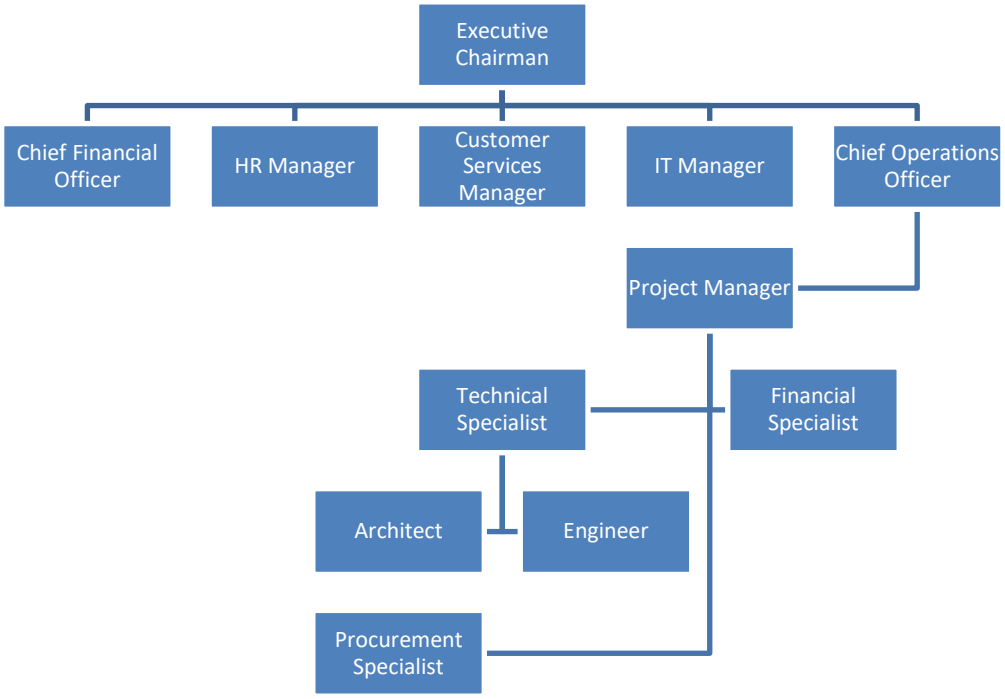
Vision:

The leading utility in the developing world, delivering excellence to stakeholders through highly trained, courteous and empowered staff (BWS, 2025).

2.1.3 Organizational structure

Figure 1.

Organizational structure for Belize Water Services.



Note. Own Work.

2.1.4 Products offered

The following services are provided by Belize Water Services

1. Potable water production
2. Potable water distribution
3. Potable water network expansion
4. Bulk water sale
5. Wastewater collection

6. Wastewater collection system expansion
7. Wastewater treatment

The above services are executed according to American Water & Wastewater Association (AWWA) standards and are regulated by the Public Utilities Commission of Belize (PUC).

2.2 Project Management concepts

2.2.1 Project management principles

According to PMI (2017), a project is a temporary endeavor undertaken to create a unique product, service, or result.

Belize Water Services engages in capital expenditure projects that add asset value and which allow for returns to invest in the expansion of its services as mandated by the utility regulator.

As described in PMI (2021), the principles of project management provide guidance for the behavior of people involved in projects as they influence and shape the performance domains to produce the intended outcomes.

Figure 2.

Principles of Project Management.

Principles of Project Management			
Be a diligent, respectful, and caring steward	Create a collaborative team environment	Effectively engage with stakeholders	Focus on value
Recognize, evaluate, and respond to system interactions	Demonstrate leadership behaviors	Tailor based on context	Build quality into processes and deliverables
Navigate complexity	Optimize risk responses	Embrace adaptability and resiliency	Enable change to achieve the envisioned future state

Note. Reprinted from *A Guide to the Project Management Body of Knowledge (PMBOK® Guide) Seventh Edition*. Project Management Institute (PMI), 2021 Figure 1-1, p. 100

2.2.2 Project management domains

The figure below illustrates the project management domains according to PMI (2021).

Figure 3.

Project Management Domains.

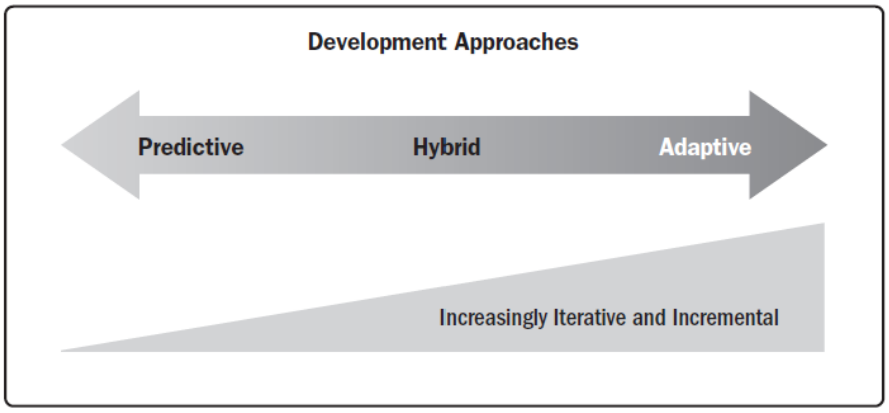
Note. Reprinted from *A Guide to the Project Management Body of Knowledge (PMBOK® Guide) Seventh Edition*. Project Management Institute (PMI), 2021 Figure 1-1, p. 100

2.2.3 Predictive, adaptative and hybrid projects

Depending on the type of project, different approaches can be undertaken to develop the product or service being created. These can be either predictive, adaptive or hybrid.

Figure 4.

Development approaches.



Note. Reprinted from *A Guide to the Project Management Body of Knowledge (PMBOK® Guide) Seventh Edition*. Project Management Institute (PMI), 2021 Figure 2-7, p. 130

Predictive approaches, also known as waterfall approaches, are the traditional means of project development whereby the project team is able to properly plan the project and minimize risks since the product or service can be easily defined from the beginning of the project (PMI, 2021).

In an adaptive approach, the project's product or service is difficult to define and so will require various iterations to refine and adjusted based on stakeholder feedback (PMI, 2021).

A hybrid approach, on the other hand, is a combination of predictive and adaptive approaches, whereby elements from each are used throughout the project lifecycle (PMI, 2021).

2.2.4 Project management

As described by PMI (2017), project management is the application of knowledge, skills, tools, and techniques to project requirements. Project management is accomplished through the appropriate application and integration of the project management processes identified for the project (PMI, 2017).

2.2.5 Project management knowledge areas and processes

As described by PMI (2017), knowledge areas are fields or areas of specialization that are commonly employed when managing projects. A knowledge area is a set of processes associated with a particular topic in project management (PMI, 2017).

Project Integration Management

Includes the processes and activities to identify, define, combine, unify and coordinate the various processes and project management activities within the project management process groups (PMI, 2017).

Project Scope Management

Includes the processes required to ensure that the project includes all the work required, and only the work required, to complete the project successfully (PMI, 2017).

Project Schedule Management

Includes the processes required to manage the timely completion of the project (PMI, 2017).

Project Cost Management

Includes the processes involved in planning, estimating, budgeting, financing, funding, managing, and controlling costs so the project can be completed within the approved budget (PMI, 2017).

Project Quality Management

Includes the processes for incorporating the organization's quality policy regarding planning, managing and controlling project and product quality requirements in order to meet stakeholders' expectations (PMI, 2017).

Project Resource Management

Includes the processes to identify, acquire and manage the resources needed for the successful completion of the project (PMI, 2017).

Project Communications Management

Includes the processes required to ensure timely and appropriate planning, collection, creation, distribution, storage, retrieval, management, control, monitoring and ultimate disposition of project information (PMI, 2017).

Project Risk Management

Includes the processes of conducting risk management planning, identification, analysis, response planning, response implementation, and monitoring risk on a project (PMI, 2017).

Project Procurement Management

Includes the processes necessary to purchase or acquire products, services or results needed from outside the project team (PMI, 2017).

Project Stakeholder Management

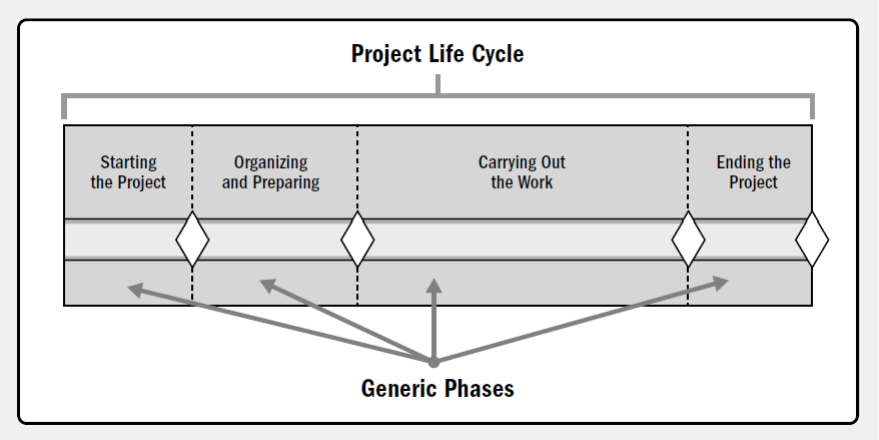
Includes the processes required to identify the people, groups or organizations that could impact or be impacted by the project, to analyze stakeholder expectations and their impact on the project, and to develop appropriate management strategies for effectively engaging stakeholders in project decisions and execution (PMI, 2017).

2.2.6 Project life cycle

According to PMI (2017), a project lifecycle is the series of phases that a project passes through from its start to its completion.

Figure 5.

Generic depiction of a project life cycle.



Note. Reprinted from *A Guide to the Project Management Body of Knowledge (PMBOK® Guide) Sixth Edition*. Project Management Institute (PMI), 2017 Figure 1-2, p. 585

2.2.7 Company portfolios and projects

Belize Water Services is currently engaged in the following portfolios and projects:

1. Building and Civil Works
    a. Generator buildings
    b. Concrete reservoirs
    c. Water treatment plants
    d. Office buildings
2. Mechanical & Electrical Works
    a. Genset installations
    b. Pump & motor upgrades
3. Waterworks
    a. Network expansions
    b. Network upgrades
    c. Smart meter installations
4. Wastewater Works
    a. Network expansions
    b. Network upgrades
5. Project Preparation
    a. Detailed designs of Caye Caulker Wastewater Treatment System
    b. Feasibility study of biogas potential from sewage lagoons

2.3 Other applicable theory/concepts related to the project topic and context

2.3.1 Current situation of the problem or opportunity in study

Caye Caulker is a small limestone coral island located in the country of Belize, approximately 20 miles north-northeast of Belize City. The island of Caye Caulker is divided in two (North and South Caye Caulker) by a split. The island measures about 5 miles (north to south) by less than 1 mile (east to west). The population of Caye Caulker is approximately 2,000 inhabitants with most residing in the southern portion. In recent years, the island has become a popular tourist destination for both foreign visitors and locals. Presently about 1,000 tourists visit the island daily during the peak season including festive holidays such as Easter and Lobster Fest. There are over 50 hotels and a number of restaurants and shops that provide service to the public in general.

In the case of Caye Caulker, the Government of Belize (GOB) and BWS successfully completed a joint project to provide residents of Caye Caulker access to potable and reliable water in 2010. Completion of this project has prompted increase in tourists' arrivals and rapid urban development. It is therefore very important to implement an adequate wastewater system to protect public health and the Belize Barrier reef ecosystem.

This project will also work towards achieving the United Nations' Sustainable Development Goal (SDG) No. 6: Clean Water & Sanitation and will address environmental and health concerns arising from poor wastewater management on the island.

2.3.2 Previous research done for the topic in study

The following research and studies have been done prior to implementing this project:

1. Feasibility Study for implementing a wastewater treatment system for Caye Caulker Belize. This included a wastewater characterization to determine a baseline for wastewater treatment, as well as a wastewater demand analysis to determine volumes and treatment capacities for Caye Caulker. An analysis of alternatives was also done which determined the most adequate wastewater treatment and collection system type based on the physical characteristics of the island as well as the financial feasibility of the different options presented.
2. Detailed Designs of a wastewater treatment system for Caye Caulker Belize. This included all engineering calculations and drawings required for the construction of a fully functioning wastewater treatment plant for Caye Caulker. All engineering designs were based on American codes and specifications, including consideration for Belize's effluent regulations for wastewater discharge.
3. The recommended treatment process was the Membrane Bioreactor (MBR) Technology. This technology utilizes MicroFiltration or UltraFiltration membranes to separate liquids from solids, followed by biodegradation of pollutants through the activated sludge process (Hansen, 2025). The latter is a biological process that depends on the flow of oxygen (air) to feed naturally occurring bacteria in wastewater to enhance the biodegradation process. The resulting effluent is of high quality, which, in the case of Caye Caulker, is desired to minimize the environmental impact on the surrounding marine environment.

3 METHODOLOGICAL FRAMEWORK

3.1 Information sources

There are various sources of information available when doing academic research. These sources of information may include websites, academic journals, textbooks, etc., and can be further categorized as primary and secondary sources (Ryan, 2023).

3.1.1 Primary sources

According to Bal (2023), primary sources are firsthand accounts of information. These are original materials that come directly from an individual who witnessed an event (Bal, 2023).

In this FGP, the primary sources to be used mostly consist of one-on-one interviews with personnel directly related to the wastewater project. It will also include reports that were created before project implementation, including any feasibility studies and design reports prepared prior.

3.1.2 Secondary sources

Secondary sources are those that summarize, analyze or interpret primary sources and are typically written after the period identified in the primary source (Bal, 2023).

In this FGP, the secondary sources will include the PMBOK 6th and 7th edition, in addition to other articles and journals related to the project.

Chart 1.

Information sources.

Objectives	**Information sources**	
	Primary	**Secondary**
To develop the project charter to formally authorize the project and provide the project manager with the authority to utilize resources for project completion.	Meetings with personnel directly related to the project; project reports (Feasibility Study and Design Report)	PMBOK 6th and 7th Edition; Online references; Articles/Journals
To develop the Scope Management Plan to outline the tasks required for successful installation and commissioning of the wastewater treatment system.	Meetings with personnel directly related to the project; project reports (Feasibility Study and Design Report)	PMBOK 6th and 7th Edition; Online references; Articles/Journals
To develop the Schedule Management Plan to define the timeframe for completion of the project, including the identification of project	Meetings with personnel directly related to the project; project reports (Feasibility Study and Design Report)	PMBOK 6th and 7th Edition; Online references; Articles/Journals

Objectives	Information sources	
	Primary	**Secondary**
milestones.		
To develop a Cost Management Plan in order to properly budget the project funds and prevent cost overruns.	Meetings with personnel directly related to the project; project reports (Feasibility Study and Design Report)	PMBOK 6th and 7th Edition; Online references; Articles/Journals
To develop a Quality Management Plan to define the quality controls required for successful implementation of the project.	Meetings with personnel directly related to the project; project reports (Feasibility Study and Design Report)	PMBOK 6th and 7th Edition; Online references; Articles/Journals
To develop a Resource Management Plan to define how the project resources will be obtained and deployed as required for all phases of the project.	Meetings with personnel directly related to the project; project reports (Feasibility Study and Design Report)	PMBOK 6th and 7th Edition; Online references; Articles/Journals
To develop a Communication Management Plan to allow for	Meetings with personnel directly related to the	PMBOK 6th and 7th Edition; Online references;

Objectives	**Information sources**	
	Primary	**Secondary**
successful information exchange and dissemination.	project; project reports (Feasibility Study and Design Report)	Articles/Journals
To develop a Risk Management Plan to assist in the identification and mitigation of potential risks throughout the project lifecycle.	Meetings with personnel directly related to the project; project reports (Feasibility Study and Design Report)	PMBOK 6th and 7th Edition; Online references; Articles/Journals
To develop a Procurement Management Plan to determine the manner in which goods and services will be purchased and contracted.	Meetings with personnel directly related to the project; project reports (Feasibility Study and Design Report)	PMBOK 6th and 7th Edition; Online references; Articles/Journals
To develop a Stakeholder Management Plan to define engagement protocols and ensure the involvement of stakeholders in all phases of the project.	Meetings with personnel directly related to the project; project reports (Feasibility Study and Design Report)	PMBOK 6th and 7th Edition; Online references; Articles/Journals

Objectives	Information sources	
	Primary	**Secondary**
To develop a Sustainable Development Plan to align the project objectives with sustainable and regenerative outcomes.	Meetings with personnel directly related to the project; project reports (Feasibility Study and Design Report)	PMBOK 6th and 7th Edition; Online references; Articles/Journals

Note. Own work.

3.2 Research methods

According to Hassan (2023), research methods refer to the techniques, procedures, and processes used by researchers to collect, analyze, and interpret data in order to answer research questions or test hypotheses. The methods used in research can vary depending on the research questions, the type of data that is being collected, and the research design (Hassan, 2023)

In the case of this FGP, the research method to be used is the analytical method.

3.2.1 Analytical method

Satter (2023) describes analytical research as "using critical thinking abilities and assessing data and information pertinent to the project at hand". This FGP will use the available data from this wastewater project along with the principles from PMBOK to develop a comprehensive project management plan. The following chart summarizes the research method for each specific objective.

Chart 2.

Research methods.

Objectives	**Research methods**
	Analytical Method
To develop the project charter to formally authorize the project and provide the project manager with the authority to utilize resources for project completion.	The analytical method will be used to develop the project charter based on one-on-one interviews and available studies and design reports.
To develop the Scope Management Plan to outline the tasks required for successful installation and commissioning of the wastewater treatment system.	The analytical method will be used to develop the scope management plan by analyzing the design reports to ensure that all works necessary to complete the project are included.
To develop the Schedule Management Plan to define the timeframe for completion of the project, including the identification of project milestones.	The analytical method will be used to develop the schedule management plan by analyzing the design reports to ensure that a proper schedule is prepared to allow for the project to be completed on time.
To develop a Cost Management Plan in order to properly budget the project funds and prevent cost overruns.	The analytical method will be used to develop the cost management plan by analyzing the design reports to ensure that a

Objectives	Research methods
	Analytical Method
	proper estimated cost is prepared to allow for the project to be completed within budget.
To develop a Quality Management Plan to define the quality controls required for successful implementation of the project.	The analytical method will be used to develop the quality management plan by analyzing the project owner's quality requirements and other relevant reports to ensure that proper quality control measures are set in place.
To develop a Resource Management Plan to define how the project resources will be obtained and deployed as required for all phases of the project.	The analytical method will be used to develop the resource management plan by analyzing the design reports and other company documents to ensure that the resources are available for successful execution of the project.
To develop a Communication Management Plan to allow for successful information exchange and dissemination.	The analytical method will be used to develop the communication management plan by analyzing the design reports and other relevant company documents to ensure

Objectives	Research methods
	Analytical Method
	that proper communication channels are established.
To develop a Risk Management Plan to assist in the identification and mitigation of potential risks throughout the project lifecycle.	The analytical method will be used to develop the risk management plan by analyzing the design reports and other relevant company documents to ensure that risks are identified and mitigated properly.
To develop a Procurement Management Plan to determine the manner in which goods and services will be purchased and contracted.	The analytical method will be used to develop the procurement management plan by analyzing the design reports to ensure that a proper guidelines are in place to successfully procure all required goods, works and services.
To develop a Stakeholder Management Plan to define engagement protocols and ensure the involvement of stakeholders in all phases of the project.	The analytical method will be used to develop the stakeholder management plan by analyzing the design reports and other relevant company documents to identify, engage and manage all relevant stakeholders.

Objectives	Research methods
	Analytical Method
To develop a Sustainable Development Plan to align the project objectives with sustainable and regenerative outcomes.	The analytical method will be used to develop the sustainable management plan by analyzing the design reports to ensure that sustainability is incorporated in all aspects of design and implementation.

Note. Own work.

3.3 Tools

PMI (2017) defines a tool as "something tangible, such as a template or software program, used in performing an activity to produce a product or result."

In this FGP, the commonly used tools will include expert judgement, data gathering and meetings. The following tools were used for each specific objective.

Chart 3.

Tools.

Objectives	Tools
To develop the project charter to formally authorize the project and provide the project manager with the authority to utilize resources for project completion.	• Expert judgment • Data gathering • Meetings • Interpersonal and team skills
To develop the Scope Management Plan to	• Expert judgment

Objectives	Tools
outline the tasks required for successful installation and commissioning of the wastewater treatment system.	• Data gathering • Meetings • Interpersonal and team skills • Scope management plan template • WBS
To develop the Schedule Management Plan to define the timeframe for completion of the project, including the identification of project milestones.	• Expert judgment • Data gathering • Meetings • MS Project • Critical Path • Schedule management plan template
To develop a Cost Management Plan in order to properly budget the project funds and prevent cost overruns.	• Expert judgment • Data gathering • Meetings • Estimation • Cost management plan template
To develop a Quality Management Plan to define the quality controls required for successful implementation of the project.	• Expert judgment • Data gathering • Meetings

Objectives	Tools
	• Quality management plan template
To develop a Resource Management Plan to define how the project resources will be obtained and deployed as required for all phases of the project.	• Expert judgment • Data gathering • Meetings • Estimation • Negotiation • Virtual teams • Resource management plan template
To develop a Communication Management Plan to allow for successful information exchange and dissemination.	• Expert judgment • Data gathering • Meetings • Communication requirements analysis • Communication methods • Communication models • Cost management plan template
To develop a Risk Management Plan to assist in the identification and mitigation of potential risks throughout the project	• Expert judgment • Data gathering • Meetings

Objectives	Tools
lifecycle.	• Risk register template • Risk management plan template
To develop a Procurement Management Plan to determine the manner in which goods and services will be purchased and contracted.	• Expert judgment • Data gathering • Meetings • Source selection analysis • Procurement management plan template
To develop a Stakeholder Management Plan to define engagement protocols and ensure the involvement of stakeholders in all phases of the project.	• Expert judgment • Data gathering • Meetings • Stakeholder register template • Stakeholder assessment matrix • Stakeholder management plan template
To develop a Sustainable Development Plan to align the project objectives with sustainable and regenerative outcomes.	• Expert judgment • Data gathering • Meetings

Note. Own work.

3.4 Assumptions and constraints

PMI (2017) describes assumptions as “a factor in the planning process that is considered to be true, real, or certain, without proof or demonstration”, while constraints are described as “a limiting factor that affects the execution of a project, program or process”.

The chart below summarizes the assumptions and constraints for each specific objective.

Chart 4.

Assumptions and constraints.

Objectives	Assumptions	Constraints
To develop the project charter to formally authorize the project and provide the project manager with the authority to utilize resources for project completion.	All relevant information to develop the project charter is readily available.	Limited time and resources to complete the project charter.
To develop the Scope Management Plan to outline the tasks required for successful installation and commissioning of the wastewater treatment system.	The design report is detailed enough to develop the project scope.	The designs are complex and will result in delays to define the complete scope.

Objectives	Assumptions	Constraints
To develop the Schedule Management Plan to define the timeframe for completion of the project, including the identification of project milestones.	MS Project is available and will suffice to develop the project schedule.	Schedule does not allow for much delays with its critical path.
To develop a Cost Management Plan in order to properly budget the project funds and prevent cost overruns.	Project budget took into account a supply, install and commission scenario.	Limited budget.
To develop a Quality Management Plan to define the quality controls required for successful implementation of the project.	The company has quality control measures readily available and are relevant to the project.	Quality requirements may be modified by the owner.
To develop a Resource Management Plan to define how the project resources will be obtained and deployed as required for all phases of the project.	All resources will be available as required.	Resources for specialized works are not readily available in-country.
To develop a Communication Management Plan to allow for	Communication channels will be accessible to all	The project location has a diverse population with

Objectives	Assumptions	Constraints
successful information exchange and dissemination.	stakeholders.	different dialects available.
To develop a Risk Management Plan to assist in the identification and mitigation of potential risks throughout the project lifecycle.	All risks will be able to be identified.	Since the project involves new technology, some risks may not be identified and mitigated properly.
To develop a Procurement Management Plan to determine the manner in which goods and services will be purchased and contracted.	Contractor will be able to supply all goods and services.	Specialized material is only available from foreign vendors.
To develop a Stakeholder Management Plan to define engagement protocols and ensure the involvement of stakeholders in all phases of the project.	All relevant stakeholders will be identified.	Lack of interest from key stakeholders.
To develop a Sustainable Development Plan to align the project objectives with sustainable and regenerative outcomes.	The wastewater project has potential for sustainable practices once fully implemented.	Cost of implementing sustainable practices is too high.

Note. Own work.

3.5 Deliverables

PMI (2017), describes a deliverable as “any unique and verifiable product, result or capability to perform a service that is required to be produced to complete a process, phase or project”.

The chart below describes the deliverables for each specific objective.

Chart 5.

Deliverables.

Objectives	Deliverables
To develop the project charter to formally authorize the project and provide the project manager with the authority to utilize resources for project completion.	Project Charter: containing all relevant information pertaining to the project, including the official authorization from the project owner to the project manager to utilize resources. Sub-components will include: 1. Project Charter 2. Integrated Change Control Process
To develop the Scope Management Plan to outline the tasks required for successful installation and commissioning of the	Scope Management Plan: containing the project scope which will guide the activities of the project. Sub-components

Objectives	Deliverables
wastewater treatment system.	will include: 1. Scope Management Approach 2. Project Scope Statement 3. Project Requirements and Acceptance Criteria 4. Work Breakdown Structure 5. Scope Validation 6. Scope Control
To develop the Schedule Management Plan to define the timeframe for completion of the project, including the identification of project milestones.	Schedule Management Plan: containing the project schedule detailing times for completion for all activities and milestones. Sub-components will include: 1. Schedule Management Approach 2. Activity List 3. Project Schedule 4. Schedule Control
To develop a Cost Management Plan in order to properly budget the project funds and prevent cost overruns.	Cost Management Plan: containing the project budget as allocated by each activity. Sub-components will include: 1. Cost Management Approach

Objectives	Deliverables
	2. Project Cost Estimate 3. Project Budget 4. Cost Control
To develop a Quality Management Plan to define the quality controls required for successful implementation of the project.	Quality Management Plan: containing a guideline for quality control. Sub-components will include: 1. Quality Management Approach 2. Stakeholder Prioritization 3. Requirements Prioritization 4. Project Quality Plan
To develop a Resource Management Plan to define how the project resources will be obtained and deployed as required for all phases of the project.	Resource Management Plan: containing a guide for utilizing project resources effectively. Sub-components will include: 1. Resource Management Approach 2. Roles and Responsibility 3. Resource Acquisition 4. Team Development 5. Recognition Plan 6. Resource Control
To develop a Communication Management	Communication Management Plan:

Objectives	Deliverables
Plan to allow for successful information exchange and dissemination.	containing options for communication channels between project stakeholders. Sub-components will include: 1. Communications Management Approach 2. Communications Matrix 3. Monitoring & Reporting Communications
To develop a Risk Management Plan to assist in the identification and mitigation of potential risks throughout the project lifecycle.	Risk Management Plan: containing a guide to identify, manage and mitigate potential project risks. Sub-components will include: 1. Risk Management Approach 2. Risk Identification, Re-evaluation and Notification 3. Risk Prioritization
To develop a Procurement Management Plan to determine the manner in which goods and services will be purchased and contracted.	Procurement Management Plan: containing a guide of activities to be done when procuring goods, works and services. Sub-components will include: 1. Procurement Management

Objectives	Deliverables
	Approach 2. Procurement Definition, Process, Criteria 3. Procurement Control
To develop a Stakeholder Management Plan to define engagement protocols and ensure the involvement of stakeholders in all phases of the project.	Stakeholder Management Plan: containing a plan to engage stakeholders effectively. Sub-components will include: 1. Stakeholder Engagement Approach 2. Identify Stakeholders 3. Manage Stakeholder Engagement 4. Monitor Stakeholder Engagement
To develop a Sustainable Development Plan to align the project objectives with sustainable and regenerative outcomes.	Sustainable Management Plan: containing a guide to implement sustainable practices during and after implementation. Sub-components will include: 1. Sustainable Management Plan Approach 2. P5 Impact Assessment

Note. Own work.

4 RESULTS

4.1 Project Charter

The project charter was created to formally authorize the project and to allow the project manager to mobilize project resources. The project charter is outlined below:

Project Name: Wastewater Treatment System for Caye Caulker, Belize.

Project Start Date: June 1, 2024

Project Finish Date: May 31, 2026

Project Objectives:

General Objective

To increase access to sanitation by planning and implementing a wastewater treatment system for the island of Caye Caulker, Belize.

Specific Objectives

1. To create a Project Management Plan for the implementation of a wastewater treatment system for Caye Caulker, Belize.
2. To procure and install a modular wastewater treatment plant that meets and exceeds the regulated wastewater effluent quality required for discharges into Class 1 waters.
3. To procure and install a suitable wastewater collection system including all appurtenances required for the transport of wastewater to the wastewater treatment plant.

Project Purpose or Justification:

As one of the top tourist destinations in Belize, the implementation of this wastewater infrastructure project for the island of Caye Caulker is expected to enhance the tourism product which Belize heavily depends on for revenue earnings. In 2020, Belize generated over 487,000,000 USD from tourism which equates to 29.76% of the country's GDP.

Another benefit of this project is the safeguarding of the environment and public health, in addition to complying with SDG6: increased access to water and sanitation. Other benefits include the protection of the Belize Barrier reef system and the marine environment.

For these reasons, it is essential that a wastewater treatment system be implemented, considering the socio-economic needs of the island is a top tourist destination.

Description of Products or Services to be generated by the Project – Final Deliverables:

1. Project Management Plan
2. Modular wastewater treatment plant
3. Wastewater collection system

Assumptions:

1. There is sufficient buy-in from stakeholders to support the implementation of a wastewater treatment system for Caye Caulker, Belize.
2. The project budget is sufficient to cover the cost of procuring a turn-key, modular wastewater treatment plant.

3. The contractor will be able to complete the installation of the wastewater treatment system in 18 months.

Constraints:

1. Due to the physical nature of the island, there will be challenges during the installation of the collection system because of narrow roads.
2. Due to lack of certified wastewater laboratories in Belize, wastewater effluent samples will be sent abroad during the commissioning phase.
3. Due to the small size of the executing agency, additional human resources will need to be hired as part of the supervision team.

Risks:

1. Due to scarcity of public land on the island, the executing agency may need to purchase prime property for the installation of the wastewater treatment facility, impacting the overall cost of the project.
2. Due to the limitations on wastewater specialization of the executing agency, there may be challenges in the supervision of the project, particularly during the installation of the collection and treatment system.
3. Due to the complexity of the project scope, foreign supervising experts with high "per-day" rates and high overheads might be the only interested experts, impacting the project budget.

Budgets:

The project budget is estimated at 33 million BZD.

Milestones and dates:

Milestone	Start Date	End Date
Installation of Treatment Plant	June 1, 2024	January 31, 2026
Installation of Collection System	August 1, 2024	February 28, 2026
Commissioning	March 1, 2026	April 30, 2026
Project Management	June 1, 2024	May 31, 2026

Stakeholders:

The following are the project's stakeholders:

1. Belize Water Services
2. Belize Public Utilities Commission
3. Residents of Caye Caulker
4. Businesses in Caye Caulker
5. Tourists and other visitors
6. Ministry of Tourism
7. Department of Environment

4.2 Scope Management Plan

The objective of the scope management plan is to outline the tasks and activities required to successfully install and commission the wastewater treatment system for the island of Caye Caulker. These tasks and activities should be clearly defined to ensure that the project is completed within time and budget.

4.2.1 Scope Management Approach

In the case of the Wastewater Treatment System for Caye Caulker Project, scope management will be the responsibility of the Project Manager with support from the Project Team and the client. This will include the vetting and approval of scope deliverables, including the management of any scope changes.

The scope management plan will include the Project Scope Statement, Work Breakdown Structure, Roles and Responsibilities, and measures to Validate and Control Scope, as detailed in the following sections.

4.2.2 Project Scope Statement

The project entails the procurement and installation of a modular wastewater treatment plant that meets and exceeds the regulated wastewater effluent quality required for discharges into Class 1 marine waters. It also entails the procurement and installation of a suitable wastewater collection system including all appurtenances required for the transport of wastewater to the wastewater treatment plant.

The project deliverables include the following:

a. Supply of wastewater treatment plant.
b. Installation and commissioning of wastewater treatment plant.
c. Supply of wastewater collection system.
d. Installation and commissioning of wastewater collection system.

The acceptance criteria for the deliverables are as follows:

a. Conformance to effluent limitation guidelines.
b. Acceptance and approval from Department of Environment.
c. Adherence to technical specifications provided by the Client.

Exclusions of the project scope are as follows:

a. Customer connections within customer's property.
b. Customer adherence to the Plumbing Code.

Project constraints are as follows:

a. Due to the physical nature of the island, there will be challenges during the installation of the collection system because of narrow roads.
b. Due to lack of certified wastewater laboratories in Belize, wastewater effluent samples will be sent abroad during the commissioning phase.
c. Due to the small size of the executing agency, additional human resources will need to be hired as part of the supervision team.

Project assumptions are as follows:

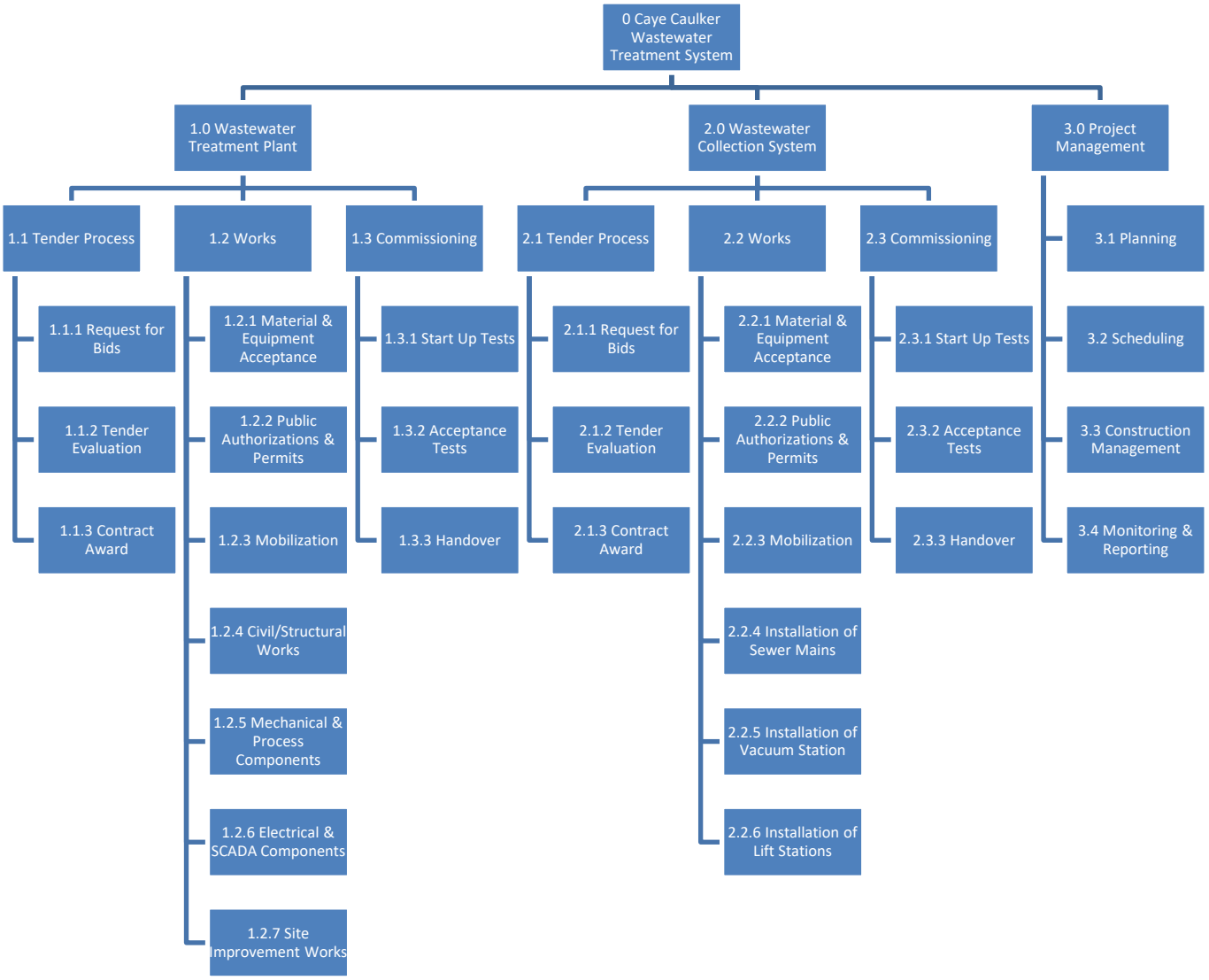
a. There is sufficient buy-in from stakeholders to support the implementation of a wastewater treatment system for Caye Caulker, Belize.

b. The project budget is sufficient to cover the cost of procuring a turn-key, modular wastewater treatment plant.
c. The contractor will be able to complete the installation of the wastewater treatment system in 18 months.

4.2.3 Work Breakdown Structure

Figure 6.

Work breakdown structure for Caye Caulker Wastewater Treatment System.



Note. Own work.

4.2.4 WBS Dictionary

Chart 6.

WBS Dictionary for Caye Caulker Wastewater Treatment System.

WBS Code	**Element Name**	**Description/Definition**	**Budget ($BZ)**	**Resources**
1.1 / 2.1	Tender Process (WWTP & WWCS)	Complete bidding process for both wastewater treatment plant and collection system. Activities include preparation, publishing, submittal, and evaluation of bids, including contract award.	$17,984,940.00	Project Manager, Procurement Specialist, Project Team
1.2	Works (WWTP)	Contract Works associated with construction of wastewater treatment plant, including material, equipment and labour.		Project Manager, Site Engineer, Site Supervisor
1.2.1	Material & Equipment Acceptance	Acceptance of material and equipment for wastewater		Project Manager,

WBS Code	Element Name	Description/Definition	Budget ($BZ)	Resources
		treatment plant based on technical specifications and detailed designs.		Site Engineer, Project Team
1.2.2	Public Authorizations & Permits	Processing of all public permits required for commencement of construction of wastewater treatment plant.		Project Manager, Project Team
1.2.3	Mobilization	Contractor mobilization including installation of site offices, delivery of materials, hiring of personnel, etc.		Project Manager, Site Engineer, Site Supervisor
1.2.4	Civil/Structural Works	Installation and construction of platforms, buildings, etc.		Project Manager, Site Engineer, Site

WBS Code	Element Name	Description/Definition	Budget ($BZ)	Resources
				Supervisor
1.2.5	Mechanical & Process Components	Installation of pumps, motors and treatment modules		Project Manager, Site Engineer, Site Supervisor
1.2.6	Electrical & SCADA Components	Installation of PLCs, remote access, sensors, etc.		Project Manager, Site Engineer, Site Supervisor
1.2.7	Site Improvement Works	Installation of site lights, drainage, fencing, signs, etc.		Project Manager, Site Engineer, Site Supervisor

WBS Code	Element Name	Description/Definition	Budget ($BZ)	Resources
1.3 / 2.3	Commissioning	Start up tests, acceptance tests, training, and handover.		Project Manager, Site Engineer, Site Supervisor
2.2	Works (WWCS)	Contract Works associated with construction of wastewater collection system, including material, equipment and labour.	$11,705,082.00	Project Manager, Site Engineer, Site Supervisor
2.2.1	Material & Equipment Acceptance	Acceptance of material and equipment for wastewater collection system based on technical specifications and detailed designs.		Project Manager, Site Engineer, Project Team
2.2.2	Public Authorizations &	Processing of all public		Project

WBS Code	Element Name	Description/Definition	Budget ($BZ)	Resources
	Permits	permits required for commencement of construction of wastewater collection system.		Manager, Project Team
2.2.3	Mobilization	Contractor mobilization including installation of site offices, delivery of materials, hiring of personnel, etc.		Project Manager, Site Engineer, Site Supervisor
2.2.4	Installation of Sewer Mains	Trenching, installation of mains, backfilling, compaction and road restoration.		Project Manager, Site Engineer, Site Supervisor
2.2.5	Installation of Vacuum Station	Installation of complete vacuum system components.		Project Manager, Site

WBS Code	Element Name	Description/Definition	Budget ($BZ)	Resources
				Engineer, Site Supervisor
2.2.6	Installation of Lift Stations	Installation of lift station components.		Project Manager, Site Engineer, Site Supervisor
3.1	Planning	Planning Project activities.	$3,000,000.00	Project Manager, Project Team
3.2	Scheduling	Scheduleing Project activities.		Project Manager, Project Team
3.3	Construction Management	Management and supervisión of construction phase of		Project Manager,

WBS Code	Element Name	Description/Definition	Budget ($BZ)	Resources
		project.		Project Team
3.4	Monitoring & Reporting	Project monitoring and reporting throughout project life cycle.		Project Manager, Project Team

Note. Own work.

4.2.5 Roles & Responsibilities

Chart 7.

Roles and Responsibilities

Role	Responsibility
Project Owner – Belize Water Services	Main owner and sponsor of the project.
Project Manager	Overall management of the project.
Site Engineer	Execution of the project based on detailed designs and technical specifications.
Site Supervisor	On-the-ground supervision of works.
Procurement Specialist	Procurement of goods and services.

Project Team – Project Execution Unit	Support to project manager, procurement specialist, site engineer and site supervisor.

Note. Own work.

4.2.6 Validate Scope

Scope validation will be the responsibility of the Site Engineer and Site Supervisor who will ensure that all activities and deliverables are completed based on the signed bill of quantities and to the required technical specifications. This will require detailed and objective inspections against the Scope Statement, WBS, and WBS Dictionary. Once the deliverable is accepted, the Site Engineer shall inform the Project Manager and Project Team to proceed with payment of completed works.

4.2.7 Control Scope

Scope control will be managed through contractual arrangements which will include a detailed bill of quantities for each activity. Regular monitoring of the scope to minimize scope creep shall be carried out by the Site Engineer and Site Supervisor. If there is a need for changes in scope, this shall be managed through Change Requests which must be approved by the Project Manager.

4.3 Schedule Management Plan

The objective of the schedule management plan is to present the project schedule along with any monitoring and control measures required to minimize delays and to ensure the timely completion of the project.

4.3.1 Schedule Management Approach

The schedule management plan will be created by utilizing the MS Project tool to elaborate further on the WBS work packages outlined under the scope management plan, along with the detailed activity list created under section 4.3.2. The project manager will be responsible for the development of the project schedule, which will later be presented to the client for approval.

4.3.2 Activity List

The schedule management plan will be created by utilizing the MS Project tool to elaborate further on the WBS work packages outlined under the scope management plan, along with the detailed activity list created under section 4.3.2. The project manager will be responsible for the development of the project schedule, which will later be presented to the client for approval.

Chart 8.

Activity List

WBS Code	Work Package	Task No	Activity Name	Description

WBS Code	Work Package	Task No	Activity Name	Description
1.0	**Wastewater Treatment Plant**			
1.1	**Tender Process**			
1.1.1	Request for Bids	1.1.1.1.1	Validation of bid document	Preparation and review of bid document with Client.
		1.1.1.1.2	Publication of bids	Bid publication on national and international platforms.
1.1.2	Tender Evaluation	1.1.1.2.1	Submittal of bids	Bid submittal and public opening.
		1.1.1.2.2	Evaluation of bids	Bid evaluation by project team.
		1.1.1.2.3	Recommendation	Contractor recommendation based on bid evaluation.
1.1.3	Contract Award	1.1.1.3.1	Notification of award	Letter of intent to award.
		1.1.1.3.2	Contract preparation	Preparation of contract and negotiations.
		1.1.1.3.3	Contract Signing	Signing of contract.
1.2	**Works (WWTP)**			

WBS Code	Work Package	Task No	Activity Name	Description
1.2.1	Material & Equipment Acceptance	1.1.2.1.1	Submittal of specs	Submittal of all material & equipment specs by contractor.
		1.1.2.1.2	Approval of specs	Approval of all material & equipment specs by project team.
1.2.2	Public Authorizations & Permits	1.1.2.2.1	Application of permits and authorizations	Application of all permits and authorizations by contractor, including building authority, department of environment, etc.
		1.1.2.2.2	Receipt of permits and authorizations	Receipt of all permits and authorizations by relevant agencies, including building authority, department of environment, etc.
1.2.3	Mobilization	1.1.2.3.1	Obtain Insurances	Submittal of all insurances (all risk, third-party and

WBS Code	Work Package	Task No	Activity Name	Description
				employer's liability) by contractor.
		1.1.2.3.2	Set up site office	Installation of mobile site office including utilities and amenities.
		1.1.2.3.3	Mobilize staff & workmen	Hiring and mobilization for staff & workmen.
		1.1.2.3.4	Mobilize material & equipment	Logistics for material and equipment to work site.
1.2.4	Civil/Structural Works	1.1.2.4.1	Site clearance	Clearing of vegetation, top soil, etc.
		1.1.2.4.2	Site fill	Filling of site to specified levels.
		1.1.2.4.3	Foundation works	Foundation piling to specified heights.
		1.1.2.4.5	Reinforcement	Preparation of reinforcements for all columns, beams, and slabs.
		1.1.2.4.6	Form work	Preparation of formwork for

WBS Code	Work Package	Task No	Activity Name	Description
				all columns, beams, and slabs.
		1.1.2.4.7	Concrete pour	Pouring of concrete for all columns, beams, and slabs.
1.2.5	Mechanical & Process Components	1.1.2.5.1	Installation of containerized modules	Lifting and installation of containers onto concrete platforms.
		1.1.2.5.2	Interconnection of pipework & fittings	Mechanical installation of all pipe connections and fittings to containerized modules.
		1.1.2.5.3	Installation of membranes	Installation of wastewater treatment membranes in containerized modules.
1.2.6	Electrical & SCADA Components	1.1.2.6.1	Installation of electrical panels	Installation of electrical panels for motor controls.
		1.1.2.6.2	Interconnection of electrical wire work	Electrical installation of all connections between motors, pumps and panels.

WBS Code	Work Package	Task No	Activity Name	Description
		1.1.2.6.3	Installation of SCADA sensors	Installation of SCADA sensors between control center and process equipment.
1.2.7	Site Improvement Works	1.1.2.7.1	Roadworks	Grading and fill for roadworks including drainage
		1.1.2.7.2	Site lights	Installation of site lights with concrete base.
		1.1.2.7.3	Security Booth	Construction of security booth with amenities.
		1.1.2.7.4	Fencing	Installation of chain link fence with toe wall, vehicular gate and pedestrian gate.
1.3	**Commissioning**			
1.3.1	Start up Tests	1.1.3.1.1	Start up of electrical equipment	Start up and testing of electrical components.

WBS Code	Work Package	Task No	Activity Name	Description
		1.1.3.1.2	Start up of mechanical equipment	Start up and testing of mechanical components.
		1.1.3.1.3	Start up of SCADA equipment	Start up and testing of SCADA components.
1.3.2	Acceptance Tests	1.1.3.2.1	Acceptance test of electrical equipment	Final acceptance test of electrical components.
		1.1.3.2.2	Acceptance test of mechanical equipment	Final acceptance test of mechanical components.
		1.1.3.2.3	Acceptance test of SCADA equipment	Final acceptance test of SCADA components.
1.3.3	Handover	1.1.3.3.1	Handover of electrical equipment	Handover of electrical equipment to owner.
		1.1.3.3.2	Handover of	Handover of mechanical

WBS Code	Work Package	Task No	Activity Name	Description
			mechanical equipment	equipment to owner.
		1.1.3.3.3	Handover of SCADA equipment	Handover of SCADA equipment to owner.
2.0	**Wastewater Collection System**			
2.1	**Tender Process**			
2.1.1	Request for Bids	1.2.1.1.1	Validation of bid document	Preparation and review of bid document with Client.
		1.2.1.1.2	Publication of bids	Bid publication on national and international platforms.
2.1.2	Tender Evaluation	1.2.1.2.1	Submittal of bids	Bid submittal and public opening.
		1.2.1.2.2	Evaluation of bids	Bid evaluation by project team.
		1.2.1.2.3	Recommendation	Contractor recommendation based on bid evaluation.
2.1.3	Contract Award	1.2.1.3.1	Notification of	Letter of intent to award.

WBS Code	Work Package	Task No	Activity Name	Description
			award	
		1.2.1.3.2	Contract preparation	Preparation of contract and negotiations.
		1.2.1.3.3	Contract Signing	Signing of contract.
2.2	**Works (CS)**			
2.2.1	Material & Equipment Acceptance	1.2.2.1.1	Submittal of specs	Submittal of all material & equipment specs by contractor.
		1.2.2.1.2	Approval of specs	Approval of all material & equipment specs by project team.
2.2.2	Public Authorizations & Permits	1.2.2.2.1	Application of permits and authorizations	Application of all permits and authorizations by contractor, including building authority, department of environment, etc.
		1.2.2.2.2	Receipt of permits and authorizations	Receipt of all permits and authorizations by relevant

WBS Code	Work Package	Task No	Activity Name	Description
				agencies, including building authority, department of environment, etc.
2.2.3	Mobilization	1.2.2.3.1	Obtain Insurances	Submittal of all insurances (all risk, third-party and employer's liability) by contractor.
		1.2.2.3.2	Set up site office	Installation of mobile site office including utilities and amenities.
		1.2.2.3.3	Mobilize staff & workmen	Hiring and mobilization for staff & workmen.
		1.2.2.3.4	Mobilize material & equipment	Logistics for material and equipment to work site.
2.2.4	Installation of Sewer Mains	1.2.2.4.1	Sewermain trenches	Trenching to specified depths.
		1.2.2.4.2	Install sewermain	Installation of sewer main including bedding and fill.
2.2.5	Installation of	1.2.2.5.1	Assemble vacuum	Assembling of vacuum

WBS Code	Work Package	Task No	Activity Name	Description
	Vacuum Station		station	station.
		1.2.2.5.2	M&E components	Installation of mechanical and electrical components for vacuum station.
2.2.6	Installation of Lift Stations	1.2.2.6.1	Assemble lift stations	Assembling of lift stations.
		1.2.2.6.2	M&E components	Installation of mechanical and electrical components for lift stations.
2.3	**Commissioning**			
2.3.1	Start up Tests	1.2.3.1.1	Start up of vacuum station	Start up and testing of vacuum station.
		1.2.3.1.2	Start up of lift stations	Start up and testing of lift stations.
2.3.2	Acceptance Tests	1.2.3.2.1	Acceptance test of vacuum station	Final acceptance test of vacuum station.
		1.2.3.2.2	Acceptance test of lift stations	Final acceptance test of lift stations.
		1.2.3.2.3	Acceptance test of	Final acceptance test of

WBS Code	Work Package	Task No	Activity Name	Description
			sewer mains	sewer mains.
2.3.3	Handover	1.2.3.3.1	Handover of vacuum system	Handover of vacuum system to owner.
		1.2.3.3.2	Handover of lift stations	Handover of lift stations to owner.
		1.2.3.3.3	Handover of sewer mains	Handover of sewer mains to owner.
3.0	**Project Management**			
3.1	Planning	1.3.1.1	Plan scope	Planning of project scope by project team.
		1.3.1.2	Plan procurement	Planning of procurement processed by project team.
3.2	Scheduling	1.3.2.1	Schedule management	Planning of project schedule by project team.
3.3	Construction Management	1.3.3.1	Site management	Planning of site management by project team.
		1.3.3.2	Resources	Planning of resources

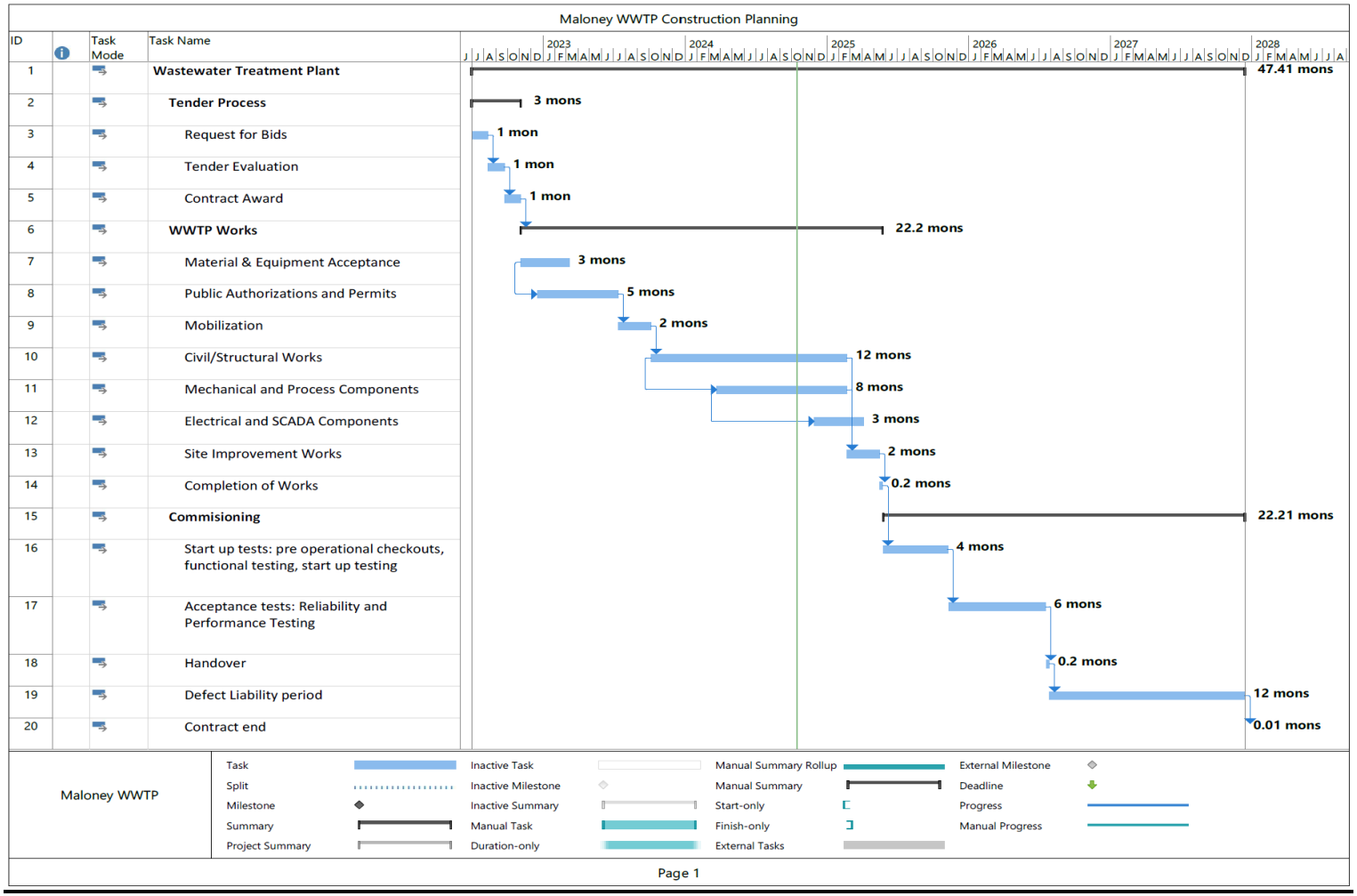
WBS Code	Work Package	Task No	Activity Name	Description
			management	management by project team.
3.4	Monitoring & Reporting	1.3.4.1	Monitor	Monitoring of project activities by project team.
		1.3.4.2	Reports	Reporting of project activities by project team.

Note. Own work.

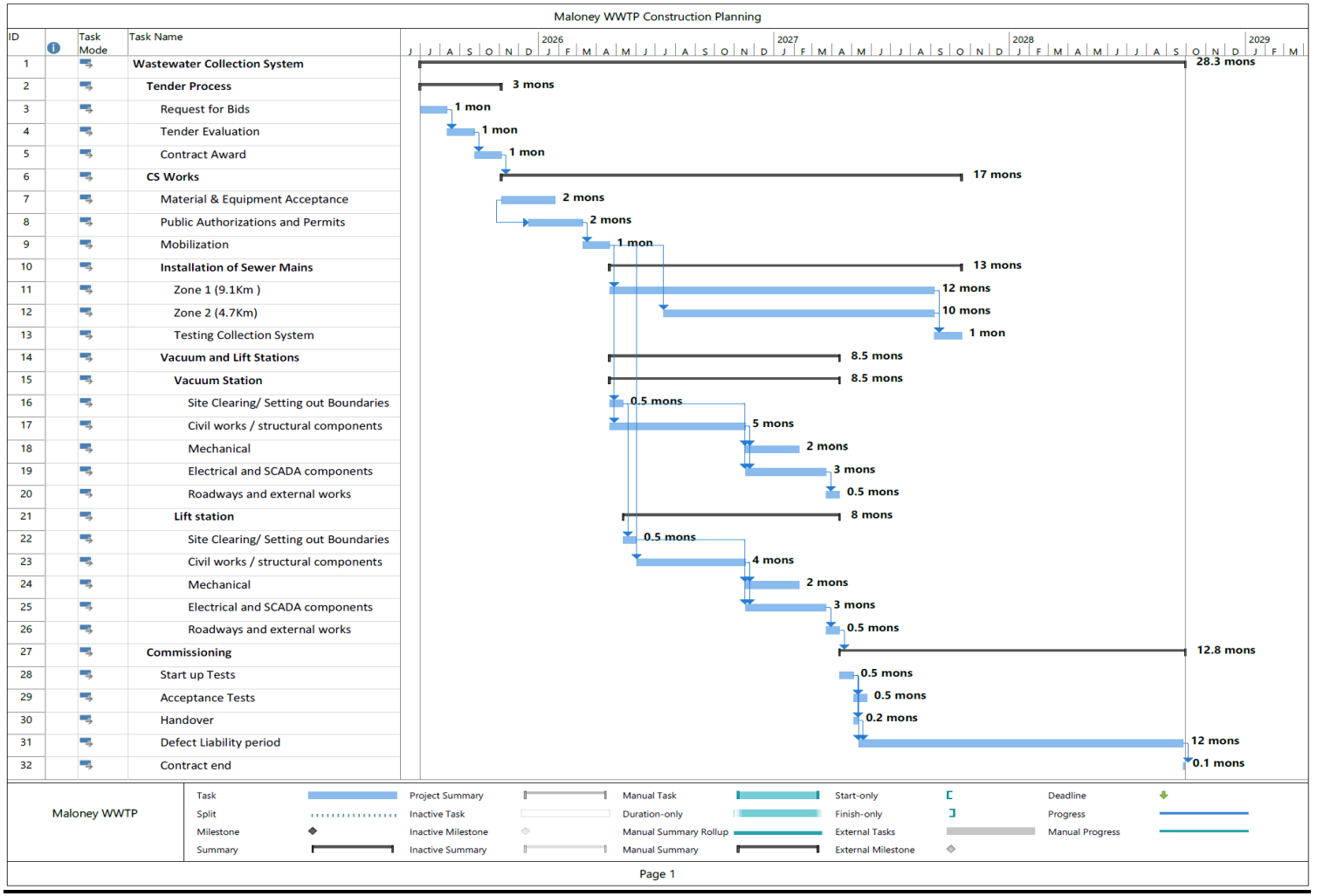
4.3.3 Project Schedule

Chart 9.

Wastewater Treatment Plant



Wastewater Collection System



Note. Own work.

4.3.4 Schedule Control

In order to ensure that the project timeline does not fall behind, the progress of the project must be closely monitored against its schedule baseline. This includes establishing schedule controls for the project team to identify potential causes of schedule slippages, and to identify and resolve schedule problems. Utilizing MS Project as a tool for schedule control greatly assists the project team in monitoring and tracking progress over time. It also allows the project to analyze for any changes in scope, schedule and cost which can then be changed by following a strict process which will not have any significant impact on the project.

4.4 Cost Management Plan

The objective of the cost management plan is to provide an adequate framework for all cost-related aspects of the project. This includes a detailed cost of the project, as well as a description of the procedures, change mechanisms and reporting requirements to measure cost performance.

4.4.1 Cost Management Approach

The cost management approach requires the establishment of the project's cost estimate and budget for the three main activities of the project: site & civil works, wastewater treatment plant, and wastewater collection system. The project manager will be responsible for the development of the project cost estimate and budget, which will later be presented to the client for approval.

4.4.2 Project Cost Estimate

Chart 10.

ITEM	DESCRIPTION	QUANTITY	UNIT	RATE	TOTAL
	CAYE CAULKER WASTEWATER PROJECT				
	Site and Civil Works				
1.0	**PRELIMINARIES**				
	Preliminaries for the Entire Project are covered separately in SECTION 1				
2.0	**SITE FILL**				
2.1	Supply and place common fill to site as shown in the drawings. **ALL VOLUMES ARE GEOMETRIC, WITH NO ALLOWANCE FOR COMPACTION AND SETTLEMENT**. Allow for 6 weeks of fill settlement prior to topping off at the required elevations as shown in the drawings.	21280	CY	$180.00	$ 3,830,400.00
2.2	Supply, place and compact hardfill as shown in the drawings, to the required elevations as indicated. **ALL VOLUMES ARE GEOMETRIC, WITH NO ALLOWANCE FOR COMPACTION AND SETTLEMENT**.	5820	CY	$137.00	$ 797,340.00
3.0	**ACCESS ROADS**				
	Excavation				
3.1	Allow to cut into site hardfill layer as necessary to enable placement of subbase as shown in the drawings. Allow to discard as instructed by the Client.	845.00	CY	$137.00	$ 115,765.00
	Subbase Material				
3.1	Supply, place and compact subbase as shown in the drawings, to the required elevations as indicated. **ALL VOLUMES ARE GEOMETRIC, WITH NO ALLOWANCE FOR COMPACTION AND SETTLEMENT**.	975.00	CY	$137.00	$ 133,575.00
	Base Material				$ -
3.2	Supply, place and compact base as shown in the drawings, to the required elevations as indicated. Allow to shape surface to the slopes shown in the drawings. **ALL VOLUMES ARE GEOMETRIC, WITH NO ALLOWANCE FOR COMPACTION AND SETTLEMENT**.	487.00	CY	$160.00	$ 77,920.00
					$ -
4.0	**PROVISIONAL SUM**				
4.1	Allow a PROVISIONAL SUM for drainage structures as directed by the Engineer, including culverts, end structures, etc.	1.00	PS	$30,000.00	$ 30,000.00
5.0	**FENCE**				
	Fence				
	Allow a PROVISIONAL SUM to Supply materials and construct a fence with reinforced concrete foundation 6" x 18" with 3 #4 long bars and #3 cross ties @ 12" centers; 4 courses of 6-inch blockwork grouted and plastered and reinforced with #3 vertical bars @ 4'-0" o.c.; 6-ft high 10-gauge galvanized chain link fence; Chain link must be held down by 1/4" bars @ 2' ctrs. Allow for fence top piping with braces, cross and top 45-degree extensions fitted with 3 strands barbed wire.	1454.00	LF	$130.00	$ 189,020.00
	Gates				
	Fabricate and install new 15-foot wide double chain link vehicular gate as shown.	1.00	No.	$5,000.00	$ 5,000.00
6.0	**WALKWAYS**				
6.1	Construct 4-foot wide by 5-inch thick reinforced concrete walkways as shown, complete with edge formwork, reinforcing steel #3 at 10 inches each way, and concrete. Allow for broom finish and jointing as indicated	150.00	LF	$25.00	$ 3,750.00
7.0	**PARKING AREA**				
7.1	Construct 6-inch thick reinforced concrete parking area as shown, commplete with edge formwork, reinforcing steel, and concrete. Allow for steel float finish and jointing as indicated	70	SY	$ 70.00	$ 4,900.00
	GRAND TOTAL				**$5,187,670.00**

Wastewater Treatment Plant:

Item	Description	Unit	Qty.	Cost per unit BZ$	Total Cost BZ$
2	**TREATMENT PLANT**				
2.1	**Preliminary Stage**				
2.1.1	Temporary EQ				
2.1.1.1	*Wastewater Pump*	pcs	*2*	$ 6,000	$ 12,000
2.1.1.2	*Agitator*	pcs	*2*	$ 7,000	$ 14,000
2.1.1.3	*Fog pump*	pcs	*1*	$ 6,000	$ 6,000
2.1.2	Treatment				
2.1.2.1	*Container treatment plant*	pcs	*1*	$ 745,000	$ 745,000
2.1.3	Drying Beds				
2.1.3.1	*Collection chambers*	pcs	*4*	$ 1,800	$ 7,200
2.1.3.2	*Wastewater Pump*	pcs	*2*	$ 4,850	$ 9,700
2.1.3.3	*Drainage trench*	gl	*1*	$ 11,760	$ 11,760
2.1.4	Piping & fittings				
2.1.4.1	*Galvanised steel STD40 D = 2"*	ft	*533*	$ 32	$ 17,056
2.1.4.2	*Galvanised steel STD40 D = 3"*	ft	*838*	$ 42	$ 35,196
2.1.4.3	*Galvanised steel STD40 D = 6"*	ft	*152*	$ 62	$ 9,424
2.1.5	Vacuum Trucks				
2.1.5.1	*Vacuum Trucks (2100 gallons capacity, includes vacuum pumps, vacuum tank, valves, discharge pumps, with A/C, manual, similar to Isuzu ELF 4x2 LHD 190 HP)*	pcs	*3*	$ 95,000	$ 285,000
2.2	**Stage 1**				
2.2.1	EQ Tank				
2.2.1.1	*Wastewater Pump*	pcs	*2*	$ 9,000	$ 18,000
2.2.1.2	*Agitator*	pcs	*2*	$ 9,000	$ 18,000
2.2.2	Vacuum Pumps & Tank				
2.2.2.1	*Vacuum Station (includes vacuum pumps, vacuum tank, valves, discharge pumps, control panel.*	pcs	*1*	$ 700,000	$ 700,000
2.2.3	Treatment				
2.2.3.1	*Container treatment plant*	pcs	*11*	$ 710,000	$ 7,810,000
2.2.4	Drying Beds				
2.2.4.1	*Drainage trench*	gl	*1*	$ 25,800	$ 25,800
2.2.5	Piping & fittings				
2.2.5.1	*Galvanised steel STD40 D = 2"*	ft	*462*	$ 16	$ 7,392
2.2.5.2	*Galvanised steel STD40 D = 3"*	ft	*3853*	$ 26	$ 100,178
2.2.5.3	*Galvanised steel STD40 D = 6"*	ft	*210*	$ 46	$ 9,660
2.2.5.4	*Suction Water Hose 6"*	pcs	*4*	$ 200	$ 800
2.2.5.5	*Geotube, 85' L 54' D 5 pieces per unit*	pcs	*4*	$ 11,800	$ 47,200
2.3	**Stage 2**				
2.3.1	Treatment				
2.3.1.1	*Container treatment plant*	pcs	*4*	$ 710,000	$ 2,840,000
2.3.2	Drying Beds (drainage trench included in stage 1)				
2.3.3	Piping & Special Pieces				
2.3.3.1	*Galvanised steel STD40 D = 2"*	ft	*168*	$ 32	$ 5,376
2.3.3.2	*Galvanised steel STD40 D = 3"*	ft	*1144*	$ 42	$ 48,048
2.3.3.3	*Galvanised steel STD40 D = 6"*	ft	*40*	$ 62	$ 2,480
2.3.3.4	*Suction Water Hose 6"*	pcs	*1*	$ 200	$ 200
2.3.3.5	*Geotube, 85' L 54' D 5 pieces per unit*	pcs	*1*	$ 11,800	$ 11,800
	GRAND TOTAL				**$ 12,797,270**

Wastewater Collection System:

Item	Description	Unit	Qty.	Cost per unit BZ$	Total Cost BZ$
1	**NETWORK**				
1.1	**Stage 1**				
1.1.1	Vacuum Mainlines & Branch Lines (includes excavation, backfil & installation)				
1.1.1.1	*PVC PN6 D = 4" (House Connections)*	ft	*41042*	$ 36	$ 1,477,512
1.1.1.2	*HDPE PE100/SDR17/PN10 D = 4"*	ft	*16974*	$ 41	$ 695,934
1.1.1.3	*HDPE PE100/SDR17/PN10 D = 6"*	ft	*2509*	$ 61	$ 153,049
1.1.1.4	*HDPE PE100/SDR17/PN10 D = 8"*	ft	*988*	$ 99	$ 97,812
1.1.1.5	*HDPE PE100/SDR17/PN10 D = 10"*	ft	*4039*	$ 151	$ 609,889
1.1.2	Interface units (includes excavation, backfil & installation)				
1.1.2.1	*Interface collection chamber & Vacuum Valve D =*	pcs	*156*	$ 11,000	$ 1,716,000
1.1.2.2	*Interface collection chamber & Vacuum Valve D =*	pcs	*19*	$ 11,500	$ 218,500
1.1.3	Section Valves (includes excavation, backfill & installation)				
1.1.3.1	*Section Valve with valve extension D = 4"*	pcs	*2*	$ 750	$ 1,500
1.1.3.2	*Section Valve with valve extension D = 6"*	pcs	*4*	$ 890	$ 3,560
1.1.3.3	*Section Valve with valve extension D = 10"*	pcs	*6*	$ 1,100	$ 6,600
1.1.4	Couplings and joints				
1.1.4.1	*Thermofusion D = 3 1/2"*	pcs	*201*	$ 700	$ 140,700
1.1.4.2	*Thermofusion D = 4"*	pcs	*306*	$ 760	$ 232,560
1.1.4.3	*Thermofusion D = 6"*	pcs	*141*	$ 10,000	$ 1,410,000
1.1.4.4	*Thermofusion D = 8"*	pcs	*30*	$ 1,650	$ 49,500
1.1.4.5	*Thermofusion D = 10"*	pcs	*139*	$ 2,000	$ 278,000
1.1.4.6	*Flange D = 4"*	pcs	*4*	$ 255	$ 1,020
1.1.4.7	*Flange D = 6"*	pcs	*8*	$ 340	$ 2,720
1.1.4.8	*Flange D = 10"*	pcs	*12*	$ 700	$ 8,400
1.1.5	Civil Works				
1.1.5.1	*Thrust Blocks*	pcs	*279*	$ 1,200	$ 334,800
1.1.5.2	*Support Blocks*	pcs	*8*	$ 1,200	$ 9,600
1.2	**Stage 2**				
1.2.1	Vacuum Mainlines & Branch Lines (includes excavation, backfil & installation)				
1.2.1.1	*PVC PN6 D = 4" (House Connections)*	ft	*20600*	$ 36	$ 741,600
1.2.1.2	*HDPE PE100/SDR17/PN10 D = 4"*	ft	*15629*	$ 41	$ 640,789
1.2.1.3	*HDPE PE100/SDR17/PN10 D = 6"*	ft	*1954*	$ 61	$ 119,194
1.2.1.4	*HDPE PE100/SDR17/PN10 D = 8"*	ft	*2299*	$ 99	$ 227,601
1.2.1.5	*HDPE PE100/SDR17/PN10 D = 10"*	ft	*1422*	$ 151	$ 214,722
1.2.2	Interface units (includes excavation, backfil & installation)				
1.2.2.1	*Interface collection chamber & Vacuum Valve D =*	pcs	*93*	$ 11,000	$ 1,023,000
1.2.3	Section Valves (includes excavation, backfill & installation)				
1.2.3.1	*Section Valve with valve extension D = 4"*	pcs	*4*	$ 750	$ 3,000
1.2.3.2	*Section Valve with valve extension D = 6"*	pcs	*1*	$ 890	$ 890
1.2.3.3	*Section Valve with valve extension D = 8"*	pcs	*1*	$ 1,000	$ 1,000
1.2.3.4	*Section Valve with valve extension D = 10"*	pcs	*1*	$ 1,100	$ 1,100
1.2.4	Couplings and joints				
1.2.4.1	*Thermofusion D = 3 1/2"*	pcs	*115*	$ 760	$ 87,400
1.2.4.2	*Thermofusion D = 4"*	pcs	*180*	$ 760	$ 136,800
1.2.4.3	*Thermofusion D = 6"*	pcs	*72*	$ 10,000	$ 720,000
1.2.4.4	*Thermofusion D = 8"*	pcs	*49*	$ 1,650	$ 80,850
1.2.4.5	*Thermofusion D = 10"*	pcs	*27*	$ 2,000	$ 54,000
1.2.4.6	*Flange D = 4"*	pcs	*8*	$ 255	$ 2,040
1.2.4.7	*Flange D = 6"*	pcs	*2*	$ 340	$ 680
1.2.4.8	*Flange D = 8"*	pcs	*4*	$ 540	$ 2,160
1.2.4.9	*Flange D = 10"*	pcs	*2*	$ 700	$ 1,400
1.2.5	Civil Works				
1.2.5.1	*Thrust Blocks*	pcs	*146*	$ 1,200	$ 175,200
1.2.5.2	*Support Blocks*	pcs	*20*	$ 1,200	$ 24,000
	GRAND TOTAL				**$ 11,705,082**

Note. Own work.

4.4.3 Project Budget

Chart 11.

Project Budget

NO.	DESCRIPTION	QTY	UNIT	UNIT PRICE	SUBTOTAL
1.0	**WORK PACKAGE COST ESTIMATES**				
1.1	**Activity Cost Estimates**				
1.1.1	Site & Civil Works	1	LS	$ 5,187,670.00	$ 5,187,670.00
1.1.2	Wastewater Treatment Plant	1	LS	$12,797,270.00	$ 12,797,270.00
1.1.3	Wastewater Collection System	1	LS	$11,705,082.00	$ 11,705,082.00
1.1.4	*Sub-total for Activities*				*$ 29,690,022.00*
1.2	**Activity Contingency Reserve**	7.5% of 1.1.4			$ 2,226,751.65
1.3	**Sub-total for Work Package Cost Estimates**				$ 31,916,773.65
2.0	**CONTROL ACCOUNTS**				
2.1	**Work Package Cost Estimates**				$ 31,916,773.65
2.2	**Contingency Reserve**	5% of 2.1			$ 1,595,838.68
3.0	**COST BASELINE**				$ 33,512,612.33
4.0	**PROJECT BUDGET**				

4.1	**Cost Baseline**				$ 33,512,612.33
4.2	**Management Reserve**	5% of 4.1			$ 1,675,630.62
	GRAND TOTAL				**$ 35,188,242.95**

Note. Own work.

4.4.4 Cost Control

Project cost control are specific measures undertaken to monitor and control the project budget. This then allows for proper management of project cost resources to ensure proper outputs and outcomes.

The importance of this process is that it helps in setting clear expectations with stakeholders. Subsequently, this helps in controlling scope creep. This process clearly identifies activities that are operating well and staying within budget from those activities that are breaking down and consuming extra funds. Corrective actions can be taken when the progress is being tracked as any issues will be seen.

4.4.4.1 Budget Control

Cost control is a continuous process and thus will be performed throughout the project lifecycle. It is the key responsibility of the project manager. This process stresses timely, clear reporting and measuring. It will determine if the resources are used as planned and any changes or modifications to the budget will be quickly identified. Key steps involved are close monitoring of the original budget, current approved budget, forecasted vs actual cost and committed costs leading to efficient cost control.

The Earned Value Management (EVM) technique will be useful in measuring the performance of work carried out against the plan to identify the cost variances. The project manager will be able to predict any future variances from the expenses to date in the project. The Planned Value (PV) will provide information on the work scheduled and the authorized budget. The Earned Value (EV) will determine the physical work completed to date and the authorized budget for the work. Actual Cost (AC) will provide visibility on the actual amount of money incurred by the project to date. These will be valuable to the project manager and the stakeholders in balancing the project between cost and its schedule to be able to deliver the project within budget and on time. The following chart outlines the calculations required for cost control.

Chart 12.

Project EVM Tool

Indicator	Description	Calculation
Actual Cost (AC)	Actual cost incurred	N/A
Earned Value (EV)	Amount of budget earned based on physical work	N/A
Planned Value (PV)	Budget for physical work scheduled	N/A
Cost Variance (CV)	Measure of cost overrun	EV-AC
Cost Performance Index (CPI)	Cost efficiency ratio. >1 means the project is within budget,	EV/AC

Schedule Variance (SV)	Measure of schedule slippage	EV-PV
Schedule Performance Index (SPI)	Schedule efficiency ratio. >1 means the project is ahead of schedule	EV/PV

Note. Own work.

4.5 Quality Management Plan

The objective of the quality management plan is to outline the different quality policies and procedures that will be set in place in order to meet stakeholder expectations. It will also define the quality assurance and control activities to monitor the performance of the project against a quality baseline.

4.5.1 Quality Management Approach

The quality management approach for this project will ensure that the quality requirements and metrics are specified and that the proper procedures are in place for its verification. The project team will be responsible for this aspect of the project.

4.5.2 Customer/Stakeholder Prioritization

Chart 13.

Identification of stakeholders

No .	Name	Organization	Role
1	Design team	Private	Engineering designs and construction supervision
2	Contractor	Private	Execute construction
3	Residents of Caye Caulker	Caye Caulker Village	Residents of the island who will be directly or indirectly impacted by the works
4	Businesses of Caye	Caye Caulker Village	Businesses of the island who will

No .	Name	Organization	Role
	Caulker (hotels, stores, restaurants)		be directly or indirectly impacted by the works
5	Future BWS Customers	Caye Caulker Village	Residents who will gain access to wastewater services once the construction is completed
6	Caye Caulker Village Council	Caye Caulker Village Council	Approves and ensures project is in line with the village's development plans
7	Area Representative	Government	Elected representative of Caye Caulker
8	Tourists/visitors	Tourists	Tourists and visitors of the island

Note. Own work.

Chart 14.

Power-Interest Matrix

High	*Area Representative*		*Design team* *Caye Caulker Village Council*
Power	*Tourists/visitors*		*Contractor* *Residents of Caye Caulker* *Businesses of Caye Caulker* *Future BWS customers*
Low			
	Low	**Interest**	**High**

Note. Own work.

Chart 15.

Influence-Impact Matrix

High	*Area Representative* *Tourists/visitors*		*Design team* *Caye Caulker Village Council*
Influence	*Residents of Caye Caulker* *Businesses of Caye Caulker* *Future BWS customers*		*Contractor*
Low			
	Low	**Impact**	**High**

Note. Own work.

Chart 16.

Influence-Power Matrix

High	*Tourists/visitors*		*Design team* *Area Representative* *Caye Caulker Village Council*
Influence	*Residents of Caye Caulker* *Businesses of Caye Caulker* *Future BWS customers*		*Contractor*
Low			
	Low	**Power**	**High**

Note. Own work.

Chart 17.

Stakeholder Prioritization

Stakeholder Prioritization	Design Team	Contractor	Residents	Businesses	Future Customers	Caye Caulker VC	Area Rep	Tourists	Row Total	Relative Dec. Value
Design Team		5.0	0.2	0.2	0.2	1.0	0.2	5.0	11.8	0.10
Contractor	0.2		0.1	0.1	0.1	0.2	0.2	0.2	1.1	0.01
Residents	5.0	10.0		1.0	1.0	1.0	1.0	1.0	20	0.17
Businesses	5.0	10.0	1.0		1.0	1.0	1.0	1.0	20	0.17
Future Customers	5.0	10.0	1.0	1.0		1.0	1.0	1.0	20	0.17
Caye Caulker VC	1.0	5.0	1.0	1.0	1.0		5.0	5.0	19	0.16
Area Rep	5.0	5.0	1.0	1.0	1.0	0.2		5.0	18.2	0.15
Tourists	0.2	5.0	1.0	1.0	1.0	0.2	0.2		8.6	0.07
								Grand Total	**118.7**	**1.00**

Note. Own work.

The prioritized stakeholders are the residents, businesses and future customers of the wastewater treatment system in Caye Caulker.

4.5.3 Requirements Prioritization

Chart 18.

Requirements prioritization for the design team view.

Requirements Prioritization, Design Team View	Adequate system flow	Reduced service interruptions	Safe & sanitary service	Excellent Customer Service	Row Total	Relative Dec. Value
Adequate system flow		10.0	1.0	10.0	21	0.47
Reduced service interruptions	0.1		0.1	1.0	1.2	0.03
Safe & sanitary service	1.0	10.0		10.0	21	0.47
Excellent Customer Service	0.1	1.0	0.1		1.2	0.03
				Grand Total	**44.4**	**1.00**

Note. Own work.

Chart 19.

Requirements prioritization for the contractor view.

Requirements Prioritization, Contractor View	Adequate system flow	Reduced service interruptions	Safe & sanitary service	Excellent Customer Service	Row Total	Relative Dec. Value
Adequate system flow		5.0	0.2	10.0	15.2	0.37
Reduced service interruptions	0.2		0.2	0.2	0.6	0.01
Safe & sanitary service	5.0	5.0		10.0	20	0.49
Excellent Customer Service	0.1	5.0	0.1		5.2	0.13
				Grand Total	**41**	**1.00**

Note. Own work.

Chart 20.

Requirements prioritization for the residents view.

Requirements Prioritization, Residents View	Adequate system flow	Reduced service interruptions	Safe & sanitary service	Excellent Customer Service	Row Total	Relative Dec. Value
Adequate system flow		10.0	1.0	5.0	16	0.49
Reduced service interruptions	0.1		0.2	0.2	0.5	0.02
Safe & sanitary service	1.0	5.0		5.0	11	0.33
Excellent Customer Service	0.2	5.0	0.2		5.4	0.16
				Grand Total	**32.9**	**1.00**

Note. Own work.

Chart 21.

Requirements prioritization for the businesses view.

Requirements Prioritization, Businesses View	Adequate system flow	Reduced service interruptions	Safe & sanitary service	Excellent Customer Service	Row Total	Relative Dec. Value
Adequate system flow		10.0	1.0	5.0	16	0.49
Reduced service interruptions	0.1		0.2	0.2	0.5	0.02
Safe & sanitary service	1.0	5.0		5.0	11	0.33
Excellent Customer Service	0.2	5.0	0.2		5.4	0.16
				Grand Total	**32.9**	**1.00**

Note. Own work.

Chart 22.

Requirements prioritization for the customers view.

Requirements Prioritization, Future Customers View	Adequate system flow	Reduced service interruptions	Safe & sanitary service	Excellent Customer Service	Row Total	Relative Dec. Value
Adequate system flow		10.0	1.0	5.0	16	0.49
Reduced service interruptions	0.1		0.2	0.2	0.5	0.02
Safe & sanitary service	1.0	5.0		5.0	11	0.33
Excellent Customer Service	0.2	5.0	0.2		5.4	0.16
				Grand Total	**32.9**	**1.00**

Note. Own work.

Chart 23.

Requirements prioritization for the Caye Caulker village council view.

Requirements Prioritization, CC VC View	Adequate system flow	Reduced service interruptions	Safe & sanitary service	Excellent Customer Service	Row Total	Relative Dec. Value
Adequate system flow		5.0	0.2	1.0	6.2	0.21
Reduced service interruptions	0.2		0.2	1.0	1.4	0.05
Safe & sanitary service	5.0	5.0		10.0	20	0.67
Excellent Customer Service	1.0	1.0	0.1		2.1	0.07
				Grand Total	**29.7**	**1.00**

Note. Own work.

Chart 24.

Requirements prioritization for the Area Rep view.

Requirements Prioritization, Area Rep View	Adequate system flow	Reduced service interruptions	Safe & sanitary service	Excellent Customer Service	Row Total	Relative Dec. Value
Adequate system flow		5.0	0.2	0.2	5.4	0.13
Reduced service interruptions	0.2		0.1	0.2	0.5	0.01
Safe & sanitary service	5.0	10.0		10.0	25	0.61
Excellent Customer Service	5.0	5.0	0.1		10.1	0.25
				Grand Total	**41**	**1.00**

Note. Own work.

Chart 25.

Requirements prioritization for the Tourists view.

Requirements Prioritization, Tourists View	Adequate system flow	Reduced service interruptions	Safe & sanitary service	Excellent Customer Service	Row Total	Relative Dec. Value
Adequate system flow		10.0	0.1	5.0	15.1	0.30
Reduced service interruptions	0.1		0.1	0.2	0.4	0.01
Safe & sanitary service	10.0	10.0		10.0	30	0.59
Excellent Customer Service	0.2	5.0	0.1		5.3	0.10
				Grand Total	**50.8**	**1.00**

Note. Own work.

Chart 26.

Stakeholder-weighted requirements prioritization using L-shaped matrix.

Stakeholder -Weighted Req's Prioritization	Design Team	Contractor	Residents	Businesses	Future Customers	Caye Caulker VC	Area Rep	Tourists	Row Total	Relative Dec. Value
Adequate system flow	0.05	0.00	0.08	0.08	0.08	0.03	0.02	0.02	0.37	0.37
Reduced service interruptions	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.02	0.02
Safe & sanitary service	0.05	0.00	0.06	0.06	0.06	0.11	0.09	0.04	0.46	0.46
Excellent Customer Service	0.00	0.00	0.03	0.03	0.03	0.01	0.04	0.01	0.14	0.14
								Grand Total	1	1.00

Note. Own work.

Based on the L-shaped matrix method, the prioritized requirement is “Safe & sanitary service”.

4.5.4 Project Quality Plan

4.5.4.1 Role & Responsibilities Chart

Chart 27.

Role & responsibilities chart.

Stakeholder	Role	Responsibilities
Design team	Designers and construction supervisors	Proper design according to AWWA standards and adherence to Technical Specifications.
Contractor	Construction contractor	Install and commission sewer mains and service connections as per contract specifications.

Stakeholder	Role	Responsibilities
Residents of Caye Caulker	Project beneficiaries	Report any construction grievances during execution and report water quality issues post-commissioning.
Businesses of Caye Caulker Pedro (hotels, stores, restaurants)		
Future BWS Customers		
Caye Caulker Village Council	Approver of project	Ensure project is in-line with the viall'ge's development goals and that there is no impact on existing village infrastructure during execution.
Area Representative		
Tourists/visitors	Tourists and visitors of the island	Report any grievances and/or issues

Note. Own work.

4.5.4.2 Key Factors Related to Quality

Chart 28.

Key factors related to quality.

Factor	Factor Definition
Adequate system flow	The wastewater collection system must be properly designed to allow for a minimum flow to prevent sewage blockages.
Reduced service interruptions	The wastewater collection and treatment system must be properly designed to ensure service continuity of at least 98% per month during normal operations.
Safe & sanitary service	Every measure must be taken to ensure safe operations to minimize impacts to public health and the environment.
Excellent customer service	BWS customer service must be prepared to answer all grievances in a timely and effective manner.

Note. Own work.

4.5.4.3 Metrics & Quality Baseline

Chart 29.

Metrics & Quality baseline.

Quality Objective	Metric	Metric definition	Expected outcome/result	Measurement frequency	Responsible
Adequate	flow	Minimum	TBD	Hourly	Operations

Quality Objective	Metric	Metric definition	Expected outcome/result	Measurement frequency	Responsible
system flow	reading in GPM	flow allowed to minimize sewage blockages			department (BWS)
Reduced service interruptions	Downtime, in hours	Amount of time (duration) that system is down for any given month	Less than 2% per month	Monthly	Operations department (BWS)
Safe & sanitary service	Water quality parameters	Water quality required for it to be deemed safe for the environment	Within recommended guidelines, AWWA & WHO	Daily	Water quality lab (BWS)
Excellent	# of	Amount of	Less than 10	Monthly	Customer

Quality Objective	Metric	Metric definition	Expected outcome/result	Measurement frequency	Responsible
customer service	complaints	complaints received	per month		Services (BWS)

Note. Own work.

4.5.4.4 Quality Activities Matrix

Chart 30.

Quality activities matrix.

Deliverable	Requirement	Manage and Control activities	Frequency	Responsible
Daily Operator's Log	Adequate flow	Manage: Operations supervision Control: Log sheets	Daily	Operations Department (BWS)
Monthly Operations Report:	Reduced service interruptions	Manage: Operations supervision	Monthly	Operations Department (BWS)

Deliverable	Requirement	Manage and Control activities	Frequency	Responsible
Service Interruptions		Control: Water interruptions chart		
Daily Water Quality Lab Reports	Safe effluent water	Manage: Lab staff supervision Control: Lab results	Daily	Water Quality Laboratory (BWS)
Monthly Customer Service Report: Complaints	Excellent customer service	Manage: Call center supervision Control: Complaints log; Grievance redress mechanism	Monthly	Customer Services Department (BWS)

Note. Own work.

4.5.4.5 Quality Documents

Water quality lab results template.

Location				
Date				
Start Time (hh:mm)				
Weather				
Sea Conditions				
Tidal Mode				
Water Depth (m)				
Monitoring Depth		Surface	Middle	Bottom
Salinity				
Temperature (°C)				
DO Saturation (%)				
DO (mg/l)				
Turbidity (NTU)				
SS Sample Identification				
SS (mg/l)				
Observed Construction Activities	<100m from location			
	>100m from location			
Other Observations				

Name & Designation Signature Date

Recorded By : _____ _____ _____

Checked By : _____ _____ _____

Note: The SS results are to be filled up once they are available from the laboratory.

Customer Service Grievance Redress Mechanism

Operator's Log Sheet

Waste Water Treatment Plant (ETP/STP) Log Sheet for Operation Designed by : A3S Enviro

Log Book for M/S : .... For the Month of : ....

Date	Water Inlet Flow (LPH)	PLANT OPERATING TIME		PH		SLUDGE QTY. (in KG)	CHEMICAL Consumption In KG				QTY. OF TREATED WATER	Electricity Meter Reading		Operator Signature	Remarks
		Start - AM	Close - PM	Inlet	Outlet		Lime	ALUM	POLY			START	CLOSE		

Notes : 1. Sludge Should be Pack for Hazardous 2. Chemicals need to make daily Basis 3. Sludge Disposal 2 times in week or as required.

4.5.4.6 Continuous Improvement Plan

Based on plan-do-check-act cycle (Rose, 2005).

Process Description
1. Plan – Select process to improve
2. Do – Execute plan at small scale
3. Check – Validate efficiency of plan
4. Act – If effective, implement plan

4.6 Resource Management Plan

The objective of the resource management plan is to help in effectively managing the project's resources, ensuring that they are identified, allocated, and budgeted for, enabling the successful execution of the project.

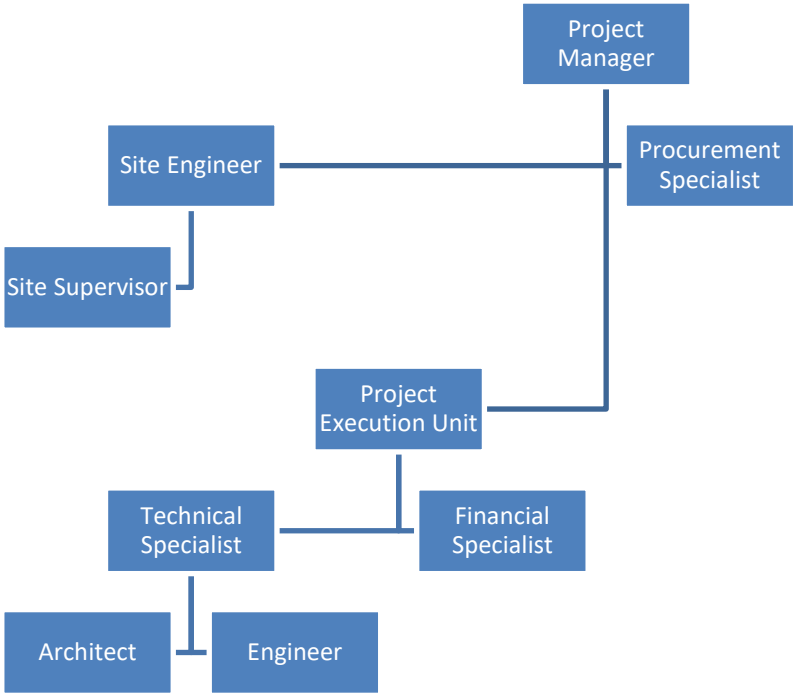
4.6.1 Resource Management Approach

The resource management approach for this project will include the identification of the project’s management team, including a description of each role and responsibility, and the necessary capacity building needs required. It will also include the identification of the physical resources required to ensure the successful completion of the project.

4.6.2 Roles and Responsibilities

Chart 31.

Organizational structure of the project management team.



Note. Own work.

Chart 32.

Role and responsibility.

Role	Responsibility
Project Manager	Overall management of the project.
Site Engineer	Execution of the project based on detailed designs and technical specifications.
Site Supervisor	On-the-ground supervision of works.
Procurement Specialist	Procurement of goods and services.
Project Execution Unit	Support to project manager, procurement

Role	Responsibility
	specialist, site engineer and site supervisor.

Note. Own work.

Chart 33.

Responsibility assignment matrix

Task Name	Project Team Member				
	Project Manager	**Site Engineer**	**Site Supervisor**	**Procurement Specialist**	**Project Execution Unit**
Wastewater Treatment Plant					
• Tender Process	R	C	I	A	C
• Works	R	A	A	I	C
• Commissioning	R	A	A	I	C
Wastewater Collection System					
• Tender Process	R	C	I	A	C
• Works	R	A	A	I	C
• Commissioning	R	A	A	I	C
Project Management					

• Planning	R	C	C	I	C
• Scheduling	R	C	C	I	C
• Construction Management	R	C	C	I	C
• Monitoring & Reporting	R	C	C	I	C
R = Responsible; A = Accountable; C = Consult; I = Inform					

Note. Own work.

4.6.3 Resource Acquisition

Project resources will be comprised of existing members from BWS's own project execution unit as well as new contract staff who will take on the roles of Project Manager, Site Engineer, Site Supervisor and Procurement Specialist specifically for this project. Physical resources will be provided by contractors and vendors who will be hired through a competitive bidding procurement process.

4.6.4 Team Development

Team development will be an important process to ensure that resources are retained throughout the life of the project. This will include continuous investments in team development activities such as: regular team meetings, performance reviews, team retreats, socials, etc.

4.6.5 Recognition Plan

The project manager will be responsible for identifying personnel who are deserving of recognition and award in the form of appraisals and cash incentives. These recognitions will be tied performance at both the individual and overall project (schedule and cost) level.

4.6.6 Resource Control

All project resources must be properly controlled once acquired. Means of control of project resources will include inventory control and performance reviews. These shall be documented and managed by the project team and approved by the project manager.

4.7 Communication Management Plan

The objective of the communication management plan is to identify and outline the way in which information will be disseminated among the different project stakeholders in an efficient and effective manner. This includes identifying the communication channels to be used and prioritizing the communication needs of each stakeholder.

4.7.1 Communication Management Approach

The communications management approach for this project will ensure that all stakeholders are provided the required information so that they can perform their duties effectively. The establishment of an adequate communication channel among stakeholders will be summarized in the form of a communications matrix.

4.7.2 Communications Matrix

Chart 34.

Communications matrix

Communication	Audience	Purpose	Frequency	Medium
Kickoff meeting	Project team, contractor	Site and project management plan handover	Once, at start of project	In person meeting
Daily debrief	Client, project team	Review tasks of the day	Daily	In person meeting

Communication	Audience	Purpose	Frequency	Medium
Project team meeting	Project team	Review and update project management plan	Weekly	In person meeting
Monthly status update	Client, project team	Report on status of project to client	Monthly	Email & in person meeting
Site meeting	Project team, contractor	Plan tasks with contractor	As needed	In person meeting

Note. Own work.

4.7.3 Monitoring & Reporting Communications

The status of the communications management plan will be included in all monthly status report prepared for the client. The project manager will be responsible for ensuring that the communications management plan is updated as needed.

In the event there is a need to escalate an issue affecting project performance, the following communication escalation process will be used:

Chart 35.

Communications escalation chart

Role	Triggers When

Role	Triggers When
Project Manager	Delays with reporting/project updates
Client	Delays due to major events (hurricanes, force majeure, etc.)
Contractor	Delays due to small weather events; delays due to material shortage

Note. Own work.

4.8 Risk Management Plan

The objective of the risk management plan is to establish a framework for identifying and mitigating risks that may arise before and during the project in order to maximize the chance for project success.

4.8.1 Risk Management Approach

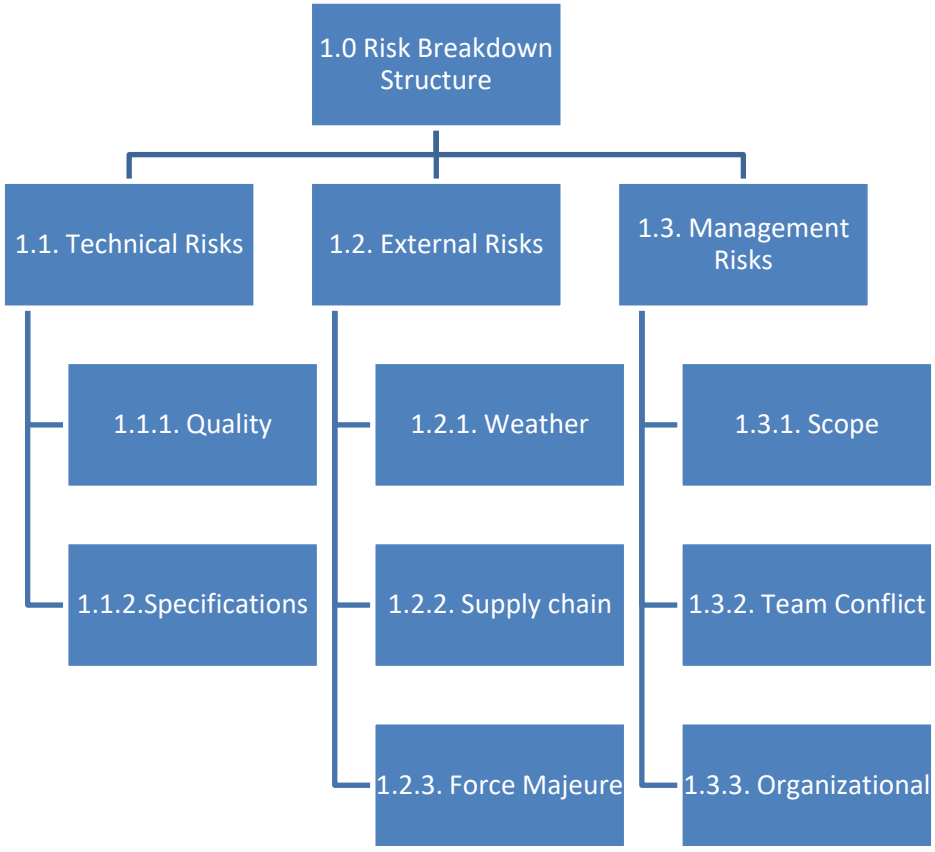
The risk management approach for this project will be led by the project manager with support from the project team. The team will continuously identify, assess, respond and monitor risks throughout the project lifecycle in an effort to minimize their impact on the project.

4.8.2 Risk Identification, Re-evaluation and Notification

Risks that can potentially impact the project shall be identified by the project team during monthly meetings. A probability and impact matrix will be used to evaluate and classify the risk level, including any mitigation measures. The risk level will then be documented in upcoming reports and any proposed measures will be implemented.

Figure 7.

Risk breakdown structure for Caye Caulker Wastewater Treatment System.



Note. Own work.

Chart 36.

Risk register

No	Cause	Risk	Consequence	Prob	Imp	PxI	Response Strategy
1.1.1	Unqualified workforce	Poor construction and	Failed structures and voided	2	4	8	Mitigate: Properly vet hired workforce

No	Cause	Risk	Consequence	Prob	Imp	PxI	Response Strategy
		installation quality	warranties on equipment				(request CV); implement supervision and quality controls
1.1.2	Specifications not included in bid packages	Non-compliance to design specifications	Equipment incompatibility	2	4	8	Mitigate: Ensure bid packages include thorough specifications
1.2.1	Extreme weather event during rainy season	Persistent rainfall	Delays to project schedule	3	3	9	Mitigate: Plan for critical path works during the dry season
1.2.2.	Extended lead times due to supply chain issues	Critical equipment does not arrive on time	Delays to project schedule	4	4	16	Mitigate: Prioritize procurement of goods before procurement of

No	Cause	Risk	Consequence	Prob	Imp	PxI	Response Strategy
							works
1.2.3.	Force Majeure (Pandemic)	Mandatory project shutdown	Delays to project schedule	3	5	15	Mitigate: Strict pandemic guidelines (face mask, social distancing, etc.)
1.3.1	Poor scope definition during planning phase	Scope creep	Delays to project schedule and increase in projet cost.	3	4	12	Mitigate: Thorough review of project scope during planning phase
1.3.2	Poor communication between project team and contractor	Conflict between project team and contractor	Delays to project schedule.	2	4	8	Mitigate: Establish clear and concise communications management plan.
1.3.3	Low salaries	Staff (project	Delays to	2	3	6	Mitigate:

No	Cause	Risk	Consequence	Prob	Imp	PxI	Response Strategy
	and benefits	team) turnover	project schedule.				Provide competitive salaries and benefits to retain staff.

Avoid – Avoid the impact by eliminating the cause.
Mitigate –Reduce the probability or the impact of the risk.
Accept – Accept the risk
Transfer – Transfer the risk to a third party
Escalate – Escalate the risk to a higher authority

Note. Own work.

Chart 37.

Probability & Impact matrix

Probability	5	10	15	20	25	25	20	15	10	5
	4	8	12	16	20	20	16	12	8	4
	3	6	9	12	15	15	12	9	6	3
	2	4	6	8	10	10	8	6	4	2
	1	2	3	4	5	5	4	3	2	1
	Threats (negative)					Opportunities (positive)				
	Impact									

	High – risk
	Medium - risk
	Low – risk

Note. Own work.

4.8.3 Risk Prioritization

The Risk Register will be used by the project team to prioritize risks based on their impact on the project. The following impact scales will be applied:

Chart 38.

Probability Scale

Rating	**Interpretation**
1	Likely to occur 1x during the project
2	Likely to occur 2x during the project
3	Likely to occur 3x during the project
4	Likely to occur 4x during the project
5	Likely to occur 5x or more during the project

Note. Own work.

Impact Scale

Level	Scale	Cost Increase	Schedule Increase
1	Insignificant	<5%	<1 week delay
2	Minor	5% - 9.9%	1 – 2 weeks delay
3	Moderate	10% - 19.9%	2 - 4 weeks delay
4	Major	20% - 29.9%	4 – 6 weeks delay
5	Catastrophic	>=30%	>6 weeks delay

Note. Own work.

4.9 Procurement Management Plan

The objective of the procurement management plan is to outline the framework for the procurement of goods and services required by the project, including contracts for supply and installation of equipment, as well as for construction works. The procurement plan also includes the process of identifying the goods and services required, as well as stablishing the evaluation criteria for their selection.

4.9.1 Procurement Management Approach

The procurement management approach for this project will be led by the project's procurement specialist with close oversight by the project manager. The project team will assist in identifying the goods and services to be procured and will also form part of the evaluating team during the selection process. Goods and services will be procured when required which will be guided by the project schedule. This will ensure proper time and cost management for the project.

4.9.2 Procurement Definition, Process, Criteria

Chart 39.

Procurement definition list

Goods or Service	Procurement Method	Required by
WWTP Equipment Supply, Install & Commission	Contract	Start of WWTP construction
WWTP Material	Direct Purchasing	Start of WWTP construction

Goods or Service	Procurement Method	Required by
WWTP Construction	Contract	Start of WWTP construction
Collection System Equipment Supply, Install & Commission	Contract	Start of Collection System construction
Collection System Material	Direct Purchasing	Start of Collection System construction
Project Team	Contract	Start of project

Note. Own work.

The supply of contracted services shall be under a competitive bidding process for qualified contractors only, after which, a fixed price contract shall be signed with the most responsive bidder. For direct purchasing, three quotations shall be requested and evaluated based on established specifications. The supplier with the most responsive quote shall be selected. The project team shall be contracted via advertised vacancies and shall be selected based on their CVs and interview performance.

The following criteria will be considered for the selection of suppliers and contractors:

- Financial Requirements
    - Financial reports
    - Access to credit line
- Experience & past performance in similar projects
- Qualifications

- Cost
- Proposed work schedule/delivery (lead) time

4.9.3 Procurement Control

The procurement process will be closely monitored by the project manager who will ultimately authorize any changes to the procurement management plan after consultation with the client. Any changes must consider impacts to the project schedule, scope and cost in order to make an informed decision.

4.10 Stakeholder Management Plan

The objective of the stakeholder management plan is to identify the key stakeholders of the project in order to determine their roles and expectations, as well as to assess the various levels of impact, power and influence they may or may not have on the project. Additionally, it will provide the means for effective engagement with these stakeholders throughout the project life cycle.

4.10.1 Stakeholder Management Approach

The stakeholder management approach for this project will be led by the project manager with support from the project team. The prescribed means for communication shall be used as required for each respective stakeholder depending on their level of influence and expectation.

4.10.2 Identify Stakeholders (Register & Matrix)

Chart 40.

Stakeholder register.

No.	Stakeholder	Role in Project	Communication	Expectation	Influence / Impact
1	Design team	Engineering designs and construction	Meetings, emails, calls, reports	Detailed designs of treatment and collection system	M/H

No.	Stakeholder	Role in Project	Communication	Expectation	Influence / Impact
		supervision		based on AWWA standards and local effluent design limits.	
2	Contractor	Execute construction	Meetings, emails, calls, reports	Delivery of fully operational treatment and collection system based on designs and technical specifications.	M/H
3	Residents of Caye Caulker	Residents of the island who will be directly or indirectly impacted by the works	Meetings, calls, infographics	Minimum inconveniences to during construction phase.	L/L
4	Businesses of	Businesses of	Meetings,	Minimum	M/M

No.	Stakeholder	Role in Project	Communication	Expectation	Influence / Impact
	Caye Caulker (hotels, stores, restaurants)	the island who will be directly or indirectly impacted by the works	emails, calls, infographics	inconveniences to during construction phase.	
5	Future BWS Customers	Residents who will gain access to wastewater services once the construction is completed	Infographics	Access to previously unavailable wastewater services.	L/L
6	Caye Caulker Village Council	Approves and ensures project is in line with the village's	Meetings, emails, calls, infographics	Positive investment in-line with village's development plans for a	H/H

No.	Stakeholder	Role in Project	Communication	Expectation	Influence / Impact
		development plans		sustainable tourism industry	
7	Area Representative	Elected representative of Caye Caulker	Meetings, emails, calls	Positive investment in-line with village's development plans for a sustainable tourism industry	H/H

Note. Own work.

Chart 41.

Stakeholder Power-Interest Matrix

High	*Keep satisfied*	*Manage Closely*
Power	• Area Representative • Caye Caulker Village Council	• Design team • Contractor

	Monitor • Tourists/visitors		*Keep informed* • Residents of Caye Caulker • Businesses of Caye Caulker • Future BWS customers
Low			
	Low	**Interest**	**High**

Note. Own work.

4.10.3 Manage Stakeholder Engagement

Chart 42.

Stakeholder assessment matrix.

No.	Stakeholder	Unaware	Resistant	Neutral	Supportive	Leading
1	Design team					C,D
2	Contractor				C	D
3	Residents of Caye Caulker	C			D	
4	Businesses of Caye Caulker (hotels, stores,	C			D	

No.	Stakeholder	Unaware	Resistant	Neutral	Supportive	Leading
	restaurants)					
5	Future BWS Customers	C			D	
6	Caye Caulker Village Council				C,D	
7	Area Representative				C,D	

Note. Own work.

Key:

Unaware – Unaware of the project and potential impacts.

Resistant – Aware of the project and potential impacts but resistant to any changes that may occur because of the project. Will be unsupportive.

Neutral – Aware of the project, but neither supportive nor unsupportive.

Supportive – Aware of the project and potential impacts and supportive of the work and its outcomes.

Leading – Aware of the project and potential impact and actively engaged in ensuring that the project is a success

C – represents the current engagement level of each stakeholder

D – represents the desired engagement level that the Project Team has assessed as essential for project success

4.10.4 Monitor Stakeholder Engagement

The stakeholder engagement process will be closely monitored by the project manager with support from the project team. The stakeholder engagement level will be regularly updated throughout the project lifecycle which will be included in all monthly reports.

4.11 Sustainable Development Management Plan

The objective of the sustainable development management plan is to align the project with regenerative practices to not only ensure project success but to ensure long-term sustainability. This will be achieved by identifying and responding to sustainability impacts relevant to the project's implementation.

4.11.1 Sustainable Development Management Approach

The sustainable development management approach for this project will be led by the project manager with support from the project team. The team will be responsible for completing the P5 Impact assessment and updating the Sustainable Development Management Plan which shall be regularly updated as the project progresses.

4.11.2 P5 Impact Assessment

Chart 43.

P5 Impact Assessment for Caye Caulker Wastewater Treatment System.

Category	Lens	Scored?	Description (Cause)	Potential Sustainability Impact	Initial Impact Score	Proposed Response	New Impact Score	Change	Outcome
People Impacts									
Labor Practices and Decent Work	Lifespan	Yes	The project will create employment.	Majority of work will be temporary.	2	Permanent posts will be created to operate and maintain the system.	4	2	Permanent jobs.
	Servicing	No							

Category	Lens	Scored?	Description (Cause)	Potential Sustainability Impact	Initial Impact Score	Proposed Response	New Impact Score	Change	Outcome
	Effectiveness	Yes	The project requires employment of staff from different disciplines and backgrounds to work together.	Possible communication, coordination, or cultural challenges amongst team members.	2	Develop a comprehensive communication plan that defines communication channels and roles and responsibilities.	3	1	Team members are aware of the communication plan and roles and responsibilities.
	Efficiency	No							
	Fairness	Yes	The project will adhere to the labour laws of Belize.	Employees may be affected by workload, stress and health risks.	2	Provide adequate staffing and breaks to avoid overworking staff	3	1	Health risks and workload is adequately managed and prevented

Category	Lens	Scored?	Description (Cause)	Potential Sustainability Impact	Initial Impact Score	Proposed Response	New Impact Score	Change	Outcome
Society and Customers	Lifespan	Yes	The project will provide sewer services and indirectly improve the environment and public health.	Potential sewermain breaks can affect the environment and inconvenience the public.	2	Ensure proper installation and continuous monitoring of sewermains to identify and mitigate leaks.	4	2	Potential contamination to the environment is mitigated.
	Servicing	Yes	The sewer system will require a maintenance program.	Planned and unplanned maintenance may pose inconveniences to customers and the community at large	2	Reduce corrective maintenance by implementing a robust preventative maintenance	3	1	Less service interruptions to customers.

Category	Lens	Scored?	Description (Cause)	Potential Sustainability Impact	Initial Impact Score	Proposed Response	New Impact Score	Change	Outcome
						program.			
	Effectiveness	Yes	The project requires employment of staff from different disciplines and backgrounds to work together.	Possible communication, coordination, or cultural challenges amongst team members.	2	Develop a comprehensive communication plan that defines communication channels and roles and responsibilities.	3	1	Team members are aware of the communication plan and roles and responsibilities
	Efficiency	No							
	Fairness	No							

Category	Lens	Scored?	Description (Cause)	Potential Sustainability Impact	Initial Impact Score	Proposed Response	New Impact Score	Change	Outcome
Human Rights	Lifespan	No							
	Servicing	No							
	Effectiveness	No							
	Efficiency	No							
	Fairness	Yes	Some residents may fall outside of the proposed system service area.	This will result in some residents not having access to sanitation service.	2	Propose alternative sewer solutions for those outside of the proposed system service area. Eg. Septic tanks with leach fields	3	1	Increased access to sanitation services.
Ethical	Lifespan	No							

Category	Lens	Scored?	Description (Cause)	Potential Sustainability Impact	Initial Impact Score	Proposed Response	New Impact Score	Change	Outcome
Behavior	Servicing	No							
	Effectiveness	No							
	Efficiency	No							
	Fairness	No							
Planet Impacts									
Transport	Lifespan	Yes	Heavy equipment and trucking will be used during project implementation.	Inconvenience to the community at large, considering the small roads of the island.	2	Limit the use of heavy equipment by establishing set operating hours.	4	2	Safety and convenience for residents.
	Servicing	Yes	Heavy equipment and trucking will require frequent maintenance.	Oil spillage and other mechanical waste may contaminate the	2	Establish a protocol for managing waste from heavy	3	1	Reduced contamination to the environment.

Category	Lens	Scored?	Description (Cause)	Potential Sustainability Impact	Initial Impact Score	Proposed Response	New Impact Score	Change	Outcome
				environment.		equipment and truck maintenance.			
	Effectiveness	No							
	Efficiency	No							
	Fairness	No							
Energy	Lifespan	Yes	The wastewater treatment plant will rely on mechanical pumps and motors for its different treatment	High energy demand with high carbon footprint.	2	Supplement energy demand with renewable energy (solar power) where possible.	4	2	Reduced carbon footprint from grid-tied energy.

Category	Lens	Scored?	Description (Cause)	Potential Sustainability Impact	Initial Impact Score	Proposed Response	New Impact Score	Change	Outcome
			processes.						
	Servicing	Yes	The wastewater treatment plant will rely on mechanical pumps and motors for its different treatment processes.	Technical issues may disrupt the service quality and customer satisfaction	2	Provide regular maintenance to pumps and motors.	3	1	Improved service quality and customer satisfaction.
	Effectiveness	No							

Category	Lens	Scored?	Description (Cause)	Potential Sustainability Impact	Initial Impact Score	Proposed Response	New Impact Score	Change	Outcome
	Efficiency	Yes	The wastewater treatment plant will rely on mechanical pumps and motors for its different treatment processes.	High energy demand with high carbon footprint.	2	Maximize operations with highly efficient processes to minimize wastage.	4	2	Energy efficient plant.
	Fairness	No							
Land, Air and Water	Lifespan	Yes	The project will eliminate the discharge of untreated sewage	Potential sewermain breaks can affect the environment.	2	Ensure proper installation and continuous monitoring of	4	2	Potential contamination to the environment is mitigated.

Category	Lens	Scored?	Description (Cause)	Potential Sustainability Impact	Initial Impact Score	Proposed Response	New Impact Score	Change	Outcome
			into the environment.			sewermains to identify and mitigate leaks.			
	Servicing	No							
	Effectiveness	No							
	Efficiency	No							
	Fairness	No							
Consumption	Lifespan	Yes	The project will eliminate the discharge of untreated sewage into the environment.	Potential sewermain breaks can affect the environment.	2	Ensure proper installation and continuous monitoring of sewermains to identify and	4	2	Potential contamination to the environment is mitigated.

Category	Lens	Scored?	Description (Cause)	Potential Sustainability Impact	Initial Impact Score	Proposed Response	New Impact Score	Change	Outcome
						mitigate leaks.			
	Servicing	No							
	Effectiveness	No							
	Efficiency	No							
	Fairness	No							
Prosperity Impacts									
Project Feasibility	Lifespan	Yes	The project is expected to have significant impacts on the lives of the	The operation and maintenance expenses of the plant may exceed revenues from	2	Implement circular economy principles through effluent and sludge reuse.	4	2	Sustainable treatment plant.

Category	Lens	Scored?	Description (Cause)	Potential Sustainability Impact	Initial Impact Score	Proposed Response	New Impact Score	Change	Outcome
			residents of Caye Caulker, including the surrounding marine environs.	service charges to residents.					
	Servicing	No							
	Effectiveness	No							
	Efficiency	No							
	Fairness	No							
Business Agility	Lifespan	Yes	The project is expected to have significant impacts on the lives of the	Climate change may affect the operation of the treatment plant.	2	Make the plant resilient by installing mechanical and electrical	4	2	Climate resilient plant.

Category	Lens	Scored?	Description (Cause)	Potential Sustainability Impact	Initial Impact Score	Proposed Response	New Impact Score	Change	Outcome
			residents of Caye Caulker, including the surrounding marine environs.			equipment on platforms above flood zone and estimated storm surge levels.			
	Servicing	No							
	Effectiveness	No							
	Efficiency	No							
	Fairness	No							
Market and Economic Situation	Lifespan	Yes	The project is expected to have significant impacts on the lives of the	Improper management of the treatment and collection system can have an	2	Prioritize the operation and maintenance of the system, consider timely	4	2	Sustainable treatment plant.

Category	Lens	Scored?	Description (Cause)	Potential Sustainability Impact	Initial Impact Score	Proposed Response	New Impact Score	Change	Outcome
			residents of Caye Caulker, including the surrounding marine environs.	indirect impact on the local tourism industry.		expansions and upgrades.			
	Servicing	No							
	Effectiveness	No							
	Efficiency	No							
	Fairness	No							

Note. Own work.

5 CONCLUSIONS

1. The Caye Caulker Wastewater Treatment System Management Plan was developed to provide a management framework to successfully plan, execute and monitor the execution of works for both wastewater treatment plant and collection system. It includes the project charter along with plans for each project management knowledge area.
2. The project charter was developed to formalize the project and to secure funding for the planning, execution and monitoring of the project. The project charter summarizes all aspects of the project, including definition of the objectives, scope and cost of the project, as well as the identification of key stakeholders.
3. The scope management plan was developed to define the scope of the project, including the development of a WBS, WBS dictionary, etc. to assist the project team in successfully executing the project.
4. The schedule management plan was developed to define the duration and sequence of the project activities. This assists the project team in determining when these activities will be completed or delivered.
5. The cost management plan was developed to define the cost of the project by determining the cost baseline and considering the contingency and management reserves.

6. The quality management plan was developed to define the project's quality objectives and to ensure that a framework for quality control is established and executed by the project team.
7. The resource management plan was developed to define the project's physical and team resources including its allocation and management. This plan assists the project team in securing the adequate resource when required.
8. The communication management plan was developed to define the project's communication strategy to ensure project success, including the elaboration of a communication matrix to assist the project team with effective communication between key stakeholders.
9. The risk management plan was developed to provide a framework for the identification of project risks. The framework, utilized by the project team throughout the project life cycle, also defines the response actions to be taken based on the risk classification and impact matrix.
10. The procurement management plan was developed to define the project's guidelines for the procurement of goods and services. This plan outlines the different criterion for the evaluation and award of contracts, including the acquisition of physical and team resources.
11. The stakeholder engagement plan was developed to define the project's key stakeholders, including the identification and classification process for the same. This plan assists the project team in defining and executing the most adequate strategy for engaging stakeholders throughout the project life cycle.

12. The sustainable development management plan was developed to align the project with sustainable practices, including the identification and planification of areas of opportunities where greater sustainability impacts can be maximized.

6 RECOMMENDATIONS

1. The project manager should ensure that the Caye Caulker Wastewater Treatment System Management Plan is in line with PMI best practices to ensure project success.
2. The project owner should ensure that an adequate project team be made available for the execution of the Caye Caulker Wastewater Treatment System.
3. The project manager, along with the project team, should ensure to develop the project charter at the beginning of the project in order to get approval from the project owner to proceed with project implementation.
4. The project manager, along with the project team, should ensure to develop the scope management plan, including the definition of scope, WBS, WBS dictionary, etc., in line with PMI best practices to ensure activities are well defined to reduce the risk of scope creep and to ensure project success.
5. The project manager, along with the project team, should ensure to develop the schedule management plan by utilizing MS Project to define activity durations and to track the progress of works in an effort to complete the project within schedule.
6. The project manager, along with the project team, should properly review the project budget to develop the cost management plan for the project, including cost estimating and cost control measures to mitigate project cost overruns.
7. The project manager, along with the project team, should ensure to properly develop the quality management plan based on established quality control standards for the construction and installation of wastewater treatment systems.

8. The project manager, along with the project team, should ensure to properly carry out the resource management plan to ensure that the required resources are available when needed to minimize delays.
9. The project manager, along with the project team, should ensure to properly carry out the communication management plan according to the communication matrix to ensure effective communication with stakeholders.
10. The project manager, along with the project team, should ensure to properly carry out the risk management plan in a timely and routine manner to identify and mitigate risks as early as possible to prevent negative impacts to the project
11. The project manager, along with the project team, should ensure to properly carry out the stakeholder engagement plan so that any concerns can be addressed in a timely manner to prevent any opposition to the project.
12. The project manager, along with the project team, should ensure to properly execute the procurement management plan to obtain value for money and to ensure transparency in the process.
13. The project manager, along with the project team, should ensure to identify areas of opportunity to implement the sustainable development management plan in an effort to make the project more regenerative.

7 VALIDATION OF THE FGP IN THE FIELD OF REGENERATIVE AND SUSTAINABLE DEVELOPMENT

There is universal recognition of the importance of improving wastewater management as a critical part of water resource management. Wastewater treatment is specifically highlighted in Sustainable Development Goal Target 6.3 (SDG 6.3), which seeks to improve water quality and reduce untreated wastewater, by aiming to cut half of the proportion of untreated wastewater by 2030. Moreover, at least five other SDGs (SDG 9.4, SDG 11.6, SDG 12.4, SDG 12.5, and SDG 14.1) are linked to wastewater and its contaminants, technologies, and reuse (GWP, 2021).

Through the implementation of an integrated wastewater treatment system, this project will allow for environmental and social safeguards where there currently are none. It is expected that risks to public health and the marine environs will be minimized through the elimination of direct discharge of untreated wastewater to receiving bodies. Those in the community that are most vulnerable will also now have access to sanitation services which will improve their living conditions and indirectly create more social equity among these residents.

It is also expected that there will be a significant boost to the local economy at the micro and macro level, given the consistent rise in tourist arrivals and the strengthening of the tourism sector through sanitation investments. These investments ensure continuous development and create job and income security for households on the island, particularly those who are dependent on the tourism industry as a livelihood.

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APPENDICES

Appendix 1: FGP Charter

CHARTER OF THE PROPOSED
FINAL GRADUATION PROJECT (FGP)

1. Student name

Ervin Flores

2. FGP name

Project Management Plan for the Implementation of a Wastewater Treatment System for the Island of Caye Caulker, Belize.

3. Application Area (Sector or activity)

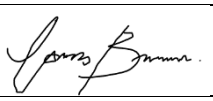
Water, Wastewater, Engineering

4. Student signature

5. Name of the Graduation Seminar facilitator

Carlos Brenes

6. Signature of the facilitator



7. Date of charter approval

October 11, 2023

8. Project start and finish date

September 28, 2023	N/A

9. Research question

What elements are required to develop a Project Management Plan to implement the installation and commissioning of a wastewater treatment system in Caye Caulker, Belize, considering the socio-economic needs of the island as a top tourist destination.

10. Research hypothesis

It is possible to develop a Project Management Plan to implement the installation and commissioning of a wastewater treatment system in Caye Caulker, Belize, considering the socio-economic needs of the island as a top tourist destination.

11. General objective

To develop a Project Management Plan to implement the installation and commissioning of a wastewater treatment system in Caye Caulker, Belize, considering the socio-economic needs of the island as a top tourist destination.

12. Specific objectives

1. To develop the project charter to formally authorize the project and provide the project manager with the authority to utilize resources for project completion.
2. To develop the Scope Management Plan to outline the tasks required for

successful installation and commissioning of the wastewater treatment system.

3. To develop the Schedule Management Plan to define the timeframe for completion of the project, including the identification of project milestones.
4. To develop a Cost Management Plan in order to properly budget the project funds and prevent cost overruns.
5. To develop a Quality Management Plan to define the quality controls required for successful implementation of the project.
6. To develop a Resource Management Plan to define how the project resources will be obtained and deployed as required for all phases of the project.
7. To develop a Communication Management Plan to allow for successful information exchange and dissemination.
8. To develop a Risk Management Plan to assist in the identification and mitigation of potential risks throughout the project lifecycle.
9. To develop a Procurement Management Plan to determine the manner in which goods and services will be purchased and contracted.
10. To develop a Stakeholder Management Plan to define engagement protocols and ensure the involvement of stakeholders in all phases of the project.
11. To develop a Sustainable Development Plan to align the project objectives

with sustainable and regenerative outcomes.

13. FGP purpose or justification

As one of the top tourist destinations in Belize, the implementation of this wastewater infrastructure project for the island of Caye Caulker is expected to enhance the tourism product which Belize heavily depends on for revenue earnings. In 2020, Belize generated over 487,000,000 USD from tourism which equates to 29.76% of the country's GDP. Another benefit of this project is the safeguarding of the environment and public health, in addition to complying with SDG6: increased access to water and sanitation. Other benefits include the protection of the Belize Barrier reef system and the marine environment. For these reasons, it is essential to develop a Project Management Plan which seeks to provide the framework for successfully implementing the project which will also consider the socio-economic needs of the island of Caye Caulker as a tourist destination.

14. Work Breakdown Structure (WBS). In table form, describing the main deliverable as well as secondary, products or services to be created by the FGP.

1. Final Graduation Project (FGP)
1.1 Graduation Seminar

1.1.1 FGP Deliverables
1.1.1.1 Week 1
1.1.1.1.1 Appendix 1 FGP Charter (Items 1 to 10)
1.1.1.1.2 Appendix 5 Bibliographical Research
1.1.1.2 Week 2
1.1.1.2.1 Appendix 1 FGP Charter (Items 11 & 12)
1.1.1.2.2 Appendix 2 FGP WBS
1.1.1.3 Week 3
1.1.1.3.1 Corrections
1.1.1.3.2 Appendix 1 FGP Charter (Items 13 to 19)
1.1.1.4 Week 4
1.1.1.4.1 Corrections
1.1.1.4.2 Chapter 2 - Theoretical Framework
1.1.1.4.3 Appendix 1 FGP Charter (Item 20)
1.1.1.5 Week 5
1.1.1.5.1 Corrections
1.1.1.5.2 Chapter 3 – Methodological Framework
1.1.1.5.3 Appendix 1 FGP Charter (Item 21)
1.1.1.6 Week 6
1.1.1.6.1 Corrections
1.1.1.6.2 Chapter 1 – Introduction

1.1.1.6.3 Chapter 7 - Project Validation in Regen & Sustainability
1.1.1.6.4 Appendix 1 FGP Charter (Item 22)
1.1.1.6.5 Appendix 3 FGP Schedule
1.1.1.7 Week 7
1.1.1.7.1 Corrections
1.1.1.7.2 Executive Summary
1.1.1.7.3 Abstract
1.1.1.7.4 Bibliographical references
1.1.1.7.5 Indexes
1.1.1.7.6 Signed FGP Charter
1.1.2 Graduation Seminar Approval
1.2 Tutoring Process
1.2.1 Tutor
1.2.1.1 Tutor Assignment
1.2.1.2 Communication
1.2.2 Adjustments of Previous Chapters (if needed)
1.2.3 Chapter 4 – Development (Results)
1.2.3.1 Signed FGP Charter
1.2.3.2 Scope Management Plan
1.2.3.3 Schedule Management Plan
1.2.3.4 Cost Management Plan

1.2.3.5 Quality Management Plan
1.2.3.6 Resource Management Plan
1.2.3.7 Communication Management Plan
1.2.3.8 Risk Management Plan
1.2.3.9 Procurement Management Plan
1.2.3.10 Stakeholder Engagement Plan
1.2.3.11 Sustainability Development Plan
1.2.4 Chapter 5 – Conclusions
1.2.5 Chapter 6 – Recommendations
1.3 Reading by Reviewers
1.3.1 Reviewers Assignment Request
1.3.1.1 Assignment of Two Reviewers
1.3.1.2 Communication
1.3.1.3 FGP Submission to Reviewers
1.3.2 Reviewers Work
1.3.2.1 Reviewer 1
1.3.2.1.1 FGP Reading
1.3.2.1.2 Reader 1 Report
1.3.2.2 Reviewer 2
1.3.2.2.1 FGP Reading
1.3.2.2.2 Reader 2 Report

1.4 Adjustments
1.4.1 Report for Reviewers
1.4.2 FGP Update
1.4.3 Second Review by Reviewers
1.5 Presentation to Board of Examiners
1.5.1 Final Review by Board
1.5.2 FGP Grade Report

15. FGP budget

The total budget to develop the FGP is estimated at $550.00 Belize Dollars or $275.00 US Dollars.

Description	**Quantity**	**Unit**	**Unit Price**	**Total**
Stakeholder meeting sessions	2	ea	$ 75.00	$ 150.00
Site visits to Caye Caulker	2	ea	$ 100.00	$ 200.00
Printing of FGP	1	ea	$ 200.00	$ 200.00
Total				$ 550.00

16. FGP planning and development assumptions

1. It is assumed that the project information will be readily available to the

researcher in order to complete all general and specific objectives.

2. It is assumed that the researcher will dedicate at least 15 hours per week to complete the FGP within the estimated cost and schedule.
3. It is assumed that the Project Sponsor will support the execution of the Project Management Plan which will later serve as a framework for project implementation.
4. It is assumed that the researcher will have access to the required software and literary references to complete the FGP.

17. FGP constraints

1. The FGP must be completed within a timeframe of 5 months.
2. The FGP must be completed within a budget of $550.00 Belize dollars.
3. All FGP deliverables must be completed by the researcher only, without the assistance of additional human resources.
4. Limited access to philologists in Belize.

18. FGP development risks

1. Serious illness by the researcher may cause delays in the development of deliverables.
2. Stakeholder meetings and site visits scheduled during the hurricane season may be disrupted if a storm develops resulting in delays.
3. Lack of timely feedback by Tutors may result in delays in making corrections to deliverables.
4. If a milestone date is missed, it may result in overall project delay.

19. FGP main milestones

Milestones are related to deliverables on the second level (deliverables) and third level (control accounts) of the WBS of section 14 of this Charter. At the same time the deliverables are related to the specific objectives (in the case of the FGP please include the times for the tutorship reviews as well as for the readership).

Deliverable	**Estimated Start Date**	**Estimated Finish Date**
1.1 Graduation Seminar	**29-Aug-23**	**29-Oct-23**
1.1.1 FGP Deliverables	29-Aug-23	16-Oct-23
1.1.1.1 Week 1		
1.1.1.1.1 Appendix 1 FGP Charter (Items 1 to 10)		

Deliverable	Estimated Start Date	Estimated Finish Date
1.1.1.1.2 Appendix 5 Bibliographical Research		
1.1.1.2 Week 2		
1.1.1.2.1 Appendix 1 FGP Charter (Items 11 & 12)		
1.1.1.2.2 Appendix 2 FGP WBS		
1.1.1.3 Week 3		
1.1.1.3.1 Corrections		
1.1.1.3.2 Appendix 1 FGP Charter (Items 13 to 19)		
1.1.1.4 Week 4		
1.1.1.4.1 Corrections		
1.1.1.4.2 Chapter 2 - Theoretical Framework		
1.1.1.4.3 Appendix 1 FGP Charter (Item 20)		
1.1.1.5 Week 5		
1.1.1.5.1 Corrections		
1.1.1.5.2 Chapter 3 – Methodological Framework		
1.1.1.5.3 Appendix 1 FGP Charter (Item 21)		
1.1.1.6 Week 6		
1.1.1.6.1 Corrections		
1.1.1.6.2 Chapter 1 – Introduction		
1.1.1.6.3 Chapter 7 - Project Validation in Regen &		

Deliverable	Estimated Start Date	Estimated Finish Date
Sustainability		
1.1.1.6.4 Appendix 1 FGP Charter (Item 22)		
1.1.1.6.5 Appendix 3 FGP Schedule		
1.1.1.7 Week 7		
1.1.1.7.1 Corrections		
1.1.1.7.2 Executive Summary		
1.1.1.7.3 Abstract		
1.1.1.7.4 Bibliographical references		
1.1.1.7.5 Indexes		
1.1.1.7.6 Signed FGP Charter		
1.1.2 Graduation Seminar Approval	16-Oct-23	29-Oct-23
1.2 Tutoring Process	**3-Sep-24**	**23-Dec-24**
1.2.1 Tutor	3-Sep-24	10-Sep-24
1.2.2 Adjustments of Previous Chapters (if needed)	11-Sep-24	14-Sep-24
1.2.3 Chapter 4 – Development (Results)	3-Sep-24	30-Nov-24
1.2.3.1 Signed FGP Charter	3-Sep-24	14-Sep-24
1.2.3.2 Scope Management Plan	15-Sep-24	21-Sep-24
1.2.3.3 Schedule Management Plan	22-Sep-24	28-Sep-24
1.2.3.4 Cost Management Plan	29-Sep-24	5-Oct-24

Deliverable	Estimated Start Date	Estimated Finish Date
1.2.3.5 Quality Management Plan	6-Oct-24	12-Oct-24
1.2.3.6 Resource Management Plan	13-Oct-24	19-Oct-24
1.2.3.7 Communication Management Plan	12-Nov-24	18-Nov-24
1.2.3.8 Risk Management Plan	19-Nov-24	25-Nov-24
1.2.3.9 Procurement Management Plan	26-Nov-24	2-Dec-24
1.2.3.10 Stakeholder Engagement Plan	3-Dec-24	9-Dec-24
1.2.3.11 Sustainability Development Plan	9-Dec-24	15-Dec-24
1.2.4 Chapter 5 – Conclusions	16-Dec-24	23-Dec-24
1.2.5 Chapter 6 – Recommendations	16-Dec-24	23-Dec-24
1.3 Reading by Reviewers	**31-Dec-24**	**8-Jan-25**
1.3.1 Reviewers Assignment Request	31-Dec-24	1-Jan-25
1.3.2 Reviewers Work	1-Jan-25	8-Jan-25
1.4 Adjustments	**8-Jan-25**	**22-Jan-25**
1.4.1 Report for Reviewers	8-Jan-25	11-Jan-25
1.4.2 FGP Update	11-Jan-25	15-Jan-25
1.4.3 Second Review by Reviewers	15-Jan-25	22-Jan-25
1.5 Presentation to Board of Examiners	**22-Jan-25**	**29-Jan-25**
1.5.1 Final Review by Board	22-Jan-25	27-Jan-25
1.5.2 FGP Grade Report	29-Jan-25	29-Jan-25

20. Theoretical framework

20.1 Estate of the "matter"

Wastewater treatment is the process of converting "used water" from domestic or industrial use into water that is safe for discharge back into the environment. Lack of wastewater treatment can result in pollution to the environment in addition to posing a serious public health risk.

In Caye Caulker, Belize, there is no centralized wastewater treatment system, with residents mostly relying on poorly constructed septic tank systems. It is expected that the implementation of a centralized wastewater treatment system for the island of Caye Caulker will result in positive economic impacts for the local tourism industry, and will promote development. Improvements to the environment and public health is also anticipated.

20.2 Basic conceptual framework

The following concepts are explored under this FGP:

1. Project management
2. Project management plan
3. Project knowledge areas
4. Sustainable design

21. Methodological framework

Objective	Name of deliverable	Information sources	Research method	Tools	Restrictions
To develop the project charter to formally authorize the project and provide the project manager with the authority to utilize resources for project completion.	Project Charter	Primary: Meetings with personnel directly related to the project; project reports (Feasibility Study and Design Report) Secondary: PMBOK 6th and 7th Edition; Online references; Articles/Journals	Analytic	• Expert judgment • Data gathering • Meetings Interpersonal and team skills	Limited time and resources to complete the project charter.
To develop the Scope	Scope Management	Primary: Meetings with	Analytic	• Expert judgment	The designs are complex

Objective	Name of deliverable	Information sources	Research method	Tools	Restrictions
Management Plan to outline the tasks required for successful installation and commissioning of the wastewater treatment system.	Plan	personnel directly related to the project; project reports (Feasibility Study and Design Report) Secondary: PMBOK 6th and 7th Edition; Online references; Articles/Journals		• Data gathering • Meetings • Interpersonal and team skills • Scope management plan template WBS	and will result in delays to define the complete scope.
To develop the Schedule Management Plan to define the	Schedule Management Plan	Primary: Meetings with personnel directly related	Analytic	• Expert judgment • Data gathering • Meetings	Schedule does not allow for much delays with its

Objective	Name of deliverable	Information sources	Research method	Tools	Restrictions
timeframe for completion of the project, including the identification of project milestones.		to the project; project reports (Feasibility Study and Design Report) Secondary: PMBOK 6th and 7th Edition; Online references; Articles/Journals		• MS Project • Critical Path Schedule management plan template	critical path.
To develop a Cost Management Plan in order to properly budget the project funds and prevent cost	Cost Management Plan	Primary: Meetings with personnel directly related to the project; project reports	Analytic	• Expert judgment • Data gathering • Meetings • Estimation Cost	Limited budget.

Objective	Name of deliverable	Information sources	Research method	Tools	Restrictions
overruns.		(Feasibility Study and Design Report) Secondary: PMBOK 6th and 7th Edition; Online references; Articles/Journals		management plan template	
To develop a Quality Management Plan to define the quality controls required for successful implementation of	Quality Management Plan.	Primary: Meetings with personnel directly related to the project; project reports (Feasibility Study and	Analytic	• Expert judgment • Data gathering • Meetings Quality management plan template	Quality requirements may be modified by the owner.

Objective	Name of deliverable	Information sources	Research method	Tools	Restrictions
the project.		Design Report) Secondary: PMBOK 6th and 7th Edition; Online references; Articles/Journals			
To develop a Resource Management Plan to define how the project resources will be obtained and deployed as required for all phases of the project.	Resource Management Plan	Primary: Meetings with personnel directly related to the project; project reports (Feasibility Study and Design Report)	Analytic	• Expert judgment • Data gathering • Meetings • Estimation • Negotiation • Virtual teams Resource management plan template	Resources for specialized works are not readily available in-country.

Objective	Name of deliverable	Information sources	Research method	Tools	Restrictions
		Secondary: PMBOK 6th and 7th Edition; Online references; Articles/Journals			
To develop a Communication Management Plan to allow for successful information exchange and dissemination.	Communication Management Plan	Primary: Meetings with personnel directly related to the project; project reports (Feasibility Study and Design Report) Secondary: PMBOK 6th and	Analytic	• Expert judgment • Data gathering • Meetings • Communication requirements analysis • Communication methods • Communication models	The project location has a diverse population with different dialects available.

Objective	Name of deliverable	Information sources	Research method	Tools	Restrictions
		7th Edition; Online references; Articles/Journals		Cost management plan template	
To develop a Risk Management Plan to assist in the identification and mitigation of potential risks throughout the project lifecycle.	Risk Management Plan	Primary: Meetings with personnel directly related to the project; project reports (Feasibility Study and Design Report) Secondary: PMBOK 6th and 7th Edition; Online	Analytic	• Expert judgment • Data gathering • Meetings • Risk register template Risk management plan template	Since the project involves new technology, some risks may not be identified and mitigated properly.

Objective	Name of deliverable	Information sources	Research method	Tools	Restrictions
		references; Articles/Journals			
To develop a Procurement Management Plan to determine the manner in which goods and services will be purchased and contracted.	Procurement Management Plan	Primary: Meetings with personnel directly related to the project; project reports (Feasibility Study and Design Report) Secondary: PMBOK 6th and 7th Edition; Online references; Articles/Journals	Analytic	• Expert judgment • Data gathering • Meetings • Source selection analysis Procurement management plan template	Specialized material is only available from foreign vendors.

Objective	Name of deliverable	Information sources	Research method	Tools	Restrictions
To develop a Stakeholder Management Plan to define engagement protocols and ensure the involvement of stakeholders in all phases of the project.	Stakeholder Management Plan	Primary: Meetings with personnel directly related to the project; project reports (Feasibility Study and Design Report) Secondary: PMBOK 6th and 7th Edition; Online references; Articles/Journals	Analytic	• Expert judgment • Data gathering • Meetings • Stakeholder register template • Stakeholder assessment matrix Stakeholder management plan template	Lack of interest from key stakeholders.
To develop a Sustainable	Sustainable Management	Primary: Meetings with	Analytic	• Expert judgment	Cost of implementing

Objective	Name of deliverable	Information sources	Research method	Tools	Restrictions
Development Plan to align the project objectives with sustainable and regenerative outcomes.	Plan	personnel directly related to the project; project reports (Feasibility Study and Design Report) Secondary: PMBOK 6th and 7th Edition; Online references; Articles/Journals		• Data gathering • Meetings	sustainable practices is too high.

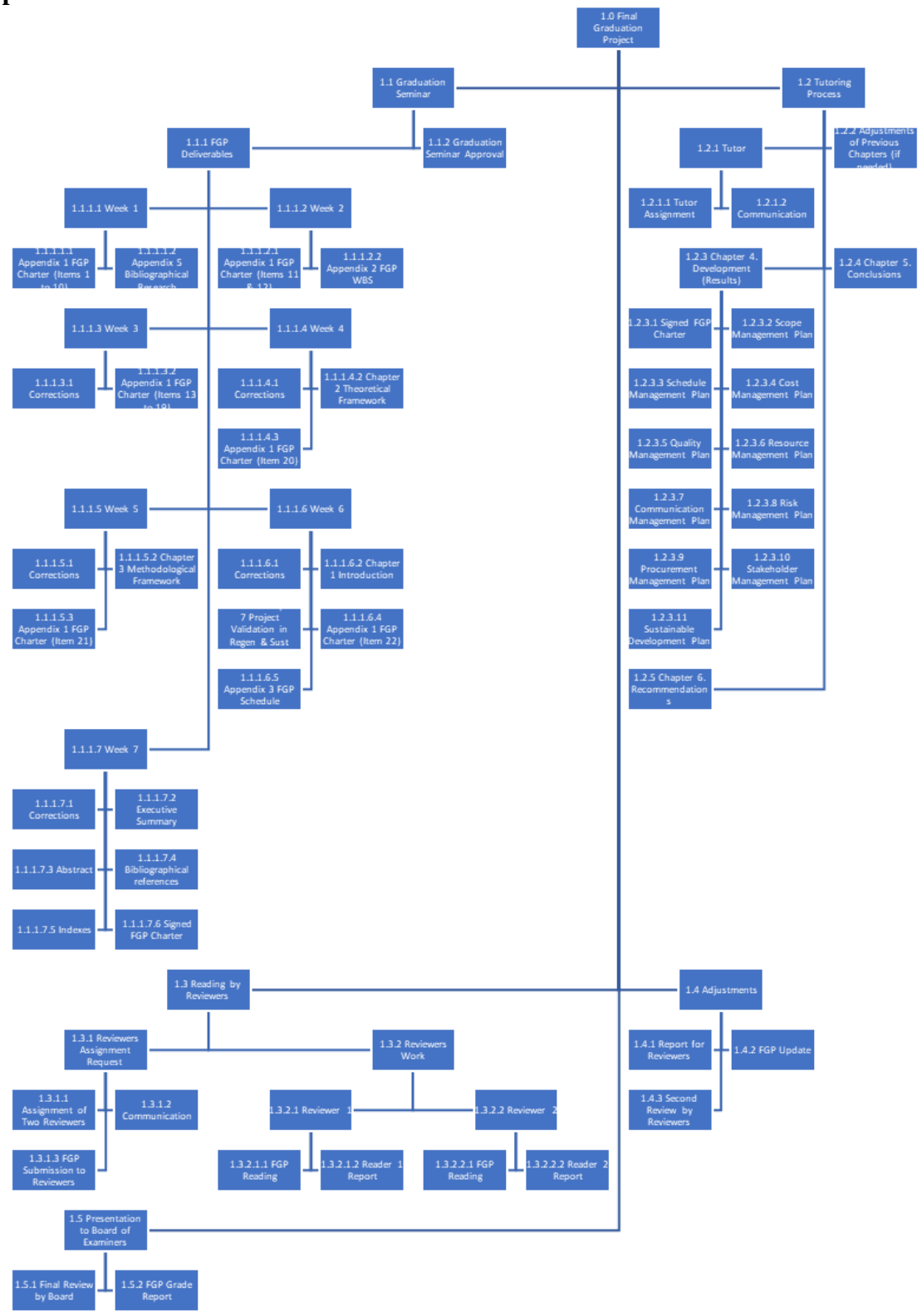
22. Validation of the work in the field of the regenerative and sustainable development.

There is universal recognition of the importance of improving wastewater management as a critical part of water resource management.

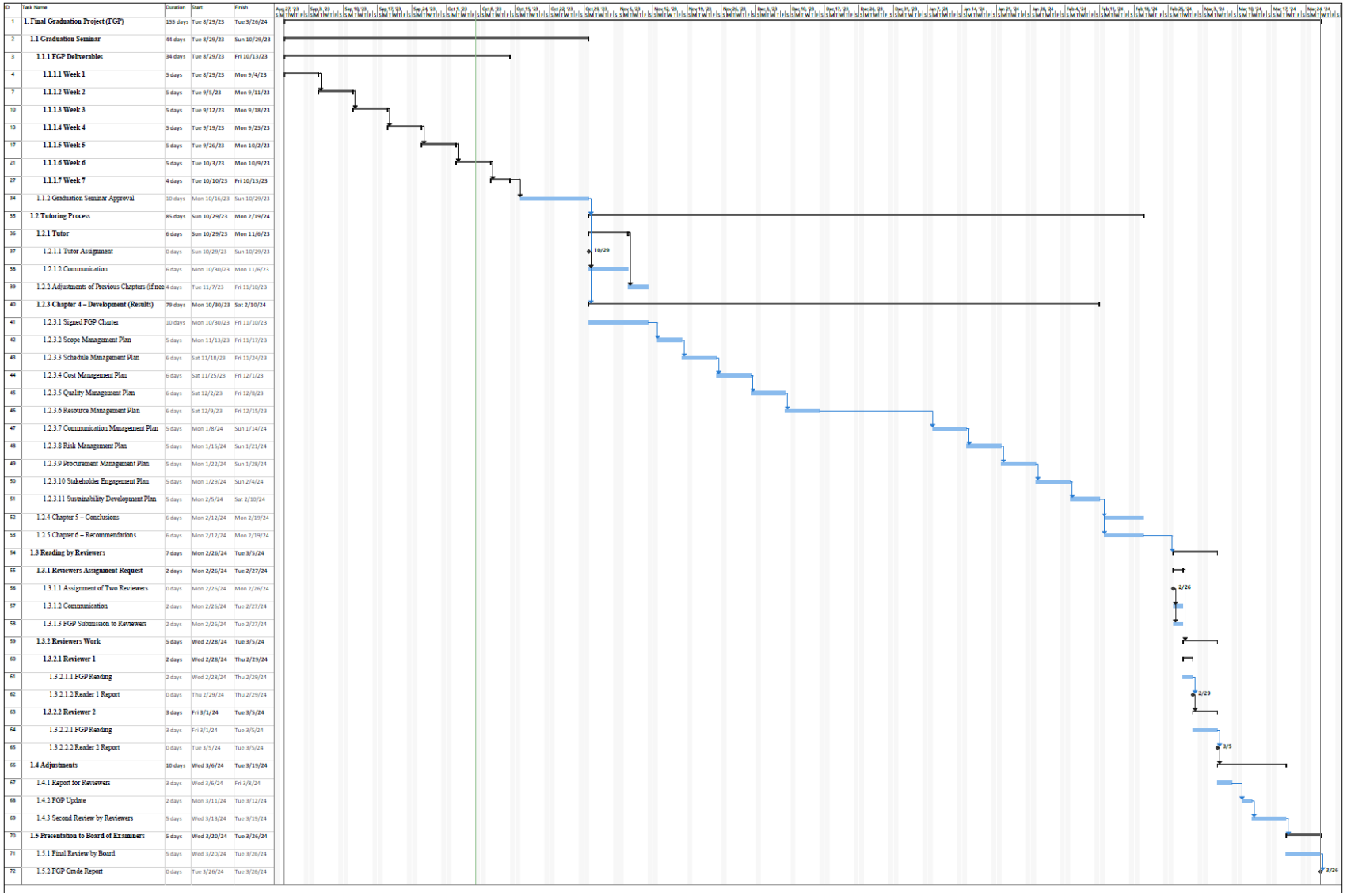
Through the implementation of an integrated wastewater treatment system, this project will allow for environmental and social safeguards where there currently are none. Those in the community that are most vulnerable will also now have access to sanitation services which will improve their living conditions and indirectly create more social equity among these residents.

It is also expected that there will be a significant boost to the local economy at the micro and macro level. These investments ensure continuous development and create job and income security for households on the island, particularly those who are dependent on the tourism industry as a livelihood.

Appendix 2: FGP WBS



Appendix 3: FGP Schedule



ID	Task Name	Duration	Start	Finish
1	**1. Final Graduation Project (FGP)**	155 days	Tue 8/29/23	Tue 3/26/24
2	**1.1 Graduation Seminar**	44 days	Tue 8/29/23	Sun 10/29/23
3	**1.1.1 FGP Deliverables**	34 days	Tue 8/29/23	Fri 10/13/23
4	**1.1.1.1 Week 1**	5 days	Tue 8/29/23	Mon 9/4/23
7	**1.1.1.2 Week 2**	5 days	Tue 9/5/23	Mon 9/11/23
10	**1.1.1.3 Week 3**	5 days	Tue 9/12/23	Mon 9/18/23
13	**1.1.1.4 Week 4**	5 days	Tue 9/19/23	Mon 9/25/23
17	**1.1.1.5 Week 5**	5 days	Tue 9/26/23	Mon 10/2/23
21	**1.1.1.6 Week 6**	5 days	Tue 10/3/23	Mon 10/9/23
27	**1.1.1.7 Week 7**	4 days	Tue 10/10/23	Fri 10/13/23
34	1.1.2 Graduation Seminar Approval	10 days	Mon 10/16/23	Sun 10/29/23
35	**1.2 Tutoring Process**	85 days	Sun 10/29/23	Mon 2/19/24
36	**1.2.1 Tutor**	6 days	Sun 10/29/23	Mon 11/6/23
37	1.2.1.1 Tutor Assignment	0 days	Sun 10/29/23	Sun 10/29/23
38	1.2.1.2 Communication	6 days	Mon 10/30/23	Mon 11/6/23
39	1.2.2 Adjustments of Previous Chapters (if nee	4 days	Tue 11/7/23	Fri 11/10/23
40	**1.2.3 Chapter 4 – Development (Results)**	79 days	Mon 10/30/23	Sat 2/10/24
41	1.2.3.1 Signed FGP Charter	10 days	Mon 10/30/23	Fri 11/10/23
42	1.2.3.2 Scope Management Plan	5 days	Mon 11/13/23	Fri 11/17/23
43	1.2.3.3 Schedule Management Plan	6 days	Sat 11/18/23	Fri 11/24/23
44	1.2.3.4 Cost Management Plan	6 days	Sat 11/25/23	Fri 12/1/23
45	1.2.3.5 Quality Management Plan	6 days	Sat 12/2/23	Fri 12/8/23
46	1.2.3.6 Resource Management Plan	6 days	Sat 12/9/23	Fri 12/15/23
47	1.2.3.7 Communication Management Plan	5 days	Mon 1/8/24	Sun 1/14/24
48	1.2.3.8 Risk Management Plan	5 days	Mon 1/15/24	Sun 1/21/24
49	1.2.3.9 Procurement Management Plan	5 days	Mon 1/22/24	Sun 1/28/24
50	1.2.3.10 Stakeholder Engagement Plan	5 days	Mon 1/29/24	Sun 2/4/24
51	1.2.3.11 Sustainability Development Plan	5 days	Mon 2/5/24	Sat 2/10/24
52	1.2.4 Chapter 5 – Conclusions	6 days	Mon 2/12/24	Mon 2/19/24
53	1.2.5 Chapter 6 – Recommendations	6 days	Mon 2/12/24	Mon 2/19/24
54	**1.3 Reading by Reviewers**	7 days	Mon 2/26/24	Tue 3/5/24
55	**1.3.1 Reviewers Assignment Request**	2 days	Mon 2/26/24	Tue 2/27/24
56	1.3.1.1 Assignment of Two Reviewers	0 days	Mon 2/26/24	Mon 2/26/24
57	1.3.1.2 Communication	2 days	Mon 2/26/24	Tue 2/27/24
58	1.3.1.3 FGP Submission to Reviewers	2 days	Mon 2/26/24	Tue 2/27/24
59	**1.3.2 Reviewers Work**	5 days	Wed 2/28/24	Tue 3/5/24
60	**1.3.2.1 Reviewer 1**	2 days	Wed 2/28/24	Thu 2/29/24
61	1.3.2.1.1 FGP Reading	2 days	Wed 2/28/24	Thu 2/29/24
62	1.3.2.1.2 Reader 1 Report	0 days	Thu 2/29/24	Thu 2/29/24
63	**1.3.2.2 Reviewer 2**	3 days	Fri 3/1/24	Tue 3/5/24
64	1.3.2.2.1 FGP Reading	3 days	Fri 3/1/24	Tue 3/5/24
65	1.3.2.2.2 Reader 2 Report	0 days	Tue 3/5/24	Tue 3/5/24
66	**1.4 Adjustments**	10 days	Wed 3/6/24	Tue 3/19/24
67	1.4.1 Report for Reviewers	3 days	Wed 3/6/24	Fri 3/8/24
68	1.4.2 FGP Update	2 days	Mon 3/11/24	Tue 3/12/24
69	1.4.3 Second Review by Reviewers	5 days	Wed 3/13/24	Tue 3/19/24
70	**1.5 Presentation to Board of Examiners**	5 days	Wed 3/20/24	Tue 3/26/24
71	1.5.1 Final Review by Board	5 days	Wed 3/20/24	Tue 3/26/24
72	1.5.2 FGP Grade Report	0 days	Tue 3/26/24	Tue 3/26/24

Appendix 4: Preliminary bibliographical research

Bal, D. (2023, February 9). *Primary vs. secondary sources - definition, differences, and examples*. Tutors. https://tutors.com/lesson/primary-vs-secondary-sources

Justification: Above reference to be used to assist in defining primary and secondary sources of information.

Bridges, J. (2023, March 6). *Project Risk Analysis: Tools, templates & techniques. ProjectManager*. https://www.projectmanager.com/training/how-to-analyze-risks-project

Justification: Above reference to be used to assist in performing project risk analysis.

BWS. (2023). *Wastewater treatment*. https://bws.bz/wastewater-treatment.html

Justification: Above reference to be used to provide background information on the client.

Carboni, J., Duncan, W., Gonzalez, M., Milson, P., & Young, M. (2018). *Sustainable Project Management: The GPM Reference Guide.* Novi MI, USA: GPM Global.

Justification: Above reference to be used to assist in determining sustainability of project.

Development and importance of tourism for Belize. Worlddata.info. (n.d.). https://www.worlddata.info/america/belize/tourism.php#:~:text=Belize%20generated%20around%20487.00%20million,tourism%20receipts%20in%20Central%20Ame

rica.&text=On%20average%2C%20each%20of%20the,spent%20about%20243%20US%20Dollars

Justification: Above reference to be used to assist in referencing statistical data about Belize's economy.

GPM. (2019). *The P5 Standard for Sustainability in Project Management.* U.S.A.: Green Project Management (GPM).

Justification: Above reference to be used to assist in preparing P5 Impact Analysis of project.

Hansen, M. (2025, January 18). *Membrane Bioreactor (MBR) technology in wastewater treatment*. Waterlyst. https://waterlyst.com/articles/membrane-bioreactor-mbr-technology

Justification: Above reference to be used to provide a theoretical background on wastewater treatment.

Hassan, M. (2023, August 14). *Research methods - types, examples and guide*. Research Method. https://researchmethod.net/researchmethods/

Justification: Above reference to be used to assist in defining research methods for the methodological framework.

Landau, P. (2023, May 19). *Resource management: Process, Tools & Techniques*. ProjectManager. https://www.projectmanager.com/blog/quick-guide-resource-management

Justification: Above reference to be used to assist in project resource management, both for human and cost resources.

Lyle, J. (1996). *Regenerative Design for Sustainable Development*. Hoboken, NJ: John Wiley & Sons.

Justification: Above reference to be used in making linkage to regenerative development for the project.

Muller, E. (2017). *Regenerative Development, The Way Forward to Saving our Civilization.* University for International Cooperation, Costa Rica.

Justification: Above reference to be used in making linkage to regenerative development for the project.

Project Management Institute. (2021). *The Standard for Project Management and a Guide to the Project Management Body of Knowledge (PMBOK Guide) (7th Ed.).* Project Management Institute, Incorporated.

Justification: Above reference to be used to reference project management processes.

Project Planning and Management. (2023). *Design Brief Report Report: Detailed Designs of a Wastewater Collection and Treatment System for the Village of Caye Caulker, Belize*. Project Planning and Management Limited and Belize Water Services Limited.

Justification: Above reference to be used to reference detailed designs for the project.

Project Planning and Management. (2023). *Functional Engineering Report: Detailed Designs of a Wastewater Collection and Treatment System for the Village of Caye Caulker, Belize*. Project Planning and Management Limited and Belize Water Services Limited.

Justification: Above reference to be used to reference designs and engineering considerations for the project.

Ryan, E. (2023, May 31). *Types of sources explained: Examples & tips*. Scribbr. https://www.scribbr.com/working-with-sources/types-of-sources/

Justification: Above reference to be used to define information sources for the methodological framework.

Satter, S. (2023, August 18). *Analytical research: What is it, importance + examples*. QuestionPro. https://www.questionpro.com/blog/analytical-research/

Justification: Above reference to be used to define analytical research methods for the methodological framework.

SIB. (2023). *Census reports*. Statistical Institute of Belize. https://sib.org.bz/publications/census-reports/

Justification: Above reference to be used to reference statistical data about Belize.

Team, S. S. N. (2023, September 14). *Managing wastewater in Caribbean Islands*. Seven Seas Water. https://sevenseaswater.com/managing-wastewater-in-caribbean-islands/

Justification: Above reference to be used in the introduction to define the impact of wastewater treatment in small developing islands.

UNEP (2019). Small Island Developing States Waste Management Outlook. Accessed at: https://www.oneplanetnetwork.org/sites/default/files/from-crm/SIDS_WMO-UNEP_compressed.pdf

Justification: Above reference to be used in the introduction to define the impact of wastewater treatment in small developing islands.

Appendix 5: Philologist Review Report

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Belize, C.A.

November 29th, 2024

Academic Advisor
Master's degree in project management
Universidad para la Cooperación Internacional (UCI)

RE: Declaration as a Certified Translator

To Whom It May Concern:

I, Chanelle Kristine Lizarraga, a Certified Translator in Belize for the English and Spanish languages, hereby declare that I have reviewed the work entitled "***Project Management Plan for the Implementation of a Wastewater Treatment System for the Island of Caye Caulker, Belize***" by Mr. Ervin Flores.

This final graduation project has been thoroughly revised and proofread. I confirm that all corrections noted during the review process have been made by Mr. Flores and that the work meets the literary and linguistic standards required for a Master's-level degree.

Chanelle K. Lizarraga
Certified Translator