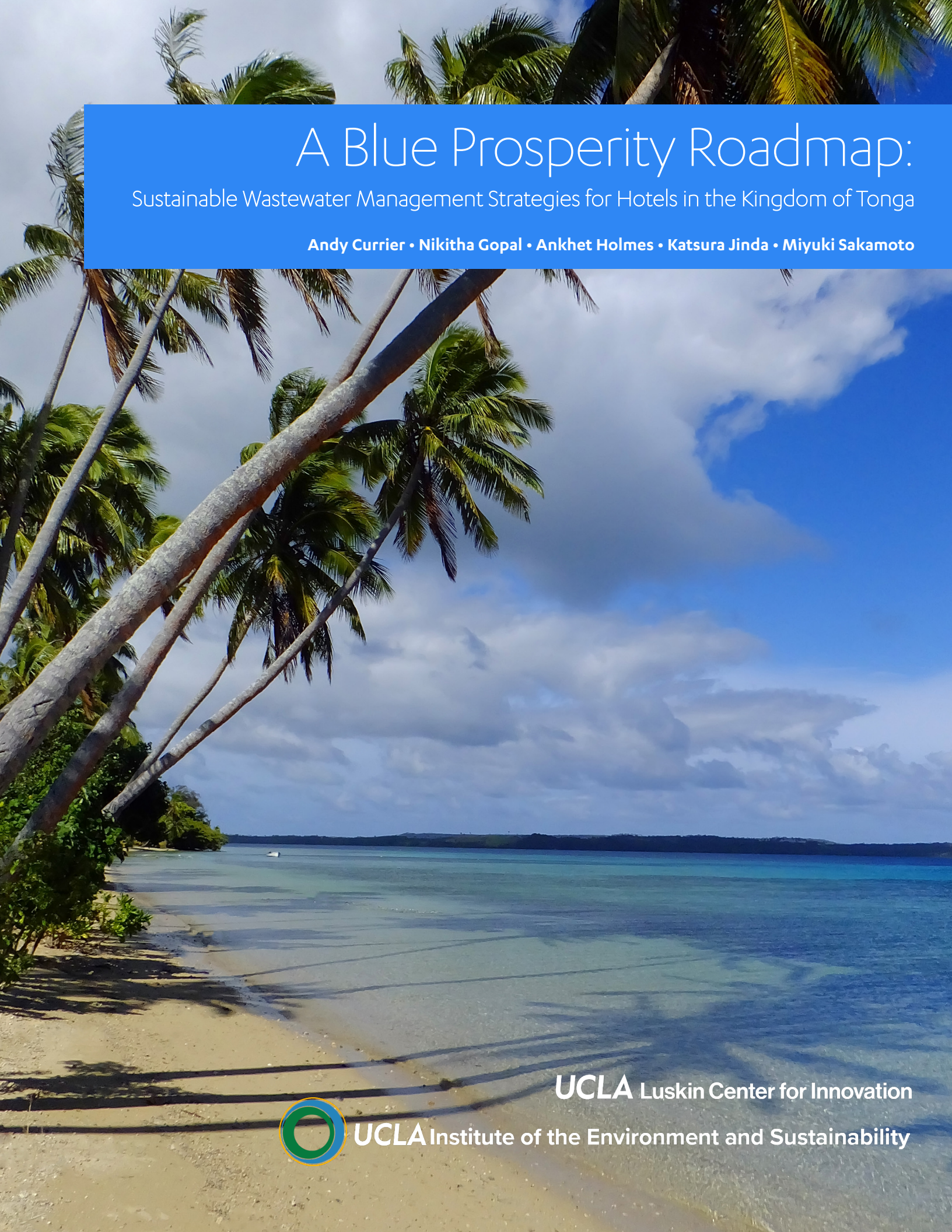

A Blue Prosperity Roadmap:

Sustainable Wastewater Management Strategies for Hotels in the Kingdom of Tonga

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Disclaimer

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Executive Summary

Small Island Developing States (SIDS) rely heavily on tourism as a strategy for economic development. Unfortunately, SIDS are uniquely vulnerable to the negative environmental impacts that tourism can generate, and must plan, manage, and monitor the sector's growth carefully. One consequence of increased tourism is increased wastewater flows, which if left untreated, can have devastating effects on ocean biodiversity and human health, and undermine the island as a tourism destination.

The Waitt Foundation believes that tourism growth and economic development can coincide with ocean conservation if SIDS use a "Blue Economy" framework. As a subset of a larger "Blue Prosperity" project, the Waitt Foundation commissioned our team to investigate how the Kingdom of Tonga (Tonga) can improve their hotel wastewater management. Tonga's hotels are currently using ineffective and detrimental wastewater systems, and their burden on the environment is increasing as the Tongan tourism economy experiences unprecedented growth. Our analysis focuses on answering:

What wastewater management strategies should the Kingdom of Tonga prioritize for sustainable hotel development?

Wastewater Management Issue Areas	
Governance Challenges	**Agency Structure:** Tonga has a structurally deficient agency structure with underdeveloped mandates and conflicts of interests.
	Agency Financing: Tonga's agencies are underfunded, resulting in an inability to effectively execute their mandated missions.
Regulatory Challenges	**Regulatory Framework:** Tonga's regulatory framework is lacking both prescriptive and punitive regulation.
	Financing Regulatory Compliance: Tongan hotels require assistance in order to comply with wastewater regulation.
Hotel Incentive Challenges	**Lack of Incentives for Hotel Action:** Tongan hotels have minimal incentive to improve their wastewater systems or habits on their own accord.

Table 1: Key hotel wastewater management challenges in the Kingdom of Tonga

Through a comprehensive literature review and interviews with regional experts, our team assessed the current wastewater management landscape in Tonga and found challenges in three main areas: governance challenges (agency structure and financing), regulatory challenges (regulatory framework and financing regulatory compliance), and hotel incentive challenges (lack of incentives for hotel action). The specific problems within those areas are broken down in Table 1.

In lieu of a single silver bullet, our solution to address these issue areas was to build a roadmap of improvements for wastewater management. For each problem above, we found best practices from similar countries. We then compared and ranked those strategies' viability in Tonga by their effectiveness in reducing wastewater pollution, their political feasibility, their financial feasibility, and their adoptability for hotels. The culmination of this process was a multi-step solution for how Tonga can build a cohesive wastewater management strategy for their hotels:

1. Agency Structure: Tonga should **reorganize functions, clarify responsibilities, and eliminate conflicts of interest** allowing **a single agency** take the lead on coordination. This can be achieved through passing the Water Resources Bill currently under consideration.
2. Agency Financing: Tonga should increase their **departure fee** to secure a large stream of revenue earmarked for wastewater management.
3. Regulatory Framework: Tonga should institute **progressive uniform regulation** to retrofit current facilities to appropriate standards and have clear guidelines for any new lodging facilities.
4. Financing Regulatory Compliance: Tonga should offer **subsidies** to hotels in need of retrofitting to help them comply with the new regulation.
5. Incentivizing Hotel Action: Tonga should implement a **green business program** to incentivize hotels to make their own changes to earn status attractive to discerning tourists.

We believe that if Tonga follows this roadmap with prudent consideration of their local geographic, political, economic, and cultural context, they will successfully improve current wastewater management systems as well as establish an impressive framework for future advancement.

Glossary of Acronyms and Terms

Acronyms

DOH	Department of Health
ECAL	Environment and Climate Adaptation Levy (Fiji's tax program)
EIA	Environmental Impact Assessments
EPA	Environmental Protection Agency
GDP	Gross Domestic Product
HGBP	Hawai'i Green Business Program
IFC	International Finance Corporation
IoES	Institute of the Environment and Sustainability
LCCs	Large Capacity Cesspools
MLNR	Ministry of Lands and Natural Resources
MOH	Ministry of Health
MOI	Ministry of Infrastructure
MOT	Ministry of Tourism
NWRC	National Water Resources Committee
PPP	Public–private partnership
SDGs	Sustainable Development Goals
SIDS	Small Island Developing States
SPC	Pacific Community
SPREP	Secretariat of the Pacific Regional Environment Program
TOP	Tongan paʻanga (Tongan currency)
WRB	Water Resources Bill
WSS	Water and Sanitation Sector
WSSCD	Water and Sanitation Sector Coordination Division

Terms

Biochemical Oxygen Demand (BOD)	"The amount of oxygen consumed by microorganisms in decomposing organic matter in stream water" (EPA 2012). Wastewater is a source of BOD for water bodies. Higher BOD means worse effects on the water ecosystem. "The greater the BOD, the more rapidly oxygen is depleted", oxygen that would go to "higher forms of aquatic life" like animals (EPA 2012). Treating wastewater to higher degrees reduces BOD.
Blue Economy	"The sustainable use of ocean resources for economic growth, improved livelihoods and jobs, and ocean ecosystem health" (World Bank 2017). It can encompass development in tourism, fisheries, maritime transportation, renewable energy, waste management, among other industries.
Blue Prosperity	The belief that "through sustainable use of ocean and coastal resources, islands can achieve greater economic stability and financial independence" (IoES 2019).
Exclusive Economic Zones (EEZs)	"Coastal waters and seabeds to which countries claim exclusive rights" (IoES 2019).
Greywater	All wastewater generated in the home, except toilet water (which is considered "blackwater") (Brain 2015)
Primary Treatment	Treatment that "removes solids by filtration, sedimentation, and chemical coagulation" (Clean Water Branch 2019).
Secondary Treatment	Treatment that "removes most of the organic matter in the wastewater using biological processes" (Clean Water Branch 2019).
Tertiary Treatment	Treatment that "removes additional organic matter, nitrogen, phosphorus, or toxics" (Clean Water Branch 2019).
On site	Centralized wastewater treatment facilities that collect waste from a variety of sources to then treat it in one location. As a contrasting concept, "off site" refers to decentralized treatment facilities
Septic Tanks	"Wastewater storage units" that allow for primary treatment where solids sink to the bottom and floatable material rises to the top (Clean Water Branch 2019). These materials must be removed regularly or they will leech into the environment.
Cesspools	"Cesspools are generally large, cylindrical excavations used to receive untreated wastewater. Solids are retained in the cesspool and the liquid percolates into the surrounding soil" (Clean Water Branch 2019). They are not considered treatment facilities as they discharge almost raw waste into the surrounding environment.

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Section 1: Introduction and Client

Poor sanitation systems that allow untreated human waste into the environment inflict a variety of ills on the environment, human health, and economic development. Implementing an effective and sustainable wastewater management system is a crucial part of sustainable development in any part of the world. Yet, despite its importance, wastewater management receives considerably less attention than other development projects. Major barriers to effective sanitation include the lack of capital, water quality standards and monitoring, and government accountability and management (Montgomery 2007; WWAP 2017; Stakeholder Interviews 2019). Investments alone will not offer access to clean water and sanitation for all, given the range of stakeholders involved and complexity of the issue. Improving sanitation requires a whole scale systems approach: from changing national policies; to improving governmental agency coordination; to securing capital and developing infrastructure, engaging technical experts, and modeling household level behavior change.

Small Island Developing Nations (SIDS) introduce a new set of geographic and economic issues to this mix. While SIDS make up only a small portion of the world's population, they control almost 30% of all "coastal waters and seabeds to which countries claim exclusive rights" (IoES 2019). These Exclusive Economic Zones (EEZs) extend 200 nautical miles from coastlines and often make up a much larger geographic area than the islands' land area. Given this fact, along with SIDS' reliance on ocean-based industries such as fishing and agriculture, poor sanitation systems directly impact economic development and the livelihoods of island residents.

Additionally, the pristine beaches, coral reefs, and biodiversity found on small islands make the tourism sector a significant contributor to their economies, as well as an attractive mode of future growth (Pratt 2015). Efforts to expand tourism in SIDS can be constrained by poor sanitation and waste management, especially if it negatively impacts the health of the environment that draws tourists to the island. Scattered populations, low lying territory, and susceptibility to natural disasters and climate change further increase the difficulty of wastewater management for Pacific SIDS' systems.

At the behest of our client, the Waitt Foundation, we focus on hotels in the Kingdom of Tonga (Tonga) and how they can begin to push their growing tourism sector towards effective wastewater management practices. Given the prominent role the tourism sector plays in Tonga's development plans, failing to adequately manage wastewater could have major implications as the sector grows. Hotels in Tonga do not currently manage wastewater sustainably, relying on septic tanks that leach waste into the environment - the cumulative result of failures in policy, governance and regulation.

To address these challenges, we ask: **What wastewater management strategies should the Kingdom of Tonga prioritize for sustainable hotel development?**

Client

The Waitt Foundation is a nonprofit organization founded in 1994 by Ted Waitt to restore oceans to their full productivity by the sustainable use of ocean resources referred to as the "Blue Economy". Through grants, technical assistance, and support for ocean science, they help governments, academies, and other non-governmental organizations (NGOs) in the field of ocean conservation. As a part of a new "Blue Prosperity" project, the Waitt Foundation has commissioned The University of California, Los Angeles' (UCLA) Institute of the Environment and Sustainability (IoES) to lead a cross-campus initiative to create sustainability toolkits for SIDS. The toolkits will advise small island nations on a number of issues relevant to their environment and economy: wastewater management systems, tourism, ports, human capital, financing, and emerging risks. They are a part of the Waitt Foundation's greater goal to encourage SIDS to commit to protect a certain percentage of their ocean territory from pollution, overfishing, and other habits that degrade the environment. In exchange for signing a legally binding memorandum of understanding (MOU), the small island nation will receive funding, advisement, and technical assistance to help them preserve and restore their ocean without disrupting economic growth.

The Waitt Foundation is currently in talks with Tonga's government about signing an MOU to begin protecting their ocean territory in exchange for funding to develop their "Blue Economy". Our project assumes that the country will agree to the memorandum and our toolkit will help guide their next steps to ensure their ocean territory is protected and restored, while they continue to develop.

Before investigating Tonga, an examination of the importance of wastewater management, particularly in the context of the South Pacific Region where Tonga is located, is deserved.

Section 2: Background

Poor sanitation systems that allow untreated human waste into the environment inflict a variety of severe negative externalities upon countries, localities, populations, and the globe. These externalities impact environmental and human health that in turn negatively impact economic development. Although this issue is of global importance, the detrimental effects are magnified in the context of SIDS. While the United Nations' Sustainable Development Goal (SDGs) 6: Ensure Access to Safe Water Sources and Sanitation For All aims to address this problem, wastewater management continues to receive less attention than other development efforts, taking a backseat on the global stage.

Wastewater and Environment

Inadequate management of wastewater has significant impacts on environmental sustainability. Domestic wastewater discharges are considered one of the most significant threats to coastal environments worldwide (Creel 2003). Large volumes of untreated wastewater discharged into oceans often result in nutrient enrichment or increased nutrient levels known as eutrophication. The excess nutrients "negatively impact the structure and functioning of freshwater and marine ecosystems by temporarily boosting the growth of certain plant species, especially algae," leading to algal blooms (UNEP 2016). This environment limits light penetration, having disastrous effects on plant and animal species reliant on sunlight, and increases pH levels to extremes during the day. When these dense algal blooms die, oxygen levels are severely depleted, creating "dead zones" that lack sufficient oxygen to support most organisms (Chislock 2013).

Wastewater and Health

Poor sanitation is directly linked to the transmission of a variety of diseases including: cholera, diarrhea, dysentery, hepatitis A, typhoid and polio (WHO 2018). For example, of the 1.5 million premature deaths caused by diarrhea that occur globally each year, an estimated 88% are attributed to inadequate water, sanitation, and hygiene (Pruss-Ustun et al. 2015). The human health impacts also cost the world a tremendous amount of money, with one estimate indicating costs of approximately $223 billion United States dollars (USD) each year (World Bank 2018; Gates Foundation 2018). Improving water sanitation and hygiene (WASH) could prevent up to 10% of the global burden of disease (Pruss-Ustun et al. 2015) and significantly reduce the negative health effects associated with poor management.

Global Action

Given the linkage between sanitation and broader development challenges, the international community has tried to address this issue. In 2000, when United Nations' member states set the Millennium Development Goals, Goal 7, centered on environmental sustainability, was to

decrease the population of people with limited access to clean water and sanitation around the world by 50% by 2015 (WHO/UNICEF 2015). The sanitation component of this goal was widely missed; over 700 million people continued to lack access to basic sanitation (WHO/UNICEF 2015; Satterthwaite 2016). The failure of Goal 7 can be traced to the lack of improvements in developing and least developed countries, as well as a global deprioritization of sanitation compared to improved access to clean water (Satterthwaite 2016). This is an unfortunate reality considering the interrelated nature of the two. If a country can realize a clean water supply, yet falls behind on providing sanitation, the untreated human waste can undermine the provision of clean water and increase the burden of disease (Alsan 2015).

Addressing the remaining gap in water and sanitation has been prioritized in the 2030 Agenda for Sustainable Development under Goal 6: Ensuring Access to Safe Water Sources and Sanitation For All. Attaining this ambitious target will not be accomplished with a one size fits all solution or large investments alone given the complex nature of providing clean water and sanitation. Wastewater treatment facilities and technologies of the past will need to be adapted and reinvented to differing local conditions and infrastructural realities (Gates Foundation 2018). Though this may require significant upfront investment, strong evidence supports an increased rate of return for sanitation-based investments. Global estimates state that each dollar spent on sanitation projects has led to at least $5 USD of return, a ratio that inspires future and continued investment (Gates Foundation 2018: World Bank 2018)

Section 3: Project Workflow and Methodology

The goal of this project is to recommend policy interventions for sustainable wastewater management in the Kingdom of Tonga. In order to do this, we collected detailed background information on the current wastewater landscape in Tonga, identified and studied successful strategies from demographically and/or geographically similar islands around the world, evaluated these strategies against a robust criteria, and finally presented the most effective strategies for the Tongan government to pursue. Figure 1 depicts our project workflow, which we explain in detail below.

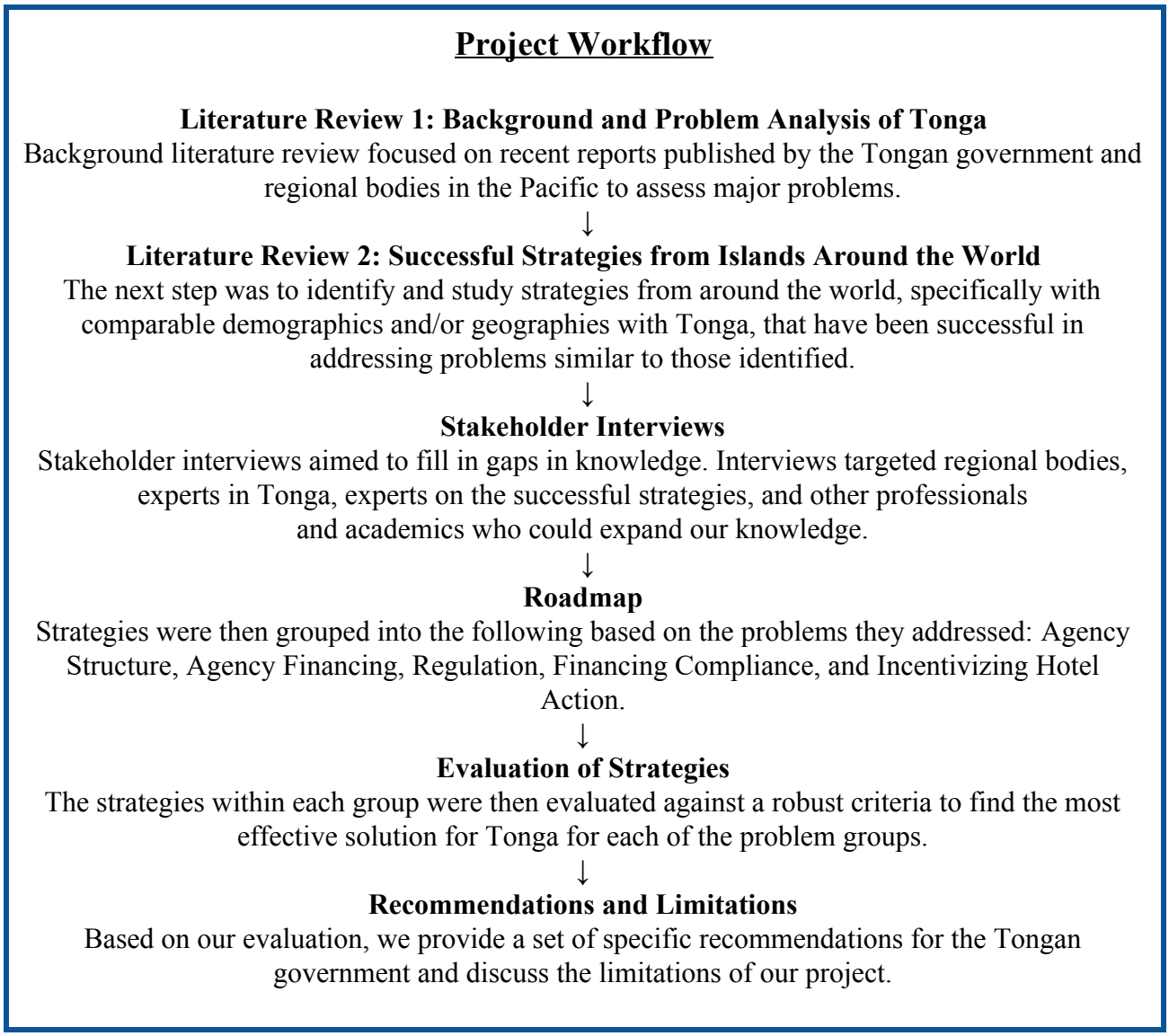

Figure 1: Project Workflow

Literature Review

The Tongan government websites are not kept up to date and offer limited access to recent reports and data. External research projects on Pacific SIDS are also relatively limited. Despite these limitations, we analyzed a number of recent government reports with relevance to wastewater management. Key reports obtained from the Tongan government include: The *Tourism Roadmap,* the *National Infrastructure Plan,* and *The Tongan Government Budget Statement 2018/9*. Our analysis additionally draws from reports published by regional bodies with a focus on Tonga. This includes reports published by the Pacific Community (SPC), a leading scientific regional body in the Pacific; the Secretariat of the Pacific Regional Environment Programme (SPREP), an intergovernmental organization focused on environmental issues in the Pacific; and a number of reviews by the International Finance Corporation (IFC).

Given the similarities between Tonga and a number of other SIDS, our analysis identifies strategies implemented in other countries that effectively manage wastewater. While limited water quality data exists throughout the Pacific, reports from regional bodies and stakeholder interviews identified a number of countries that manage wastewater effectively. We then identified the core components of successful management from these cases and analyzed their applicability to Tonga.

Stakeholder Interviews

Stakeholder interviews focused on filling in the information gaps from the literature review, as well as placing the information we already had into the broader environment of Tonga and Pacific SIDS. In order to do this, we identified and targeted key stakeholders in the following four groups: **regional bodies** with broad knowledge of Pacific SIDS, individuals located on the **island of Tonga** with knowledge of the local context, individuals from other islands around the world who have knowledge of the **policy options** we were studying and **other** international experts who could answer questions. You will find more detail on each stakeholder interview in Appendix 1.

At the end of each interview, we inquired if we could be connected to anyone else with subject matter expertise regarding the topics we had discussed. We used this form of "snowball sampling" to identify additional subject matter experts to consult. When granted permission, interviews were recorded to ensure accuracy.

The next chapters of this report will explain the current situation in Tonga, the criteria for evaluating sustainable wastewater management strategies, the evaluation of strategies, our recommendations, and limitations of our analysis in more detail.

Section 4: Tonga Problem Analysis

4.1: Overview of Tonga

The Kingdom of Tonga (Tonga) is a country of islands in the South Pacific (see Maps of Tonga, Appendix 2). A constitutional monarchy and parliamentary democracy, the country is led by King Tupou VI, Prime Minister ʻAkilisi Pohiva and an elected legislative assembly (Commonwealth Network 2019). The middle-income country has a GDP of $427 million USD and a population of a little over 108,000 people (World Bank 2017). Though the country has over 150 islands, only 36 are inhabited, with the population concentrated on Tongatapu, Utu Vava'u, Eua, and Niuafo'ou islands. Main industries include subsistence forms of living (e.g. farming, fishing, hunting), construction, and tourism (CIA 2019). See Appendix 3 for further background data about Tonga.

Though Tonga has a smaller tourism industry than many other islands in the South Pacific, it has ambitious goals for the industry's growth. In 2014, tourism directly accounted for $50 million Tongan paʻanga, Tonga's currency (TOP), with total expenditure making up 15% of total GDP (TRIP Consultants 2013). In 2016, Tonga received over 59,000 tourists, an increase of 10% from the previous year (South Pacific Tourism Agency 2017). That year, Tonga received approximately 3% of the total number of visitors to the South Pacific Islands, ranking 10th as a tourist destination (South Pacific Tourism Agency 2017). By 2020, Tonga aims to have tourism account for 30% of GDP and generate over $100 million TOP in Gross National Income (GNI), while increasing the number of annual arrivals to 80,000 (TRIP Consultants 2013).

Tonga currently has 85 different accommodation options and approximately 957 total rooms available to tourists - ranging from small guest houses with a handful of rooms to large hotels (TRIP Consultants 2013). Approximately 60% of hotels are smaller properties that are locally owned. The largest property, the International Dateline Hotel in Nukualofa has 125 rooms and is owned by the Tongan government (TRIP Consultants 2013). The next largest properties are the Puataukanave International Hotel (36 rooms), and a few hotels/guest houses with 12 rooms (Ibid).

Tonga Hotel Wastewater Management: Current Overview

Understanding the challenges and potential solutions to how hotels in Tonga manage wastewater requires a brief overview of the wastewater treatment process. Without a reticulated central sewage system, wastewater in hotels is treated through the use of septic tanks (Stakeholder Interviews 2019). When a toilet is flushed or water runs from sinks and showers down the drain, it is piped into the septic tank. Once in the tank, it is held for a period of time sufficient for solids to settle down into the bottom and form a "sludge" layer. The oil and greases rise to the top as "scum" and are kept in the tank by designed compartments and outlets (EPA 2018).

Once the solids have settled to the bottom and scum has risen to the top, the liquid wastewater, known as "effluent" exits the tank and is funneled into a drain field. Drain fields are shallow, covered excavations made in unsaturated soil (EPA 2018). At this stage, the wastewater has been given what is known as "primary treatment" as the major solids have been removed (FAO n.d.). A visual representation of the internal functions of a septic tank is provided below in Figure 2. Figure 3 describes an example of septic tank settlement.

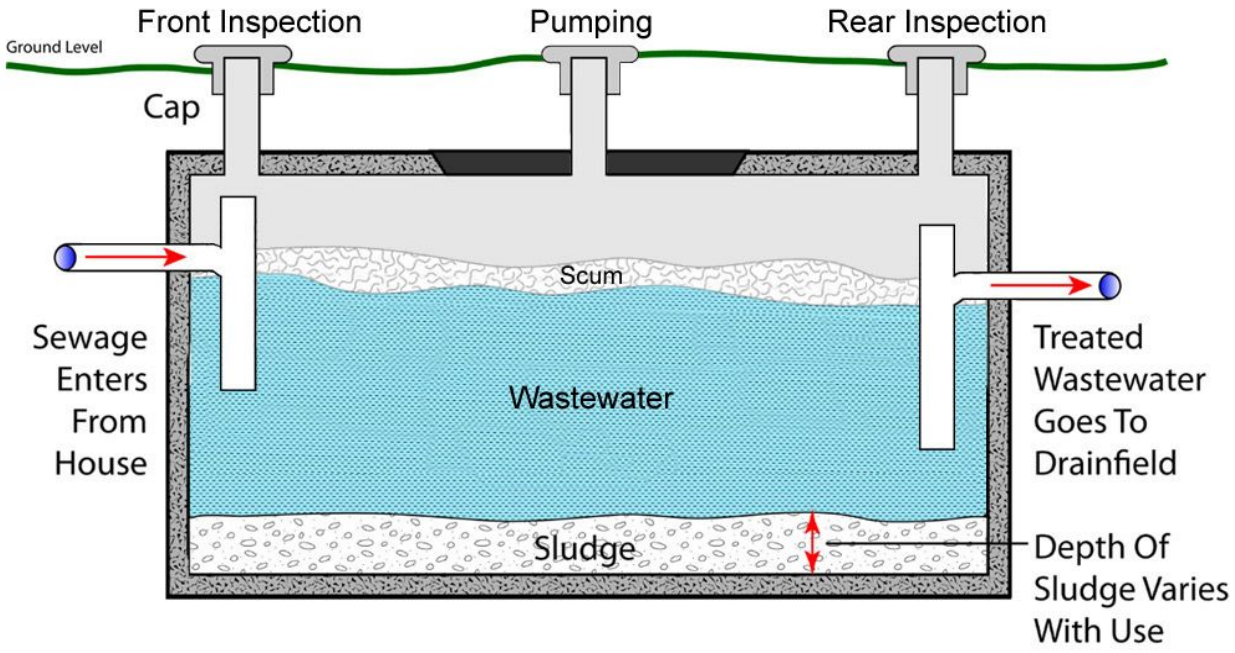

Figure 2: Septic tank internal function (EPA 2018)

Once wastewater enters the drain field, the effluent is naturally treated as it filters through the porous soil (Canter & Knox 1985). The soil provides additional secondary treatment of the effluent by naturally removing harmful coliform bacteria, viruses and nutrients (EPA 2018). This natural purification process can only successfully treat a certain level of effluent effectively and can be overburdened in a number of ways (Canter & Knox 1985).

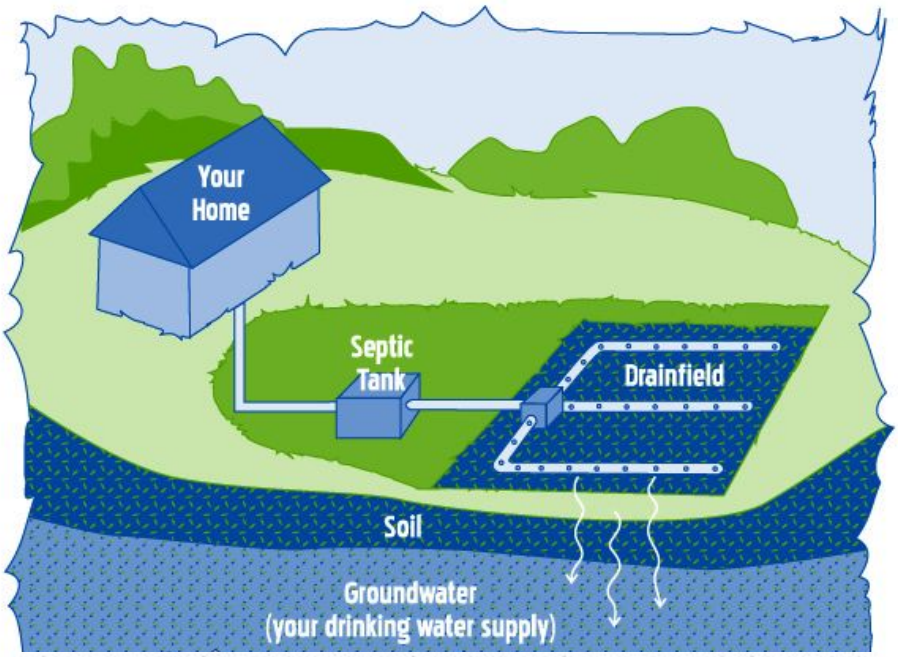

Figure 3: Septic System Overview (Groundwater Foundation 2019)

In theory a properly functioning and maintained septic tank and correctly placed drainage field remove harmful bacteria from wastewater and allow it to percolate back into the water table without causing adverse impacts on the environment and human health (Carter & Knox 1985). On the ground in Tonga, a number of challenges arise. Primarily, septic tanks are not de-sludged with adequate frequency and drainage fields are often poorly placed near coastal waters (Stakeholder Interviews 2019). As a result, the effluent can flow directly into the ocean or nearby bodies of water before having harmful bacteria removed.

As the natural and pristine beauty of Tonga remains a primary asset in attracting tourists to the island, visible pollution will have direct economic consequences as well (Lal & Takau 2006). Poor septic tank placement in addition to improper maintenance have led to visible issues with groundwater, marine pollution and human health (Stakeholder Interviews 2019; Newton 2008), posing a considerable risk to future tourism growth. Current impacts are poorly quantified by the available data, however, there are some clear indicators. Aesthetic concerns regarding poor waste management have already been raised, as visitor surveys frequently cite the issue of litter and garbage on Tonga's beaches and urban areas (Lal & Takau 2006; TRIP Consultants 2013). The Fanga'uta Lagoon, a critical contributor to the economic and environmental health of Tonga, has been on the decline for several years largely due to damaged septic tanks and their placement near flood zones, with recent interventions having limited impact on eutrophication effects (Kingdom of Tonga 2017). Tonga has also experienced several waste-related typhoid, dengue and cholera outbreaks, as recently as 2018 (RNZ 2017; RNZ 2018).

During the literature review and stakeholder interviews, it became clear that given financial and geographic constraints, Tonga is likely considerably far off from implementing a centralized reticulated sewerage system (system of pipes, sewers, and drains that are used

to convey sewage from a property to a sewage treatment plant that could provide tertiary treatment of water). As a result, our analysis focuses on improving the current decentralized system of wastewater management and reducing the negative externalities associated with a breakdown of the septic tank and drain field system. However, future plans should work towards providing higher levels of water treatment. Beyond the primary treatment provided by the current system, the process and end result of secondary and tertiary treatment are overviewed in Figure 4 below. Treating water at the tertiary level could allow Tonga to reuse wastewater for drinking purposes and directly address rising water scarcity amidst the impacts of climate change (Kingdom of Tonga 2015).

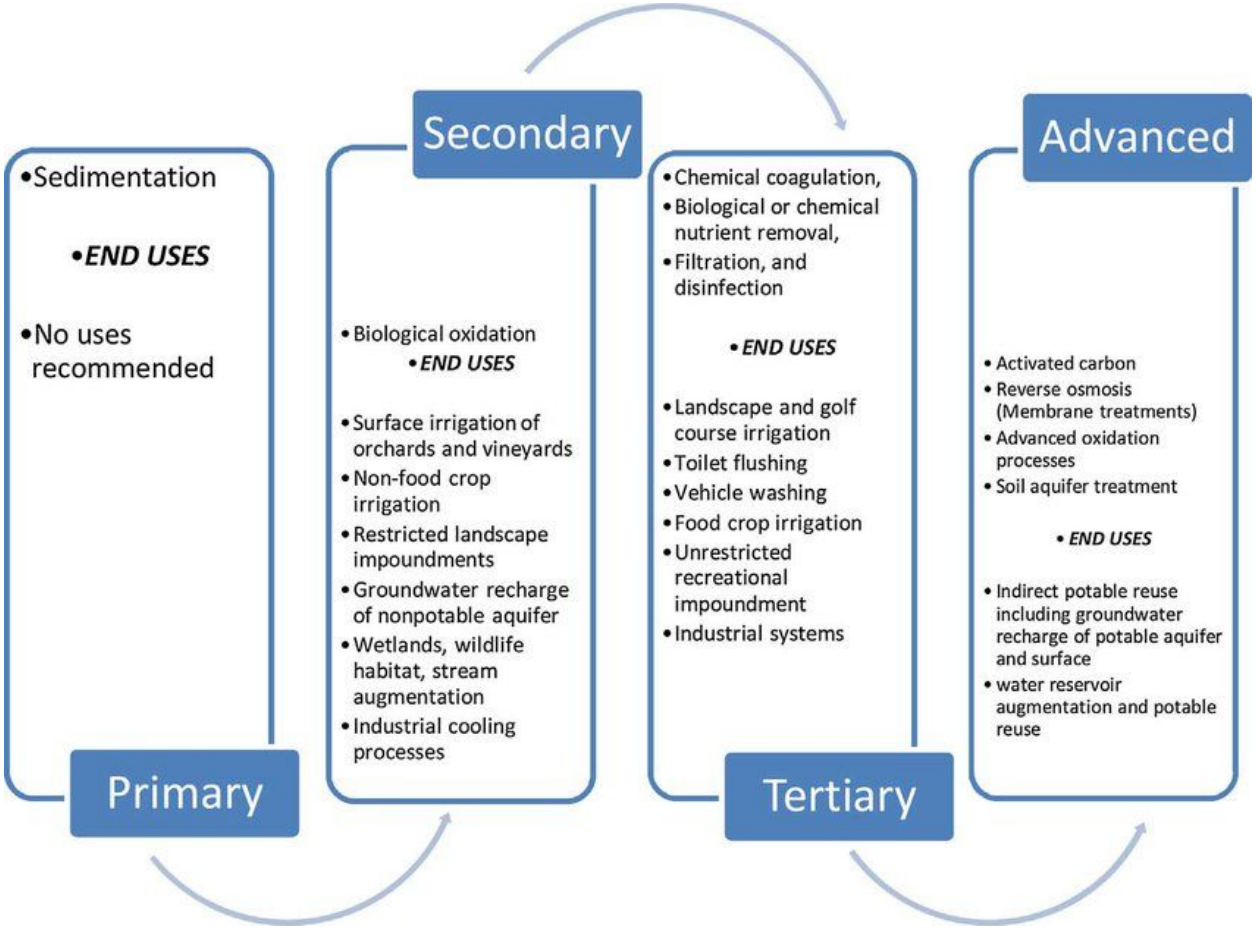

Figure 4: Wastewater treatment levels (Maryam et. al. 2017)

4.2: Why Hotels?

Our project scope focuses on hotels for three reasons:

1. The hotel industry generates significant amounts of waste and the problem will only be exacerbated as tourism to Tonga increases.

Tonga's tourism sector is projected to experience significant growth. Increased tourism will lead to increased water usage and consequently higher levels of wastewater generation. There are two primary reasons for this. Firstly, tourists use more water on holiday than at home because of their "pleasure" attitude while on vacation. This usage is estimated to be 330L per day versus 222L per day at home, but can go upto 2000L per day (Ceron et al. 2012). Secondly, hotels use significantly more water than households due to the watering of gardens, swimming pools, daily cleaning of rooms, and laundry (Ibid). Additionally, the majority of hotels in Tonga are located in Nuku'alofa, the capital, and so the detrimental impact of wastewater is severely concentrated (Ibid). These effects are exasperated annually between May and October during peak tourist season (Stakeholder Interview 2019).

2. Hotels currently use septic tanks, a treatment method that is both inefficient for their capacity and damaging to the environment when improperly maintained.

Hotels in Tonga are completely reliant upon septic tanks, the same rudimentary treatment systems that individual households use. Septic tanks require proper placement, regular sludge removal and effective facilities to dispose of sludge in order to avoid the contamination of ground and surface water with dangerous bacteria. Though hotels are large generators of waste, in Tonga they have not been examined or addressed in wastewater management policy. In Tonga, the tourism industry is robust and one of the crucial contributors to their GDP, but they have no policies for encouraging high levels of wastewater treatment. As the peak tourist visitor season is concentrated over a relatively short time frame, the influx of visitors can overwhelm septic tank systems.

3. Hotels are uniquely capable of making changes to their wastewater management habits.

The revenue from tourism gives hotels greater financial resources to handle the added burden of wastewater regulation. Individual households will have a harder time, with their fixed income, to make the necessary upgrades. Hotels also have a strong commercial imperative for reducing their water use since hotels often pay for their water use twice - first by purchasing fresh water and then paying a fee for the disposal of wastewater. Additionally, proper wastewater management will ensure tourists can continue to enjoy the environment that attracted them to the locale, consequently improving their business prospects. Sustainability-related improvements by hotels will also likely have positive externalities. These may include new avenues of employment, a new market for "green tourism", and the spread of environmental awareness.

4.3: Structural Challenges for Hotel Wastewater Management in Tonga

This section examines the structural issues that lead to poor wastewater management for hotels in Tonga, through a closer examination of governance challenges and agency financing, the regulatory landscape, and the lack of incentives for hotels' to prioritize wastewater management.

Governance Challenges

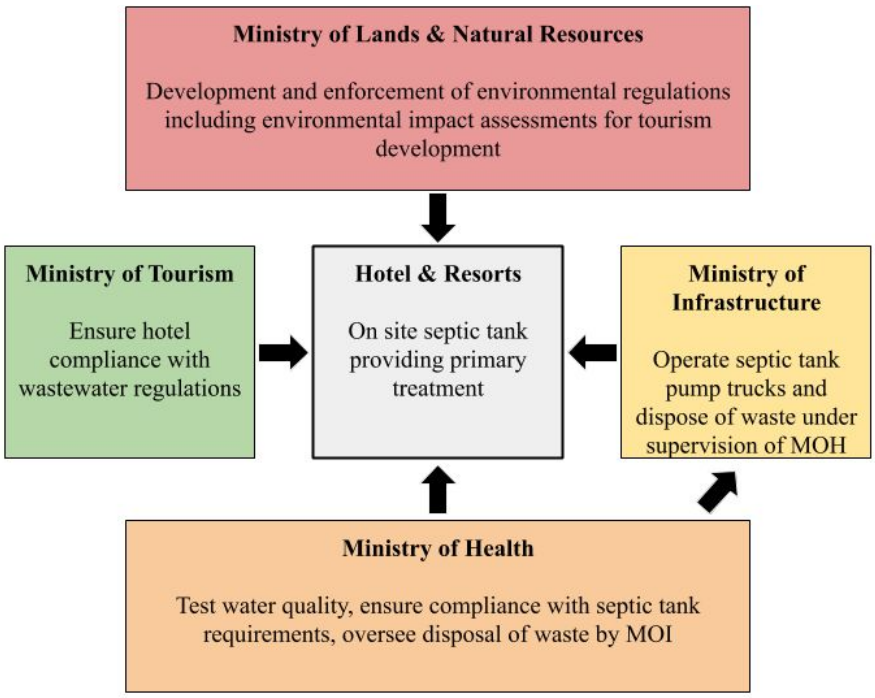

Figure 5: Current agency structure for all Tongan ministries involved with the management of hotel wastewater.

Agency Responsibility & Structure

A variety of agencies have responsibility for various stages of managing sanitation and wastewater for hotels in Tonga (See Figure 5). The Ministry of Health (MOH), tasked with testing water quality is also responsible for ensuring the functionality and proper design of septic tanks. The agency works in coordination with the Ministry of Infrastructure (MOI) to desludge septic tanks and responsibly dispose of it (SPC 2018; Lal & Takau 2006). Responsibility for ensuring that hotels and resorts comply with wastewater regulations falls to the Ministry of Tourism (MOT). Finally, the Ministry of Lands and Natural Resources (MLNR) develops and enforces environmental regulations, including environmental impact assessments and zoning for tourism development.

Structural & Performance Issues

Data on water quality in Tonga remains scarce as the MOH lacks the funding and capacity to conduct testing with appropriate frequency (SPC 2018; SOPAC 2007). While septic systems require routine desludging and drainage, this does not happen with adequate frequency and drainage only occurs after a leak has been spotted (SPC 2018). Reports estimate that septic tank drainage happens fewer than once every five years, far under the required timeframe for functional upkeep regardless of size (SOPAC 2007). While the MOH has clear responsibility for testing and monitoring water quality, specific water quality standards are not specified within the legal framework (SOPAC 2007). Additionally, the test results are not required to be made public, undermining the public's ability to hold polluters and agencies accountable.

Given this landscape of agency responsibilities for each stage of hotel wastewater management, a high degree of coordination is required. The current system would benefit from clarification of roles and responsibilities across the water and sanitation sectors in addition to increased coordination and cooperation within the sector (Tonga National Infrastructure Plan 2013).

Agency Financing Issues

Stakeholder interviews and a literature review identify chronic agency underfunding as a major barrier to effective wastewater regulation and oversight. Improving sanitation broadly has not been a priority issue in Tonga as reflected by the most recent 2019 budget statement. The Tonga Strategic Development Pillars contain 30 priorities across the the five sectors of economic institution, social institution, political institution, infrastructure and technology and natural resources and environment. Sub Indicator 4.6 of the infrastructure and technology pillar, focuses on "building a more reliable, safe, affordable water supply and control, and sanitation services" (Government of Tonga Budget Statement 2018/9). In 2017/8 this goal was earmarked to receive $133,000 USD, yet only ended up spending roughly $89,000 USD (Government of Tonga Budget Statement 2018/9). In 2018/9, the spending on this goal is again estimated to be $133,000 USD and comprises just 0.082% of the total budget of roughly $162 million USD (Ibid).

While improving sanitation has been listed as one of the 30 key government priority areas, the level of funding budgeted and actually received illustrate limited financial support. While this does not make up the entirety of the budgets for the relevant wastewater management agencies, it underscores how low improving sanitation remains on the priority list for Tonga. Insufficient funding has greatly limited the ability of the MOH, MOI and MOT to adequately carry out their stated missions.

Regulatory Challenges

Prescriptive Regulation

According to the International Finance Corporation's (IFC) *Diagnostic Report* on Tonga's tourism industry, the current environmental regulatory framework in Tonga is "not sufficient to mitigate the risks related to environmental degradation through human population impacts and development" (IFC 2010). While nearly 10 years have passed since this diagnosis, the situation has not improved (Stakeholder Interview 2019). Currently, regulation affecting hotel wastewater systems includes the Public Health Act of 1992, a National Building Code from 2007, and the pending Water Resources Bill (WRB) of 2016 (remains under consideration). The National Building Code, which "contains specifications for septic tank design and construction" was only amended in 2007 (SPC 2007). Prior to the code, there was minimal direction for owners of septic tanks on proper construction, design, and upgrades except for a *2005 Manual of Residential Septic Tank Practice.* Without guidance for decades, "it is generally assumed that numerous tanks have been improperly constructed prior to the requirement for formal permit procedures" (SPC 2007). The IFC also believes the policy framework has inadequately defined processes for the application and resourcing for Environmental Impact Assessments (EIA's) carried out during the planning stages of building new hotels (IFC 2010). With the combination of inadequate EIAs and deficient septic tank building regulation, hotels have far too often been built on "reclaimed coastal land" that results in inadequately treated wastewater being directly emitted into the coastal and marine ecosystems (Stakeholder Interview 2019; IFC 2010). Even if properly maintained, a septic tank that leads to an improper drainage field results in effluent being discharged directly into the environment.

Punitive Regulation

While regulation currently fails to adequately govern wastewater discharge in Tonga, the proposed WRB from 2016 does have a fine for pollution in place. The fine specifies that any person found to be discharging pollutants into Tonga's water resources will be fined up to $50,000 TOP, or $100,000 TOP in the case of a company or 10 years imprisonment (WRB 2016). As the WRB has stalled, fines are currently not enforced and many individuals drain greywater straight into the ground (Prescott 2007). This is likely because without adequate wastewater technology regulation, people have not understood or cared about this form of pollution. Wastewater pollution is often invisible as it only shows up in septic tank leaks or in groundwater pollution in the long run. With no fine in place yet, Tonga is also being deprived of a potential source of revenue that could contribute to monitoring or other state expenditures in this area.

Tonga's minimal regulation fails to do several things. It fails to set technical standards for appropriate levels of treatment of wastewater discharge to then give power to its punitive pollution laws, which could be a source of revenue. It fails to consider whether there are differential wastewater management needs to the Tongan geography, through adequate EIAs. Finally, it fails to think about how to improve the past mismanagement of wastewater and plan

for the future. This is an important consideration as Tonga looks to increase the sustainability of their growing tourism industry and the challenges of climate change and population growth.

Hotel Incentive Challenges

Lack of Incentives for Hotels to Take Action on Wastewater Management

Though there are plans for tourism growth, the state is missing out on an opportunity to encourage hotels to take on wastewater management improvements for themselves. Positive incentives like subsidies or public recognition would encourage Tongan hotels to improve their wastewater management systems for their own benefit, not by mandate or with the threat of punishment. Though curbing wastewater pollution would seem to be its own benefit, the effects of pollution are too far downstream, too communal, and go through too confusing of a process for it to be its own incentive. The absence of clear and visible positive incentives to return a benefit to hotel owners more immediately is a missed opportunity for Tonga.

Section 5: Roadmap and Criteria: Evaluating Sustainable Wastewater Management Strategies

Roadmap Structure

As presented in Section 5, wastewater management in Tonga presents several layers of challenges that need to be addressed individually. These layers are interdependent and addressing one will reinforce the progress made in another. We characterized these challenges as:

- Agency Structural Reform
- Agency Financing
- Regulatory Framework
- Financing Regulatory Compliance
- Incentivizing Hotel Action through Innovation and Consumer Demand

A cohesive agency structure creates the requisite foundation for any country to finance, implement, and evaluate effective wastewater management policy. Adequately financing the relevant agencies enables the government to enforce the regulatory framework as well as provide the necessary support to the private sector and ensure compliance. Ensuring compliance can involve a combination of prescriptive and punitive regulations in addition to financial support. Finally, incentivizing hotels to take action on improving wastewater management can serve as an additional step to reduce detrimental environmental and health impacts associated with untreated wastewater.

Strategy Option Criteria

For each problem area listed above, we found several different strategy options from around the globe to assess as potential solutions. Because Tonga is further behind in developing its wastewater management capabilities, there are many positive examples to draw upon. We relied on our literature analysis and stakeholder interviews to identify potential solutions, and instituted several measures to say that these practices were successful and comparable to Tonga's situation. Each strategy had to meet one or more of the following metrics in Figure 6:

Strategy Option Criteria

1. Strategy in place results in the effective management of wastewater in an island.
    - ❖ Metric: The percentage of country connected to wastewater treatment system and water quality levels.

2. Strategy resulted in significant improvement to wastewater management to reduce previously high environmental/human health negative externalities.
    - ❖ Metric: The World Health Organization (WHO) data 2016 on deaths and disability-adjusted life years (DALY) from poor sanitation.

3. Strategy has been adaptable to growing population or tourism.
    - ❖ Metric: Wastewater treatment system's capacity to manage larger amounts of waste.

Figure 6: Criteria for determining if each option is successful and should be considered in Tonga

Table 2 lists strategy options as defined by our geographic, health, and tourism requirements. Every chapter in the roadmap includes case studies of the strategy options that have been used in other places to overcome the specific issue Tonga is now facing. The options are then ranked for their ability to be successfully applied in Tonga.

(1) Agency Structural Reform	(2) Agency Financing	(3) Regulatory Framework	(4) Financing Regulatory Compliance	(5) Incentivizing Hotel Action
Effective Policy Framework	General Environmental Tax	Uniform Standards	Subsidies from Tax Credits	Innovative Technology
Agency Coordination	Increased Water Use Fee	Zoning	Revolving Loan Fund	Environmental Checklist
	Increased Departure Fee	Progressive Standards		Green Business Program

Table 2: List of strategy options organized by the challenge addressed

Evaluative Criteria

In order to evaluate these strategies, we utilized a criteria alternatives matrix for each problem grouping. Those that were easily implementable alongside other policies were labelled "complementary" and were not compared in the matrix, but were still evaluated for their ability to address the relevant problem section. The criteria we assessed strategies by includes:

- Effectiveness
- Political Feasibility
- Financial Feasibility
- Hotel Adoptability

All strategies were compared and given ranks between "Very Low" and "Very High" depending on the criterion (See Table 3 as an example). These results were then summarized across the criteria to determine the best options for Tonga to implement.

	Effectiveness	Political Feasibility	Financial Feasibility	Hotel Adoptability
Strategy Option 1	**High (Favorable)**	**High (Favorable)**	**Low (Unfavorable)**	**Medium**
Strategy Option 2	**Medium**	**Low (Unfavorable)**	**Medium**	**High (Favorable)**
Strategy Option 3	**Low (Unfavorable)**	**Medium**	**High (Favorable)**	**Low (Unfavorable)**

Table 3: Evaluation summary example. In the table, darker colors have more favorable rankings, while lighter colors have less favorable rankings.

Effectiveness in Reducing Wastewater Pollution

Effectiveness measures the degree to which wastewater pollution is reduced through improvements to the treatment process. Strategies that rank most favorably will be given "Very High" or "High" depending on the number of strategies being compared. The effectiveness criterion was given the highest priority, as any strategy that does not improve wastewater management is of little use to our client or Tonga. Reducing the level of untreated wastewater that reaches Tonga's environment is the primary goal of our project.

Available data on water quality in Tonga remains scarce and accurately determining the impact a policy will have on discharged water quality will be difficult. As a result, we evaluate the effectiveness of reducing wastewater pollution through the strategies' ability to speak to the more narrow issue they address. For instance, agency financing strategies are evaluated on their effectiveness in generating funds to complete agency duties, which should mean more effectively reducing wastewater pollution. This effectiveness measure is ultimately measuring tangible

results in wastewater improvements, but for each step of the roadmap how we get to wastewater improvement is different.

Political Feasibility

Political feasibility refers to how viable a proposed solution seems given the political climate of Tonga. This includes the idea of political willpower in the face of potential opposition or support by different segments of the population. Political feasibility is a core aspect to determining if a strategy can be implemented. Favorable strategies earn "Very High" or "High."

Wastewater and sanitation broadly do not carry political weight or rank highly in terms of priority areas in need of government action. Currently, action around pumping out septic tanks or testing water quality is only addressed by government agencies once a problem has manifested and the negative impacts are visible (Stakeholder Interview 2019). Passing new legislation in Tonga can be undone if broad stakeholder support has not been secured. In the case of the WRB, progress stalled after opposition from a farmers' group that did not feel included in the consultation process (Stakeholder Interview 2019). While passing each law comes with unique challenges, this signals the need for broad support before successfully passing legislation, especially if it is not currently seen as a high priority issue.

Financial Feasibility

Financial feasibility includes the administrative costs incurred by the Tongan government upfront and in the future to expand government responsibilities, properly implement and enforce new policies, and potentially hire additional staff. "Very High" and "High" are favorable rankings for this category; indicating the strategies' cost are relatively low and therefore feasible to a cash-strapped government.

Currently, agencies with mandates relevant to sanitation have been described as underfunded and understaffed. The MOI, responsible for pumping out septic tanks for the MOH, does not have the capacity to do this with the requisite frequency and in accordance with best practices (Lal & Takau 2006; Stakeholder Interview 2019). Concurrently, the MOH does not have the capacity to adequately test water quality as a result of underfunding. The reality of expanding responsibilities and increasing administrative costs, given current inabilities to carry out essential functions will be quite difficult. Scores for financial feasibility reflect this reality and take into consideration the costliness of strategies.

Hotel Adoptability

Hotel adoptability considers the costs versus the benefits of implementing a strategy from the hotel owners' perspective. In Tonga, the majority of hotels (60%) are locally-owned with a small number of rooms (TRIP Consultants 2013). Given this breakdown and the absence of large chains capable of implementing costly updates, Tongan hotels are susceptible to new regulations or taxes. Policy options were therefore evaluated by how they would impact smaller, locally

owned hotels with smaller profit margins. For this category, “Very High” and “High” adoptability are favorable rankings indicating a hotel owner’s likely willingness and ability to take on these changes. Tonga’s ambitious tourism growth goals will require a collaborative relationship between government and hotels and as a result, the government needs to consider how potential strategies will impact the tourism industry.

With our dual criteria processes, we ensure that the options suggested have succeeded elsewhere and have the potential to be successful in Tonga. All together, options addressing each key issue area will provide a roadmap for Tonga to comprehensively improve hotel management of wastewater.

Section 6: Strategy Evaluation

In this section, we evaluate the strategies that speak to the problem areas we defined earlier - agency structure, agency financing, regulation, regulation compliance, and lack of hotel incentives. We explain how the strategies have worked in their original context, provide some idea of how Tonga might adapt the strategy to best suit their needs, then rank them according to our criteria. Any nonexclusive strategies are not ranked, but instead combined or provided as additional options to provide a fuller picture of what good wastewater management can entail. A review of all our recommendations at the end of this chapter follows and summarizes the multi-step solution we propose for Tonga.

6.1: Agency Structural Reform

In Tonga, responsibility for various stages of wastewater management remains vaguely allocated across multiple agencies that have conflicting interests. For the management of hotel wastewater, a great deal of coordination is required amongst the relevant agencies from setting standards and allocating areas suitable for hotel development to enforcing building codes, desludging septic tanks, and testing water quality. This section examines complementary strategies for improving the applicable agencies' coordination and mandates.

Agency Structural Reform Strategy Options

Samoa Case: Effective Policy Framework

The leader of a regional NGO identified the Independent State of Samoa (Samoa) as having a uniquely effective wastewater management policy framework implemented through their Water and Sanitation Sector Coordination Division (WSCCD) (Stakeholder Interview 2019). The WSSCD provides day-to-day coordination, orientation, and governance of the water and sanitation sector (WSS). It provides an essential service, binding the sector together for unified action. The WSS is listed as one of the priority sectors in Samoa as it directly impacts the quality of life and overall productivity for Samoans.

Hawai'i Case: Agency Coordination

The Hawai'i State Department of Health (DOH) is the primary agency in charge of wastewater management. DOH's Environmental Health Administration has a Wastewater Branch that administers their various programs to improve wastewater management. The Clean Water Branch works on the monitoring side. The Sanitation Branch is in charge of accommodating health compliance. The Hawai'i Public Utilities Commission attached to the Department of Commerce and Consumer Affairs is in charge of regulating the 39 water and sewage companies that handle centralized wastewater treatment. Finally, Hawai'i's Department of Business,

Economic Development, and Tourism is in charge of the relationship between Hawaiian governance and the tourism industry. This structure is supported by the federal government through the Environmental Protection Agency (EPA). This clear division of responsibilities spreads out the costs, keeps agency responsibilities in line with their original mandate, and encourages collaboration on a multifaceted issue.

Agency Structural Reform Solutions

Table 4 summarizes the two strategies mentioned above and how they may apply to Tonga. Because these strategies are non-exclusive, they are not ranked in a criteria alternative matrix, but instead we imagined and presented how they may work together.

Strategy	Current Application	Tongan Application
Effective Policy Framework	Samoa's Water and Sanitation Sector Coordination Division	Use the WRB to establish a single coordinating agency
Agency Coordination	Hawai'i	Use the WRB to clarify agency responsibilities

Table 4: Current Application and Tongan application of agency reform strategies

We evaluated that current agency structure in Tonga would benefit from a re-organization of functions to manage wastewater issues more effectively. We recommend that Tonga pass the Water Resources Bill (WRB) that was first introduced in 2016, as it will clarify agency responsibilities and establish a single coordinating agency in the national government as seen in Hawai'i and Samoa, respectively. If passed, the WRB would create the National Water Resources Committee (NWRC) with representatives from relevant agencies, enabling the government to work on routine tasks effectively and plan for the future. This newly established coordinating agency could ensure that each stage of comprehensive wastewater governance remained functional, sharing information to coordinate and successfully carry out missions. The NWRC would ensure that water testing done by the MOH was provided to the MLNR for it to levy fines against those polluting water sources, as mentioned later in our regulation section (Government of Tonga 2016). The NWRC would hold the MLNR accountable for conducting EIAs to properly plan for septic systems.

With passage of the WRB, the Ministry of Tourism (MOT) will be removed from ensuring hotels comply with wastewater regulations. The MOT has the primary goal for growing the tourism industry in Tonga. This secondary mandate, to ensure compliance with wastewater regulations, presents a conflict of interest for the MOT. Responsibility for ensuring that hotels comply with the necessary placement and maintenance of septic tanks needs to be given to an agency that is primarily concerned with protecting the sustainability of Tonga's environment. Passage of the WRB will cede control of wastewater standard setting and regulation to the MLNR which will work in coordination with the MOH for testing water quality and with the NWRC for

compliance. This reorganization would clarify specific agency responsibilities and ensure that the sector remains committed to achieving broader goals towards improved sanitation. Figure 7 summarizes our recommendation regarding agency structure.

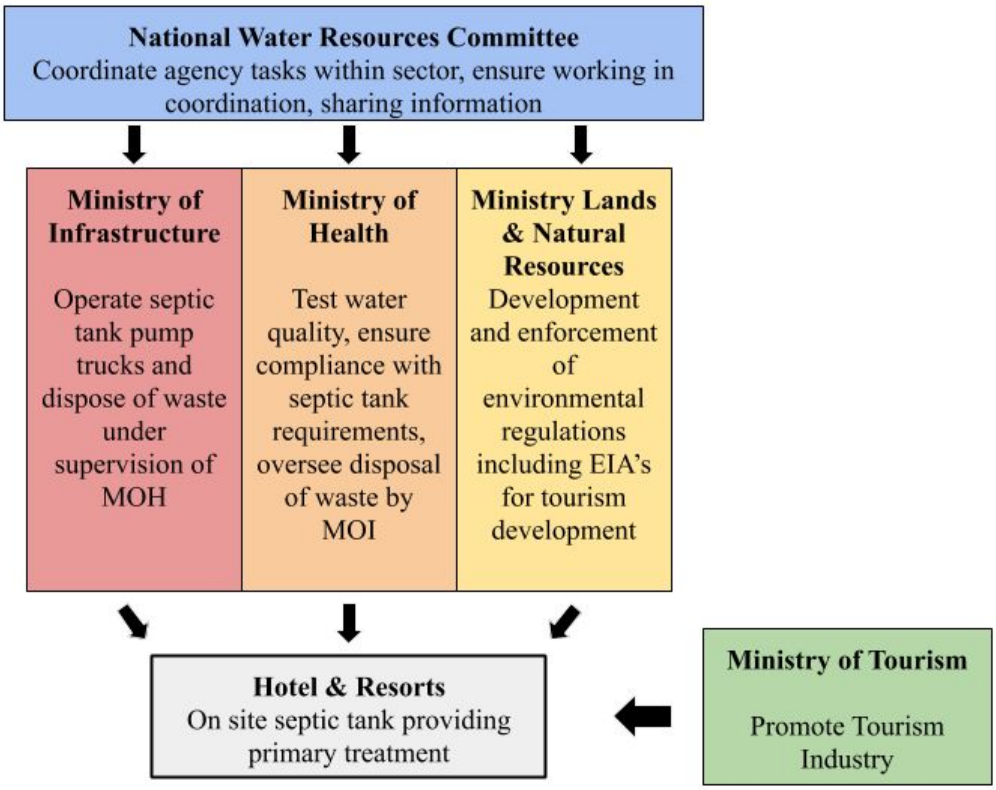

Figure 7: Desirable Agency structure for all Tongan ministries involved with the management of hotel wastewater.

6.2: Agency Financing

Upon adopting the aforementioned set of complementary structural reforms, Tonga's relevant agencies will continue to face inadequate budgets to fully carry out their mandated responsibilities. In order to finance water quality monitoring, sludge collection, and technical and financial assistance, the government needs to create a sustainable source of revenue. Market-based instruments that charge companies or individuals for their costs on the environment can be used to make up some of the financial gaps in wastewater management in Tonga. The following section compares various options to improve agency funding in Tonga to improve the regulation and management of hotel wastewater.

Agency Financing Strategy Options

Fiji Case: General Environmental Tax

In order to stabilize financing for environmental protection, The Republic of Fiji (Fiji) instituted a 10% tax on hotel revenue, specifically on prescribed services, items, and income (Ministry of Environment, Fiji 2018). The tax, known as the Environment and Climate Adaptation Levy (ECAL), helps fund work to protect Fiji's natural environment, to reduce guests' carbon footprint, and to adapt its economy, community and infrastructure to the worsening impacts of climate change (Ibid). Between August 2017 and April 2018, the Fiji Revenue & Customs Services (FRCS) collected $110.6 million FJ from ECAL (Ibid). In 2018, ECAL funds were not used for wastewater projects directly, but were instead used on groundwater monitoring and other development infrastructure projects (Ibid; Stakeholder Interviews 2019).

Hawai'i Case: Increased Water Use Fee

Because water and wastewater services are usually coupled, increasing the cost for water use can raise extra funds to cover wastewater costs. Hawai'i is currently raising its water fees to improve all water related services including: replacing water pipelines, pumps, and reservoirs, and introducing more sustainable technology. The rate changes are not uniform, but instead are dependent upon more complex measures including: household type, meter size, and categorization of "essential needs" related to low income and/or high conservation households (Board of Water Supply 2019). Besides raising revenue, making the cost of water and sanitation more visible has the added benefit of showing companies or individuals the prudence of investing in improved technology or changing practices.

Fiji and Palau Case: Departure Fee

Fiji charges tourists a fee for departing the island that in 2013 was increased to be $200 FJ, the most expensive departure fee in the South Pacific (Langford 2013; Tourism Fiji 2019). Though the fee is substantial, it is largely invisible to tourists because it is included in the airfare (Langford 2013). Many countries of the South Pacific have a similar fee, including Samoa, the Cook Islands, Tonga, and Palau. Palau's fee is explicitly for environmental purposes. It finances Palau's decision to use the majority (80%) of their EEZ as a National Marine Sanctuary, saving the remaining 20% for domestic fishing management (Kesolei 2018).

Agency Financing Evaluation

Drawing from the strategies employed in various island states, we judged their ability to sustainably finance Tonga's wastewater management agencies. Table 5 summarizes the three candidate strategies.

Strategy	Current Application	Tongan Application
General Environmental Tax	Fiji: Environment and Climate Adaptation Levy (ECAL)	Levy a 2% tax on hotel revenue [Currently no tax for environmental conservation. Current Consumption tax rate is 15%].
Increased Water Use Fee	Hawai'i	Increase water use fee by 60% and allocate this revenue to wastewater management [Current fee estimated at approximately $12 TOP per room/month, no fixed proportion toward wastewater management].
Increased Departure Tax (12 years old and above)	Tonga, Palau, Fiji	Increase tax to $50 TOP [Current level is $25 TOP].

Table 5: Current application and Tongan application in agency financing

Effectiveness in Generating Funds for Agencies to Reduce Wastewater Pollution

For the Agency Financing step of the roadmap, effectiveness is measured as the ability of the agency to generate enough funds to then do their mandated duties that will reduce pollution from wastewater systems. According to our estimates, an Increased Departure Tax would generate the most revenue, $2,766,825 TOP from the increased fee of $25 TOP. This tax is only levied on tourists over 12 years old and our estimate assumes that this target groups makes up 90% of all tourists (Statistics Department 2017). Adding a 2% General Environmental Tax on hotel revenue would generate $1,141,650 TOP. It would be difficult for an increased Water Use Fee to generate a similar amount of funds; increasing the cost of water by 60% only earns an extra $84,063 TOP (For all estimates, see Appendix 4). People in Tonga pay relatively little for water and might forgo paying the water bill entirely in the case of an increase. According to a 2007 Diagnostic Report, paying the water bill is of the lowest priority to Tongans after paying for electricity, fuel, food, and church donations (SOPAC 2007). As a result the Base Water Fee receives the lowest score for effectiveness in generating funds for agencies to improve wastewater management.

Political Feasibility

The increased departure tax has the highest political feasibility because it would be the least visible to Tongan citizens and visitors. In Tonga, a small departure tax ($25 TOP) is currently built-in to the price of airline tickets. This incremental fee is much less noticeable when incorporated into an already expensive airline ticket. As the tax primarily falls on tourists, it would receive little pushback from Tongan citizens. The tourism industry might be hesitant to make travelling to Tonga more expensive, as it is trying to grow their tourism industry amidst competition with other South Pacific Islands. However, Tonga's increased departure tax would still remain on the lower end in the South Pacific, making this argument less powerful (Appendix 5).

For a general environmental tax modeled after Fiji's ECAL, a 2% tax would be levied on all hotels revenue and applied to fund environmental initiatives broadly. Given that this type of tax would impact hotels according to their amount of revenue it would concentrate the costs and spread the benefits widely, making it a relatively feasible tax.

Increasing the cost of water for hotels to cover the costs of treating wastewater would be the most visible of the three proposed options and likely face the heaviest resistance. As this would impact all hotels and likely have the greatest cost burden spread amongst the most stakeholders, it has the lowest level of political feasibility.

Financial Feasibility

None of the new levies we propose would require much additional cost, as the government already collects a consumption tax, a water fee, and a departure tax. However, taxes in general need strong enforcement to ensure collection, including penalties levied on those who fail to pay on time. An increased departure tax and an increased water use fee would be the most financially feasible as administrative support is already in place. Calculating and then enforcing a new general environment tax would be adding a new task with new costs for agencies to take on and so it is ranked as being the least financially feasible.

Hotel Adoptability

If the departure tax was raised to the point of significantly deterring tourism it would be costly to hotels. This analysis assumes that the tax would not be set at such a level, resulting in the lowest cost to hotels and therefore the highest adoptability. As mentioned above, increasing the departure tax to $50 TOP departure tax would still leave Tonga with one of the lowest departure taxes in the region, while still generating an impressive revenue of $2,766,825 TOP (See Appendix 4 & 5). A general environmental tax would carry the highest cost on the most profitable hotels and likely not impact the majority of smaller lodges. Because of this differential burden, it is ranked in the middle. The increased water use fee would have the greatest negative impact on hotel revenues. In theory, the water use fee might encourage hotels to change some of their water habits and consume less, however, those changes might not spread to short-term

guests and the price of water would still be higher. Therefore, this option is ranked the least adoptable for hotels. .

Table 6 below summarizes the discussion for the agency financing evaluation.

	Effectiveness	Political Feasibility	Financial Feasibility	Hotel Adoptability
Increased Departure Tax	**High**	**High**	**High**	**High**
General Environmental Tax	**Medium**	**Medium**	**Medium**	**Medium**
Increased Water Use Fee	**Low**	**Low**	**High**	**Low**

Table 6: Agency financing evaluation

Recommendation

Agency financing is one of the most critical parts to sustain effective wastewater management since it affects the ability of an agency to carry out necessary monitoring and enforcement tasks. We believe an **increased departure tax** will be the most readily introduced financing mechanism considering its high scores on political feasibility and low score on hotel burden. We estimated an increase of $25 TOP (a 100% increase), to generate a substantial stream of revenue that still remains below average for departure fees in the Pacific. An important note is that the new revenue collected from this increase should be explicitly earmarked for wastewater management to have an impact on the goal of reducing wastewater pollution.

Complementary Options

While our current roadmap deals with upgrading the existing system of septic tanks, in the future Tonga may be interested in more communal wastewater management systems, if not a fully centralized system. In that case, Tonga would need a much larger influx of cash than what may be generated through the taxes explored in this section. At that point, Tonga should consider investigating potential public-private partnerships (PPP) to provide the government another source of funding for a communal infrastructure project. The following case from the Asian Development Bank (ADB) is a good example of a successful PPP.

ADB Case: Public Private Partnerships

A public-private partnership is defined as a contractual arrangement between a public and a private entity “for providing a public asset or service in which the private party bears a

significant risk and assumes management responsibilities" (ADB 2016; World Bank 2018). The Asian Development Bank outlines this as a financing mechanism in their regional project (of which Tonga is included), *Promoting Innovations in Wastewater Management in Asia and the Pacific*. It has used this mechanism in the Alandur Sewerage Project in Chennai, India to build a sewerage line, pump, and treatment plant. The city government funded the sewerage line and pump through loans and grants (some of which came from the private sector), while the treatment plant was funded by the private sector which recuperated costs through the fees on the public to use the system.

6.3: Regulatory Framework

After the creation of a financed and structurally sound wastewater coordination agency, Tonga needs to revise their existing wastewater regulation to be prescriptive. It should mandate technical specifications, like treatment level, as well as appropriate septic tank placement, design, and construction. Tonga should be aiming to treat all wastewater to the secondary treatment level - the standard level of treatment to reduce pollution and recycle water, which can be accomplished with proper septic system management (Stakeholder Interview 2019; NEIWPCC n.d.). The following strategy options outline several ways that Tonga can consider implementing the full series of regulations to push hotels (hopefully followed by the greater population) up to a healthy level of treatment. While the strategies below are designed to minimize the problems of retrofitting current hotels, new hotels would also have to meet these standards to be built or to operate legally. Though we do not suggest what the new regulation should specifically contain, we compare the different styles of codes of other countries as examples.

Regulatory Framework Strategy Options

Samoa Case: Uniform Standards

Samoa's detailed building code regulates specific wastewater management specifications for all hotels during each stage of hotel development: planning, construction, and completion. The code additionally requires oversight from professional consultants to ensure every stage of development complies with the clearly outlined standards and that the final building will be properly equipped to sustainably manage wastewater.

Fiji Case: Zoning

Fiji's National Liquid Waste Management Strategy (2006) regulates domestic, commercial, and industrial wastewater as well as animal waste. For the hotel industry, there are two national liquid waste standards depending on the adjacent environment: a general standard for wastewater discharged into most environments and a higher standard for discharges into sensitive ecological

zones. The Environment Management (Waste Disposal and Recycling) Regulations of 2007 set those sensitive ecological zones (Department of Environment, Fiji 2007).

Hawai'i Case: Progressive Standards

Current wastewater regulation in Hawai'i includes a progressive ban on cesspools, a disposal system that discharges untreated water into the ground. This rule began in 1999 with the US EPA's Underground Injection Control (UIC) Program ban on building new large capacity cesspools (LCCs). Existing LCCs had to be upgraded or closed according to federal regulation by 2005 or risk a fine (Wastewater Branch 2004). In 2016, Hawai'i Administrative Rule 11-62 banned new construction of all cesspools and agreed to phase them all out by 2050. This rule applies to small domestic cesspools as well as the cesspools previously targeted by the US EPA's UIC. This rule will affect the 88,000 cesspools in the state (43,000 of which pose a risk to water resources) stopping the 53 million gallons of sewage that gets discharged to Hawaiian ground each day (Wastewater Branch 2019). This ban has been accompanied by a cesspool conversion working group for planning purposes, a tax credit, and environmental zones earmarked for special targeting because of their proximity to water sources.

Regulatory Framework Evaluation

The three strategy options from above could be combined in four different ways to give Tonga more prescriptive regulation (see Table 7).

Strategy	Current Application	Adapted to Tonga
Uniform Standards	Samoa	Tonga would strengthen existing regulation to institute a universal standard on wastewater technology that would go into effect in the near future.
Zoning	Fiji	Tonga would revise existing regulation to institute standards that differ based on hotels' proximity to environmentally sensitive areas. It would go into effect in the near future.
Progressive Uniform Standards	Hawai'i	Tonga would write new regulation to institute a universal standard that would go into effect in the distant future (10+ years) perhaps with certain actors (hotels that generate larger volumes of waste) leading the way.
Progressive Zoning	Hawai'i	Tonga would write new legislation to institute a differential standard by proximity to ecologically sensitive areas that would go into effect in the distant future (10+ years) perhaps with certain actors (hotels that generate larger volumes of waste) leading the way.

Table 7: Current application and Tongan application in regulatory framework

Effectiveness in Reducing Wastewater Pollution

Because regulation has a direct impact on wastewater technology used, here effectiveness is measured directly as the option's ability to reduce pollution from wastewater. Progressive zoning would be the most effective for reducing wastewater pollution as it would impose the highest wastewater standards in Tonga based on the location and capacity of each hotel. As the majority of hotels in Tonga are located on the coast, this would require a higher level of compliance for most. progressive uniform standards would set a high bar as well, but because the law would be one size fits all it might be less stringent than regulation that includes zoning. Zoning for the near future would have a lower standard than the progressive options, but still would allow for higher standards in ecologically important areas. A uniform standard set for the near future would require all hotels to meet the same, lower bar of compliance and as a result would provide the least effective reduction in wastewater discharge.

Political Feasibility

A progressive uniform ban will have the highest political feasibility. This process will clearly outline the standards various hotels need to meet and give them sufficient time to plan for and implement the necessary changes. No one group will be targeted by a higher standard, reducing backlash from stakeholders. Progressive zoning has the second highest feasibility because of the extended timeline as well. An immediate uniform standard would be fairly unfeasible as it would impose the same regulations upon all hotels with no buffer of time. Zoning in the near future will be the least feasible as it will target some groups and ask them all to make changes immediately.

Financial Feasibility

It is difficult to compare the costs of creating uniform standards versus zoning-based regulation because finding the one appropriate but effective standard might be as difficult as setting several different standards based on hotel location or size. Additionally, if zoning does happen to be more expensive, then those expenses might be later offset by the more fine-tuned requirements for hotels to meet. Considering this, we estimated uniform standards and zoning to be ranked the same for financial feasibility. However, both zoning and uniform standards would be more expensive in their progressive version because they require more monitoring, more advertisement and more research into better technologies and future forecasting. The immediate versions of uniform standards and zoning received high feasibility rankings, while their progressive forms received low feasibility rankings.

Hotel Adoptability

The costs of hotels adopting these strategies will mostly apply to existing hotels that need to be retrofitted. New hotels will have a much easier time building new structures that apply to the rules. Enacting a new uniform or zoning standard would require immediate action by existing hotels and present a greater challenge overall. Zoning's extra requirement for some places to take more action, makes it the most burdensome and least adoptable option. A progressive uniform standard will be the most adoptable for existing hotels as it will incorporate a long time horizon for hotels to phase in the appropriate technology. Progressive zoning is less adoptable as some areas would be asked to do more because of their proximity to ecologically sensitive areas.

Table 8 below summarizes the discussion for the regulatory framework evaluation.

	Effectiveness	Political Feasibility	Financial Feasibility	Hotel Adoptability
Uniform Standards	**Very Low**	**Low**	**High**	**Low**
Zoning	**Low**	**Very Low**	**High**	**Very Low**
Progressive Uniform Standards	**High**	**Very High**	**Low**	**Very High**
Progressive Zoning	**Very High**	**High**	**Low**	**High**

Table 8: Regulatory framework evaluation

Recommendation

In order to improve its regulatory framework, we suggest Tonga pursue a **progressive uniform standard** in future wastewater regulation. This strategy is rated highest for performance and acceptability. It is worth noting that either form of zoning or uniform standard is rated higher in its progressive form than in its immediate action form. However, making regulation progressive does increase administrative costs due to the complexity and plural monitoring responsibilities. With progressive uniform standards, Tonga can require new hotels looking to build property to meet the upgraded standards immediately, but allow existing hotels to have the time to save up the money to change their wastewater technology to meet higher standards. This would close the gaps of existing regulation that left old dwellings with improper systems and inadequately specified all the technological specifications new dwellings should meet.

Complementary Options

In addition to pursuing a progressive uniform standard, we believe Tonga should consider a series of complementary regulations: a pollution fine, local engineer training, and a community monitoring program. The examples below are not a formal part of the criteria matrix, but are additional complementary measures for Tonga to consider.

Pollution Fee System

The Republic of the Philippines (Philippines) has a unique pollution fee system where businesses that discharge wastewater into the Laguna Lake must pay an environmental user-fee based upon the amount of pollution being discharged. Only companies that have obtained a discharge permit are able to participate in this system after verifying that all discharged water meets a base standard set by law. Since the implementation of this system, the Laguna Lake Development Authority has observed decreasing annual biochemical oxygen demand (BOD) loadings (Laguna Lake Development Authority 2019). Tonga does not have the capacity for the same system, but

should consider implementing a simple pollution fee to act as a deterrent to hotels refusing to treat their waste. Tonga is already considering implementing a fine through the WRB, but as it stalls in the government, we would like to emphasize the importance of such a measure. It would answer the need for punitive regulation to exist alongside prescriptive regulation.

Local Engineer Training

In many Pacific SIDS, top engineering jobs are held by expatriates (typically Australians or New Zealanders) who then return to their homes with the institutional knowledge on the specifics of the onsite wastewater treatment system. Without adequate maintenance and oversight, even the most cutting edge wastewater treatment systems can break down and result in negative externalities (Stakeholder Interview 2019). Requiring that after a period of time, Tongan residents are employed for engineer positions would improve the management of on-site wastewater management systems and increase Tongan capacity.

Community Monitoring

Many Tongan hotels are locally-owned, small and medium enterprises, fully integrated into the community. As such, making wastewater management a community problem would increase buy-in and feelings of inclusion and reduce separation between hotel owners and their community. Community members could be in charge of doing checks on septic tanks or reporting instances of wastewater pollution to make them a part of the solution, similar to how Samoa has instituted community illegal fishing monitoring (Stakeholder Interview 2019).

By instituting local engineer training or having a community monitoring program, Tonga could ensure that its progressive uniform regulation is accompanied by community buy-in and tangible benefits to human capacity. A pollution fine would give teeth to the regulation of this chapter, filling in the gap of punitive regulation.

6.4: Financing Regulatory Compliance

To dispel complaints that instituting regulations for wastewater treatment will force expensive and burdensome changes unto hotels, Tonga should consider some mechanisms to help finance existing hotels' compliance. Implementing regulations without addressing the inability of hotels to comply will punish smaller hotels without the capital and technical expertise to adapt to the new regulatory environment. Financing will make greater adherence to the regulation possible for all, which in the end is what will make regulation effective at reducing wastewater pollution. Hand in hand, these steps work to address Tonga's need to institute enforced wastewater regulations. The following cases show different financing forms Tonga can consider to strengthen its regulation.

Financing Compliance Strategy Options

Hawai'i Case: Subsidies from Tax Credits

Hawai'i's cesspool ban and requirement to upgrade them is complimented by a tax credit redeemable for up to $10,000 USD. It is limited to $5 million USD or 500 upgrades per year. It is available for hotel owners within 500 feet of oceans, streams, marshes, or drinking water sources. These are "priority areas" close to recreation sites and drinking water sources (Ige 2017). The ban for cesspools for all dwellings has been in place since 2016 and as of February 2019, 117 tax credits have been submitted (Stakeholder Interview 2019).

Hawai'i Case: Revolving Loan Fund

Hawai'i has a revolving loan fund wherein communities can borrow money at low interest rates to fund pollution control projects. This loan fund was created by the federal Water Quality Act of 1987 to fund "the construction of publicly owned wastewater treatment works (POTWs), for implementation of a nonpoint source (NPS) pollution control management program, and for implementation of an estuary conservation and management program" (Wastewater Branch 2019). Hawai'i added their own affordability criteria, environmental review process, and technical assistance to the federal program requirements.

Financing Regulatory Compliance Evaluation

The following options in Table 9 are compared based on how effectively they can transition hotels into regulatory compliance.

Strategy	Current Application	Tongan Application
Subsidies	Hawai'i's tax credit	Tonga would bear 40% of the cost for hotels to install a typical septic tank [Currently no financial support].
Loans	Hawai'i's revolving loan fund	Tonga would offer 2% interest rate loans for hotels to install a typical septic tank [Currently 8% to 10% interest rate].

Table 9: Current application and Tongan application in financing regulatory compliance

Effectiveness in Increasing Compliance and therefore Reducing Wastewater Pollution

Effectiveness here is measured as increasing compliance to the new wastewater regulation, which will then affect how wastewater is treated. Subsidies are the most effective in increasing compliance as more people will be attracted to the "free money" offered for upgrades. Because loans must be repaid, even with low interest rates, fewer people will opt in to them.

Political Feasibility

Subsidizing or providing loans for the cost of upgrading on-site wastewater management systems will require large amounts of capital. While a partnership with the Waitt Foundation offers some funding, Tonga does not currently seem interested in spending much money on wastewater. For the 2018/9 year, it plans to allocate only 0.082% of the national budget to water and wastewater issues (Government of Tonga 2018). For this reason, both options have low scores for political feasibility.

Financial Feasibility

Considering that a larger amount of people will be attracted to the program's "free money," subsidies are the least financially feasible for the government. Based on our estimate (See Appendix 4), subsidizing installation of hotel septic tanks will involve a higher cost ($14,222 TOP per tank) than the loan support ($13,798 TOP per tank). That said, loans are still expensive as they require a government agency to monitor progress and follow up on the collection of payments. In addition, given the limited financial flexibility for hotels in Tonga, these loans will likely need to be paid back over a long period of time, which will increase the amount of the required budget.

Hotel Adoptability

Subsidies could provide hotels a significant portion of the funds to implement the necessary upgrades leading to high adoptability. Loans require hotels to make payments over time for any changes, meaning lower adoptability.

Table 10 summarizes the discussion for the Financing Regulatory Compliance Evaluation.

	Effectiveness	Political Feasibility	Financial Feasibility	Hotel Adoptability
Subsidies	**High**	**Low**	**Low**	**High**
Loans	**Low**	**Low**	**High**	**Low**

Table 10: Financing regulatory compliance evaluation

Recommendation

To finance regulatory compliance from the private sector, subsidies will best encourage hotels to update and manage their septic tanks properly. However, beforehand, the government must have its own sources of financing to expend on the restructuring, monitoring, and evaluation mentioned in previous steps of the roadmap. The structural strength of the agency is also important as the government will need strict rules about who is eligible to apply for funding and

what projects may be subsidized through this program. There will also have to be long term monitoring to make sure projects develop as intended and produce the wanted results.

6.5: Incentivizing Hotel Action through Innovation and Consumer Demand

Tonga's hotels currently have no incentive to institute better wastewater management practices. While previous steps of the roadmap set norms and mandates good practices, the final step of the roadmap will make wastewater management seem attractive to hotels as money-making institutions. Here we offer a few mechanisms to motivate the good behavior outlined in the previous steps through technology options that would lower water and sewage costs over time, through a manual to reduce the cost of information, and through a green accreditation program that harnesses consumer demand for environmentally friendly lodging. Because none of these strategies would be mandatory for hotels, we see them as extra "pull" factors to get hotels on board and excited about prioritizing wastewater management.

Incentivizing Hotel Action Strategy Options

Innovative Technology

For the innovative technology option, we offer two examples of what that technology could look like. Both exemplify the same ideas - technology can save hotels money, can enhance tourist destinations, and can go beyond the basic upgrades mandated by regulation. We are not comparing the two versions of technology below as they would have to be proven geographically and economically viable in Tonga. The idea of technology is compared to our other incentive-driven strategies for hotels.

Innovative Technology: Constructed Wetlands in Malaysia

In 2009, the Frangipani Langkawai Resort & Spa in Malaysia built a constructed wetland based on a surface flow wetland design with six types of plants that play specific roles in water treatment. Testing shows an average reduction in BOD of 52%, reducing BOD to a level in line with current standards for the Department of Environment in Malaysia (Akhir et al. 2016). Owners of the constructed wetland found that wetlands are a cheap, relatively low tech, and more natural solution that produced results similar to traditional treatment plants (Akhir et al. 2016). If willing to take on the upkeep of a system, constructed wetlands can offer a low cost, visually appealing way to reuse water that might help hotels save money in the future.

Innovative Technology: Greywater Systems in Indonesia

The Nusa Dua is a self-contained tourist enclave of over 20 four- and five-star resorts, located in the southern part of Bali, Indonesia. It boasts its own parks, travel and tour agencies, golf course, fire station, sewerage system and even emergency clinic. To handle the massive amount of wastewater generated daily, the tourist enclave built their own communal wastewater treatment system (known as Bali Tourism Development Corporation Lagoon). The system uses "biological water processing technology" to filter up to 10,000 m^3/day through its lagoon-type system with thin mangroves. After going through natural oxidation, mechanical aeration, fermentation and filtering processes, the water is distributed back to the hotels' parks, golf course, and general premises. In 2008, over 30% of treated water was reused for irrigation (Suci Murni 2014). The lagoon draws tourists who appreciate the ambience of another beautiful natural setting and want to support sustainable hotel ventures.

Environmental Checklist

The second idea Tonga should consider to incentivize hotels to make wastewater management changes on their own is to provide free information. Fiji's environmental checklist explained below would be directly scalable to Tonga with some adjustments for technology type, geography, and regulation.

Fiji Case: *Environmental Checklist*

In 2003, the Fiji Integrated Coastal Management Project published the 33-page booklet, *Making Small Hotels and Resorts Environmentally Sustainable: A Simple Checklist for Fiji Operators*. The checklist at 33 pages, works as a manual, giving hotels advice on construction and building design, energy and water use, reducing waste, discharge, and emissions, along with recommendations for suppliers and contact information for relevant Fiji agencies. The checklist is relatively old and it is unknown how often it has been utilized. A regional stakeholder said, "educational institutions and NGOs produce guidelines like this a lot, but it is not a legal document so the chances of them following the booklet are very slim" (Stakeholder Interview 2019).

Green Business Program

The final solution option we recommend is the creation of a green business program that offers green accreditation. This solution would brand hotels in Tonga as "green" or environmentally friendly after they have instituted positive changes to their business. This branding would work as a status symbol signaling the consumers' altruism, motivating them to choose the green hotel over the non-green hotel, even if the latter is cheaper or more luxurious (Griskevicius 2010). Green businesses can also get technical advice, networking opportunities, and can earn awards on top of the recognition badge.

Hawai'i Case: Green Business Program

The Hawai'i Green Business Program (HGBP) is a free state program that awards businesses for completing a set number of items on a sustainability checklist. Hawai'i's checklist includes measures for: energy and water conservation, waste reduction, pollution prevention, community involvement, and cultural preservation. Over the years, they have updated the checklist to fit changing best practices. They have expanded it to include the restaurant industry and events and have created a checklist specifically for small hotels. As of 2019, over 100 businesses and 26 events have been recognized as "green". HGBP is the least expensive Hawaiian government environmental program as it provides businesses a new entry point to access technical assistance the state is already equipped to provide and this work is spread out across several agencies. Certification is free for the hotel owners, unlike expensive private company accreditations like the Leadership in Energy and Environmental Design (LEED) certification. There is a small annual cost of around $1,500 for the recognition ceremony (Stakeholder interview 2019).

Incentivizing Hotel Action Strategy Evaluation

We propose three strategies, summarized in Table 11 below. While the Tongan government could promote all of these strategies, even the promotion of voluntary strategies enacts a cost on government resources. As such we compared cost saving technology, an environmental checklist, and a green business program by the same metrics as other steps of the roadmap.

Strategy	Current Application	Adapted to Tonga
Innovative Cost-Saving Technologies	Malaysia's constructed wetlands, Indonesia's greywater system	Tonga would choose to promote some form of innovative technology.
Environmental Checklist	Fiji	Tonga would have their own checklist appropriate for their geography, laws, and technology. It could be an updated and expanded version of their 2005 Manual of Residential Septic Tank Practice.
Green Business Program	Hawaii	Tonga would have their own business program with appropriate checklist, networking opportunities, and rewards.

Table 11: Current application and Tongan application of incentivizing hotel tction

Effectiveness in Reducing Wastewater Pollution through Incentivizing Action

Effectiveness here is measured as what option is most likely to incentivize hotel owners to voluntarily act. By taking on these voluntary, proven successful actions, wastewater pollution will be reduced. A green business program would be the most successful in convincing hotel owners to take voluntary action because it offers a clear reward that can be earned relatively easily. Because hotel owners can choose which steps they take to be certified green, large and small hotels will be able to participate. Innovative technologies is the next most effective at encouraging hotel owners to take action. These technologies have been proven to have direct impacts on wastewater treatment in the regions they have been implemented with cost-saving potential in the long-run. That may convince hotel owners with the capacity and foresight to take on projects, but might leave out smaller and poorer hotels without the capacity to take on a seemingly risky venture on their own. An environmental checklist would be the least effective in motivating hotels to reduce wastewater pollution. The only benefit it offers is a lowered cost of information. This is not very beneficial to hotel owners for voluntary actions, as they could choose to take no action beyond the required regulation.

Political Feasibility

The environmental checklist would be the most politically feasible. It displays government investment in the environment with limited ongoing involvement required from it, and has no cost to the community. The green business program would require more political will as it would require more political involvement, but it would offer positive economic externalities and branding for Tonga more widely. Implementing innovative technologies is likely to be the least politically feasible option as it requires a lot of technical know-how to recommend it to the public, and could be seen as foisting responsibility onto hotel owners even after requiring them to make significant changes under the regulations outlined in previous steps.

Financial Feasibility

The environmental checklist is the most financially feasible of the options. While it would require a small initial investment to create and distribute the checklist, this strategy's primary goal is to educate and encourage hotel owners to be environmentally-conscious, requiring minimal to no monitoring and ongoing costs. The green business program would have higher costs and be less feasible as it involves ongoing communication between the government and the tourism industry; it is ranked in the middle for financial feasibility. Finally, estimating the administrative costs of innovative technologies is challenging as it would be based on the government's level of involvement. The government would take on the costs of discovering what technology is actually appropriate for the Tongan environment. The research, surveying, and then advertising would involve high costs that might not diminish over time as technology and the environment evolve

Hotel Adoptability

Because none of these strategies involve mandated improvements to wastewater systems of hotel management behaviour, they do not automatically place a burden on hotel owners. The green business program and an environmental checklist both allow for hotel owners to determine for themselves how and to what extent they implement changes. Because green accreditation offers more benefits to hotels, it is ranked the most adoptable, followed by the environmental checklist. Finally, innovative technologies are ranked least adoptable. Though this technology is encouraged, and the effort may pay off in the long-run, the short-run fixed costs required could be large and could place a financial strain on hotel owners.

Table 12 below summarizes the discussion on strategies to incentivize hotel action.

	Effectiveness	Political Feasibility	Financial Feasibility	Hotel Adoptability
Innovative Tech	**Medium**	**Low**	**Low**	**Low**
Environmental Checklist	**Low**	**High**	**High**	**Medium**
Green Accreditation	**High**	**Medium**	**Medium**	**High**

Table 12: Evaluation of incentivizing hotel action

Recommendation

Based on our rankings, a green business program that offers green accreditation should be implemented in Tonga. A green business program that awards hotels with positive branding through certification will work as a status symbol, differentiating these hotels as altruistic. Travelers with environmental concerns will be more attracted to and reward those hotels that expend more effort on wastewater management.

Complementary Option

Once Tonga understands and prioritizes wastewater management, it will be beneficial for them to have a range of technological strategies in their arsenal. As such, we think Tonga should consider promoting and investing in innovative technology in the future to complement their green business program. The government should do this as they consider the future of wastewater management treatment after septic tanks, but individuals and companies can begin thinking about this too. This may be where environmental NGOs and private companies can take the lead until Tonga is ready to address more innovative technological solutions.

Section 7: Recommendations

All of the strategy options considered in our analysis have had success improving wastewater management and reducing pollution's negative impacts on water safety and ocean health. However, after considering the characteristics of each strategy and the social constraints of Tonga, we recommend pursuing the highest ranked strategy for each step of our roadmap:

1. Agency Structure: Tonga should pass the Water Resources Bill (WRB) that will: clarify roles and responsibilities, eliminate conflicts of interest, and allow the newly established National Water Resources Committee to take the lead on coordination.
2. Agency Financing: Tonga should increase its departure fee to secure a revenue stream earmarked for wastewater management. In the future, if Tonga is looking to create more centralized wastewater systems they should consider looking into public-private partnerships.
3. Regulatory Framework: Tonga should institute progressive uniform regulation to retrofit current facilities to appropriate standards and have clear guidelines for any new lodging facilities. Adding fines, local training, and community monitoring programs as complementary strategies could supplement and empower this framework.
4. Financing Regulatory Compliance: Tonga should find a way to offer subsidies to hotels in need of retrofitting to help them comply with new regulations.
5. Incentivizing Hotel Action: Tonga should add a green business program to incentivize hotel owners to make their own changes that will signal environmental responsibility to tourists. Promoting innovative technology may be an additional next step after necessary due diligence.

Together these strategies provide an actionable and cohesive plan for Tonga. While Tonga might characterize the feasibility of any of these strategies differently, hopefully they will agree on the prioritization and order of necessary steps to improve wastewater management. Reorganizing **agency structure** is the nucleus in addressing Tonga's structural and performance issues while expanding Tonga's capacity to reform overall wastewater management. **Agency financing** will help fund necessary agency duties to contribute to the enforcement of the strong **regulatory framework**. As a complementary step, **financing compliance** ensures compliance with new regulations. Finally, **incentivizing hotel action** through innovative ideas that tap into lowered costs and consumer demand will be the cherry on top of this comprehensive wastewater management plan.

Section 8: Limitations and Next Steps

Data collection in developing countries is limited, and in smaller Pacific SIDS such as Tonga, it is almost non-existent. Government websites are outdated and provide minimal access to recent country statistics. While the difficulty in locating data itself exacerbates the wastewater management challenges discussed in this paper, it also compelled us to rely on the modest supply of existing literature and stakeholder interviews to conduct our analysis. Additionally, while we were able to speak to wastewater experts in other countries and in regional organizations, our contact with Tongan government officials and locals was prohibited shortly after the beginning of this project to avoid jeopardizing crucial ongoing negotiations between our client and the Tongan government.

These restrictions impeded our ability to conduct a complete and precise quantitative and qualitative analysis on Tonga's water quality and wastewater production, government costs and revenues, as well as existing hotel characteristics. Having access to this information would have been useful to compare and contrast the strategy options with a heavier emphasis on their specific ability to be implemented in Tonga, rather than on their success in the countries they are currently used in, as well as allowed us to undertake a more rigorous and precise methodologically process. As a result, our recommendations based on an ordinal ranking system are relatively general.

The report does, however, provide a range of strategies that the Kingdom of Tonga can consider with our recommendations for prioritization. We hope that future research can build upon this project with the addition of data analysis and conversations with Tongan government officials and locals. Additionally, our project focuses primarily on policy changes, and changes to hotel systems will require a heavy infrastructure and technology component that considers systems' resilience against natural disasters and climate change, as well as input from experts in the environment, public health, and the hospitality industry. A thorough revamp of wastewater management on the island will require continued research and development.

Section 9: Conclusion

Solving wastewater management issues in SIDS requires simultaneously instituting various changes at multiple levels, with the cooperation of many stakeholders. Our project focused on the Tongan hotel industry as a key player to break through what is currently poor wastewater management in all sectors of Tongan society. Our problem analysis led us to examine advanced practices in geographically and demographically similar countries, and through interviews, we reconfirmed that policy frameworks do not always lead to proper implementation even in countries more experienced with wastewater management. We hope the recommendations provided in this report will be useful to Tonga and other Pacific SIDS facing similar challenges. We believe these integrated strategies will incur a virtuous circle of enhanced wastewater management, increased tourism, and sustainable economic development.

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Appendices

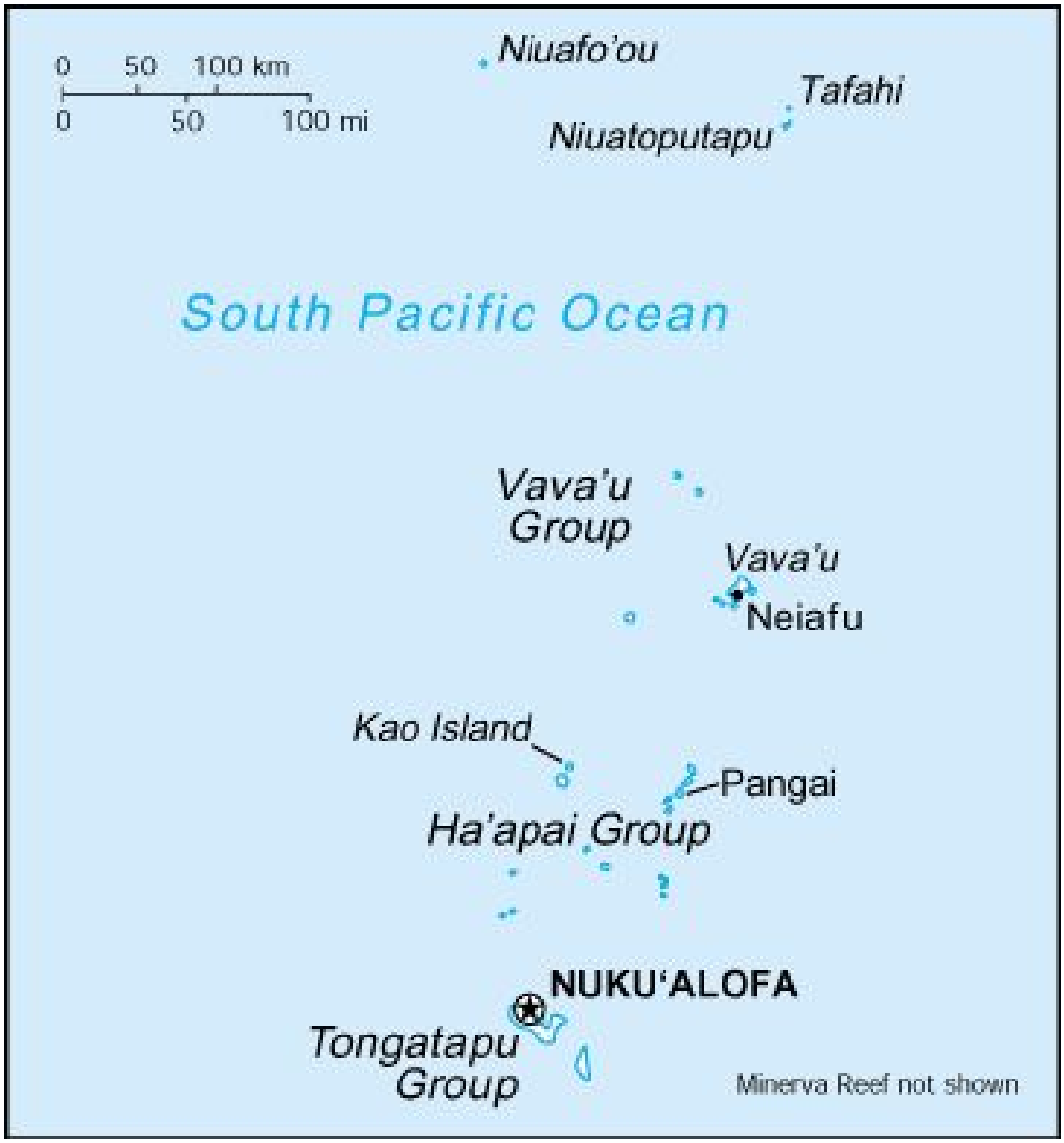
Appendix 1: Details of Stakeholder Interviewees

Stakeholder Name	Position	Organization	Organization Description
Regional Bodies			
Vicki Hall	Director, Waste Management and Pollution	The Secretariat of the Pacific Regional Environment Programme (SPREP)	Based in Apia, Samoa, SPREP is an inter-government environment and sustainable development organization that aims to promote cooperation between its members to protect the Pacific's natural resources.
David Hebblethwaite	Water Governance Coordinator	The Pacific Community (SPC)	The SPC is an international development organization that serves as the principal scientific and technical organization in the Pacific.
Christina Leala Gale	Manager, Sustainable Tourism Department	South Pacific Tourism Organization (SPTO)	The SPTO is an intergovernmental organization that develops, promotes and markets tourism in the South Pacific to overseas markets.
Tonga Island			
Mr. Sione Faka'osi	Executive Director	Tonga Community Development Trust	The Tonga Community Development Trust is a non-governmental organization, focused on capacity building, particularly in the poorest communities of the island. Their experience working on rural water supply and sanitation, sustainable development, and disaster preparedness were relevant to our project.
Karen Stone	Director	Vavau Environmental Protection Association (VEPA)	The Vava'u Environmental Protection Association's four focus areas aim at ensuring biodiversity and conservation, increasing knowledge exchange, and securing sustainable livelihoods.

Strategy Options			
Harley Sofield	General Manager	For Earth (South Pacific Limited)	For Earth (South Pacific Limited) liaises with EPA, councils, and consultants to provide top-end solutions for the tourism industry, as well as a number of other industries, to develop a biological solution for overloaded and poorly designed wastewater retention systems.
Gail Suzuki-Jones	Energy Analyst	Hawai'i Green Business Program	The Hawaii Green Business Program, a partnership between Hawaii's Department of Business, Economic Development, and Tourism; Department of Health; Chamber of Commerce of Hawaii; and the Board of Water Supply, is a free state program that aims to assist, recognize, and highlight businesses that strive to operate in a sustainable and socially conscious manner.
Randall Robinson	East Asia and the Pacific Policy advisor for Government Relations	US State Department, Office of Oceans and International Environment and Scientific Affairs	The US Department of State's "Oceans, Environment and Science" office or "OES" advances U.S. strategic interests through policy aimed at ensuring that economic growth and a healthy planet go hand in hand.
Mark Tomomitsu	Environmental Engineer, Planning & Design Section, Wastewater Branch	State of Hawai'i Department of Health	The Department of Health is a state agency of Hawai'i whose mission is to protect and improve the health and environment for all people in Hawai'i. The wastewater branch is in charge of carrying out programs to help citizens follow wastewater regulation.
Other			
William Shuster	Senior Research Hydrologist, US Embassy Science Fellow	Environmental Protection Agency (EPA)	The US EPA's mission is to protect the environment and human health. Embassy science fellows are experts hosted by US embassies around the world to give technical assistance on short term projects. Mr. Shuster advised a water and sanitation project in the nearby Marshall Islands.
Mimpei Itoh	Section Manager, Global Environment Department	Japan International Cooperation Agency (JICA)	JICA is a governmental agency is chartered with assisting economic and social growth in developing countries, and the promotion of international cooperation. It is providing assistance in Tonga with a focus on environment, climate change measures and disaster preparedness projects.

Jack Kittinger	Senior Director of the Global Fisheries and Aquaculture Program	Conservation International	Conservation International is an American nonprofit environmental organization. It uses science, policy and partnerships with businesses and communities to protect natural resources.
Jude Kohihase	Project Officer	Asian Development Bank (ADB)	The ADB is a regional development bank that provides loans, technical assistance, grants, and equity investments to promote social and economic development in Asia. Jude is the Project Officer for the "Fiji: Project Design Advance Urban Water Supply and Wastewater Management Project" that is working in Fiji to improve urban water supply and wastewater management systems.
Gregory Pierce	Associate Director of Research	Luskin Center for Innovation, UCLA	The Luskin Center aims to conduct and translate world-class research and expertise into real-world policy solutions. Its current initiatives are linked by the themes of sustainability, energy and environmental justice. Gregory Pierce's research looks at water infrastructure and technology.

Appendix 2: Maps of Tonga (The World Factbook 2019)


0 50 100 km
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Niuafo'ou
Tafahi
Niuatoputapu
South Pacific Ocean
Vava'u Group
Vava'u
Neiafu
Kao Island
Pangai
Ha'apai Group
NUKU'ALOFA
Tongatapu Group
Minerva Reef not shown

Appendix 3: Background Data about Tonga (The World Bank 2017)

Tonga Country Profile 2017

World view

Population, total (millions)	0.11
Population growth (annual %)	0.8
Surface area (sq. km) (thousands)	0.8
Population density (people per sq. km of land area)	150
Poverty headcount ratio at national poverty lines (% of population)	..
Poverty headcount ratio at $1.90 a day (2011 PPP) (% of population)	..
GNI, Atlas method (current US$) (billions)	0.43
GNI per capita, Atlas method (current US$)	4,010
GNI, PPP (current international $) (billions)	0.65
GNI per capita, PPP (current international $)	6,050

Economy

GDP (current US$) (billions)	0.43
GDP growth (annual %)	2.7
Inflation, GDP deflator (annual %)	3.1
Agriculture, forestry, and fishing, value added (% of GDP)	17
Industry (including construction), value added (% of GDP)	17
Exports of goods and services (% of GDP)	22
Imports of goods and services (% of GDP)	74
Gross capital formation (% of GDP)	..
Revenue, excluding grants (% of GDP)	..
Net lending (+) / net borrowing (-) (% of GDP)	..

People

Income share held by lowest 20%	..
Life expectancy at birth, total (years)	73
Fertility rate, total (births per woman)	3.6
Adolescent fertility rate (births per 1,000 women ages 15-19)	15
Contraceptive prevalence, any methods (% of women ages 15-49)	..
Births attended by skilled health staff (% of total)	..
Mortality rate, under-5 (per 1,000 live births)	16
Prevalence of underweight, weight for age (% of children under 5)	..
Immunization, measles (% of children ages 12-23 months)	85
Primary completion rate, total (% of relevant age group)	..
School enrollment, primary (% gross)	106.9
School enrollment, secondary (% gross)	94
School enrollment, primary and secondary (gross), gender parity index (GPI)	1
Prevalence of HIV, total (% of population ages 15-49)	..

States and markets

Time required to start a business (days)	16
Domestic credit provided by financial sector (% of GDP)	32.6
Tax revenue (% of GDP)	..
Military expenditure (% of GDP)	..
Mobile cellular subscriptions (per 100 people)	74.7
Individuals using the Internet (% of population)	40
High-technology exports (% of manufactured exports)	2
Statistical Capacity score (Overall average)	52

Environment

Forest area (sq. km) (thousands)	0.1
Terrestrial and marine protected areas (% of total territorial area)	1.5
Annual freshwater withdrawals, total (% of internal resources)	..
Urban population growth (annual %)	0.6
Energy use (kg of oil equivalent per capita)	..
CO2 emissions (metric tons per capita)	1.14
Electric power consumption (kWh per capita)	..

Global links

Merchandise trade (% of GDP)	54
Net barter terms of trade index (2000 = 100)	104
External debt stocks, total (DOD, current US$) (millions)	169
Total debt service (% of exports of goods, services and primary income)	9.9
Net migration (thousands)	-5
Personal remittances, received (current US$) (millions)	159
Foreign direct investment, net inflows (BoP, current US$) (millions)	-6
Net official development assistance received (current US$) (millions)	80.3

Source: World Development Indicators database

Figures in blue refer to periods other than those specified.

Last Updated:01/30/2019

Appendix 4: Cost Estimation about Strategies Options

The following charts show the way we estimated strategies options to understand the revenue, burden or benefit. [$1TOP = $0.45 USD approximately (March 2019)]

2. Government Financing

Data and Assumptions

Assumption: Avg. Length of Stay (days)	8.5	(Tonga Tourism Roadmap 2014-2018)
# of Tourists (2016)	59,000	(South Pacific Tourism Agency 2017)
# of Rooms	957	(Tonga Tourism Roadmap 2014-2018)
Assumption: Hotel Revenue Per Person Per Night (TOP)	129	* price for the Tanoa International Dateline Hotel (for two adults) is 116USD (=258TOP) 258/2=129
Policy Option: General Environmental Tax Increase	2%	
Current Water Use Fee Per Household Per Month (TOP)	24.4	Household Level (SOPAC 2007)
Policy Option: : Water Use Fee Increase	60%	
# of Departures in 2017	122,970	(Statistics Department 2017)
Assumption: Departures Over 12 Years Old	90%	(Statistics Department 2017)
Current Departure Tax (TOP)	25	
Policy Option: Departure Tax Increase (TOP)	25	

Policy Option Estimates	TOP	↓ calculation notes
New General Environmental Tax (2% of Hotel Revenue)	1,141,650	revenue * tax% * #tourists * (days-1) = 129 * 0.02 * 59,000 * (8.5-1) = 1,141,650
Increased Water Use Fee	84,063	current water use fee (4 person household) / 2 (2 person hotel room) * 12 (month) * fee percentage * #rooms = 24.4/2 * 12 * 60% * 957= 84, 063
Increased Departure Tax (Additional $25 TOP)	2,766,825	# of departures * increased tax * percentage of passenger over 12 yrs =122,970 * 25 * 0.9 = 2,766,825

4. Financing Compliance

Data and Assumptions

Septic Tank Cost For a Small Hotels with 12 bedrooms (TOP)	35,556	Septic tank establishment for 3 bedrooms cost 4,000 USD (Zillow Porchlight 2014) 1TOP=0.45 USD approximately 4000 / 0.45 * 4 = 35,556
Policy Option: New Subsidy Rate	40%	
Current Loan Interest Rate	10%	(Tonga Development Bank 2018)
Current Debt at 10% Interest (TOP)	52,605	
Policy Option: Reduced Interest Rate On Loan	8%	
Length of Loan (years)	10	

Estimate: Assistance Per Hotel	TOP	↓ calculation notes
Subsidies	14,222	septic tank cost * subsidy rate = 35,556 * 40%
Loan Supported	13,798	(Current Debt at 10%) - (New Debt at 2%) =52,605 - 38,807 = 13,798
Loan total	52,605	Excel calculation (-PMT()*10)
Loan after supported	38,807	Excel calculation (-PMT()*10)

Appendix 5: Comparable Departure Taxes

Country	Departure Fee in Local Currency	Fee in US Dollars
Australia	A$60 (Wikipedia 2017)	$43
Samoa	65tālā (Wikipedia 2016)	$25
Palau	$100 (Kesolei 2018)	$100
Fiji	F$200 (Langford 2013)	$95
Cook Islands	NZ$55 (CK Travel 2017)	$38
Solomon Islands	S$40 (SPS 2013)	$5
Micronesia	$15-20 depending on airport (SPS 2013)	$15-20
Kiribati	AUD$20.00 (SPS 2013)	$15
Niue	NZ$34 (SPS 2013)	$23
Vanuatu	VUV 2,500 (SPS 2013)	$22
Tuvalu	A$30 (SPS 2013)	$21
Average Departure Tax		$36.77
Median Departure Tax		$23
Current Tonga	TOP $25	$11
Policy Option: Proposed Tonga	TOP $50	$22