Initial Environmental Examination

February 2020

Kiribati: South Tarawa Water Supply Project

Prepared by the Ministry of Infrastructure and Sustainable Energy for the Asian Development Bank and World Bank. This is an updated version of the draft originally posted in August 2019 available on https://www.adb.org/projects/documents/kir-49453-002-iee.

Environmental and Social Impact Assessment (ESIA) –Desalination Facilities (Betio and McKenzie) VOL 1 - MAIN TEXT

February 2020

Kiribati

South Tarawa Water Supply Project

Project Design Advance -1, Grant No. 6012-KIR

FCG

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Abbreviations

ADB	Asian Development Bank
ALARP	As low as reasonably practicable
AP	Affected People
CCP	Communication and Consultation Plan
CESMP	Construction Environmental and Social Management Plan
CIP	Clean-in-place (method of cleaning)
CSS	Country Safeguards System
DBO	Design-build-operate
ECD	Environment and Conservation Division (within MELAD)
EIA	Environmental Impact Assessment report (as per the CSS)
ES	Environmental Specialist
ESIA	Environmental and Social Impact Assessment Report
EHSG	Environmental Health and Safety Guidelines (of the World Bank Group)
EHSO	Environmental Health and Safety Officer
ESMP	Environmental and Social Management Plan
ENSO	El Nino Southern Oscillation
GAP	Gender Action Plan
GCF	Green Climate Fund
GRM	Grievance Redress Mechanism
HDD	horizontal direct drilling
KAPII	Kiribati Adaptation Project Phase II
KAPIII	Kiribati Adaptation Project Phase III
MDS	Material data sheet
MELAD	Ministry of Environment, Lands and Agricultural Development
MFED	Ministry of Economic and Finance Development
MHMS	Ministry of Health and Medical Services
MISE	Ministry of Infrastructure and Sustainable Energy
NIWA	New Zealand Institute of Water and Atmosphere
O&M	Operation and maintenance
PDA	Project Design Advance
PEO	Principal Environment Officer (of ECD)
PIA	Project Implementation Assistance
PMU	Project Management Unit
PPTA	Project Preparatory Technical Assistance
PSA	Poverty and Social Assessment
PUB	Public Utilities Board
PV	Photovoltaic
PVC	Polyvinyl chloride
RF	Resettlement Framework
RO	Reverse Osmosis
RP	Resettlement Plan

SDS	Safety data sheet
SEMP	Stakeholder Engagement and Management Plan
SPREP	Secretariat of the Pacific Regional Environmental Programme
STSISP	South Tarawa Sanitation Improvement Sector Project
SWRO	Salt Water Reverse Osmosis
TWMP	Tarawa Water Master Plan

EXECUTIVE SUMMARY

The South Tarawa Water Supply Project (STWSP) will increase access to safe water supply to residents of South Tarawa. To achieve this STWSP will construct new water supply infrastructure including a 3,500 m3/day seawater reverse osmosis desalination plant in Temakin, Betio and another one 2,500 m3/day in McKenzie. The required power generation to offset by a new solar photovoltaic (PV) array will be installed on the Bonriki water reserve. New and rehabilitated water supply network infrastructure will reduce leakage and provide a pressurized and safe drinking water 24/7 to each household. In addition, the project includes a 5-year climate change, water, sanitation and hygiene (WASH) awareness program with strong involvement of local civil society organizations.

The objectives of the project are to improve access to safe potable water supply services in South Tarawa, to increase resilience of the services to climate change and to improve health and sanitation of the residents of South Tarawa.

The project is being co-funded by the Asian Development Bank (ADB) and the World Bank (WB), with additional funding from Green Climate Fund (GCF). The project will be transitioned to and managed by the Kiribati Public Utilities Board (PUB), once the infrastructure is fully installed and rehabilitation works are completed. The executing agency for the project is the Ministry of Finance and Economic Development (MFED) and the implementing agency is the Ministry of Infrastructure and Sustainable Energy (MISE) and Public Utilities Board (PUB) for the operations and maintenance (O&M) stage.

The need for the project is obvious, water supply situation and water management in Kiribati is complex and challenging due to the pressures on the physical resources in terms of water quality and quantity, and also because of the increasing social pressures applied to the resource. Water resources are fragile, and vulnerable to drought, over-extraction and contamination. This is further complicated by issues of land ownership and water rights, and in the urban area of South Tarawa, a rapidly increasing population. Even without the projected population growth, as a result of high physical losses in the water supply system (estimated at 67%), the average available per capita water supply from the piped water system (11 L/day) is far less than the actual estimated demand of between 57 and 112 L/day and, in the context of disaster response, is considered the absolute minimum quantity required for basic drinking, cooking and personal hygiene needs. Consequently, people are required to use unsafe alternative water sources, with a high proportion of the population using contaminated well-water for bathing.

This document is the Environmental and Social Impact Assessment (ESIA) for the **desalination component** of STWSP, one of the three ESIA documents of STWSP. The preparation of this ESIA has had various stages, starting in 2017 and gone through ADB and WB approval process in August-September 2019. The first versions covered the entire project, including desalination plant, network and solar PV components and some sanitation aspects. During the Project Design Advance (PDA), the ESIA was split into three separate documents. Consequently, separate ESIA documents have been prepared for the solar PV component and the water network component. The ESIA documents contain the policy and legal framework, details of the proposed project component, baseline environmental and social data, potential environmental and social impacts of the project and their mitigation measures. They also introduce the environmental management measures, environmental and social management plans (ESMP) and TORs for environmental specialists/officers of the contractors as well as the methods and results of the community engagement process. A grievance redress mechanism is also described.

The proposed activity includes construction of **two reverse osmosis desalination plants** to provide safe drinking water, one in Betio and one in McKenzie. The reverse osmosis system is reducing the salinity of the ground water supplied from drilled bores below fresh water lenses. Saline groundwater from the bores is pumped through the media filters into a filtrate tank. The filtrate from the tank is then pumped by low pressure forwarding pumps through cartridge filters into the suction of the reverse osmosis high pressure pumps. The end result is safe permeate, which is the low salinity potable water produced by the reverse osmosis system. The ratio of permeate to feed water is 43%. The balance of 57% is effluent which is discharged as a brine stream which will have a salinity almost twice as high as the incoming feed water.

The location in Betio is in Temakin, Betio Western, the area that was previously occupied by Nippon causeway contractor. In McKenzie, an area on the compound of the proposed OTEC project has been allocated for the desalination plant.

The **studies and surveys** carried out during PDA phase in 2019 include topographic study, UXO survey and hydrogeological survey (including water quality analysis) and effluent dispersion survey. Relevant studies done by other projects include sewage outfall (Betio) BEIAs of STSISP and EIA for the OTEC site in McKenzie.

The **project benefits** of the desalination plants will be to provide adequate quantity of safe potable safe water for all households in South Tarawa, which enables improved hygiene practices and leads to better health. The project will lead to reduced water losses. The project will also increase the resilience of the services to climate change by installing a system to provide freshwater to local residents, even if the freshwater aquifer becomes contaminated due to salt water inundation and by locating the new infrastructure at a suitable elevation above the current high tide level.

The **potential adverse impacts** are manageable, once the mitigation measures presented in the environmental and social management plan are followed. The only less predictable impacts which cause most vulnerability are those related to climate risks, but will be taken into account in all stages of the project and in the structures of the improvements. The project impacts and mitigation measures are divided to those of pre-construction, construction and operation of the systems.

Pre-construction period mitigation relate to planning of items to prevent impacts to the community, improve longevity of infrastructure and protect cultural and heritage important sites as well as measures to facilitate compliance with environmental legislation of Kiribati and ADB and WB safeguards policies. Pre-construction concerns also include UXO, site selection and site clearance issues. The major discussion related to environmental and social issues related to the desalination plants have been the suitability of the locations, including outfalls and the potential hazards of brine disposal. An effluent dispersion survey was conducted, which shows that salinity declines rapidly as water flows away from the diffuser in the end of the outfall pipeline.

During the **construction** period, mitigation actions to be undertaken are related to the usual disturbance and construction impacts including waste management. Construction of outfall in McKenzie needs to be done in environmentally friendly manner, not to cause harm to marine life. In Betio, the existing sewage outfall will be utilized. The safety of workers and the public need to be properly addressed during construction. In the **operation** stage, the main concern

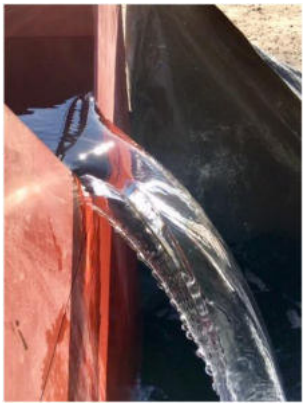
is the safe disposal of effluent. The environmental management obligations become the responsibility of the proponent, MISE, and the operator, PUB.

Extensive **community engagement** processes have been implemented during the project preparatory and detailed design phases and will be continued during implementation phase. The project has also supported the World Water Day, Global Environment Day, International Handwashing Day and World Toilet Day activities in South Tarawa, as part of its community engagement actions.

The project's key environmental and social management and mitigation measures include the development, implementation and monitoring of an **Environmental and Social Management Plan**, ESMP. The ESMP addresses the impacts and risks associated with construction and operation of the infrastructure and will be updated and further developed as a CESMP by the contractor. Where possible, government owned or leased land has been identified for siting of project infrastructure.

The ESIA has found that no major short-term or cumulative environmental or social impacts are likely to occur from the Project, provided that the ESMP is updated, implemented and monitored and the Resettlement Plan is implemented. The overall environmental, health and socio-economic benefits of the project more than outweigh the adverse environmental and social impacts that will occur.

Conclusion: The project is classified as category B for environment. The impacts are largely site-specific, intermittent and/or temporary (during construction) and mitigation measures can be readily designed and implemented. An environmental and social impact assessment (ESIA) – as equivalent to an initial environmental examination (IEE) and appropriate for the category B project – has been undertaken and includes an environmental management plan (EMP) which will be updated based on detailed design. The ESIA will form the basis of the application for environmental license under the country safeguard system. Institutional arrangements have been incorporated into the project management structure and system to ensure effective safeguards implementation. The contractor will prepare a construction EMP (CEMP) responding to the EMP and environmental license conditions, the PMU will review and clear the CEMP. Implementation of the approved CEMP will be monitored for effectiveness.



Clear water flowing from the test bore

Ocean view from Betio Western – close to outfall site

Drilling and operating bore in Betio passes environmental audit

1 INTRODUCTION

Kiribati and in particular South Tarawa has the highest infant mortality rate in the Pacific, this is partly attributable to infantile diarrhoea. Overcrowding and inadequate water, sanitation and hygiene (WASH) are closely related to dysentery, diarrhoea and other waterborne diseases. The obvious solution is to improve the access to safe water across South Tarawa.

1.1 South Tarawa Water Supply Project

a) Outputs and Outcomes

The South Tarawa Water Supply Project (STWSP) will increase access to safe water supply to residents of South Tarawa. To achieve this the STWSP will have the following outputs:

1. Construction of the water supply infrastructure including:
    a. New 3,500 m^3/day seawater reverse osmosis desalination plant in Temakin, Betio and another one 2,500 m^3/day in McKenzie, upgradable to 3,500 m^3/day
    b. The required power generation to offset by a new solar photovoltaic (PV) array to be installed on the Bonriki water reserve;
    c. New and rehabilitated water supply network infrastructure to reduce leakage and provide a pressurised and safe drinking water 24/7 to each property household
2. 5-year climate change, water, sanitation and hygiene (WASH) awareness program with strong involvement of local civil society organizations

The STWSP aims at providing the following outcomes:

1. Equitable access to safe and reliable drinking water services to all South Tarawa residents;
2. Effective management and maintenance of the infrastructure;
3. Improved hygiene practices among the population;
4. Institutional strengthening, capacity building and medium-term performance-based contracts for operation and maintenance of the new infrastructure;
5. Implementation of sanitation pilot systems in selected communities.

The project is being co-funded by the Asian Development Bank (ADB), Green Climate Fund (GCF) and the World Bank (WB). The project will be transitioned to and managed by the Kiribati Public Utilities Board (PUB), once the infrastructure is fully installed and rehabilitation works are completed. The executing agency for the project is the Ministry of Finance and Economic Development (MFED) and the implementing agency is the Ministry of Infrastructure and Sustainable Energy (MISE). The Public Utilities Board (PUB) will be responsible for the operations and maintenance (O&M) of the new water supply infrastructure.

b) Location of South Tarawa

The STWSP project is located in South Tarawa on the island republic of Kiribati. The Republic of Kiribati consists of 32 low-lying atoll islands and one raised limestone island located in three main island groups, the Gilbert, Line and Phoenix Islands. The islands are scattered over a large area (3.5 million sq. km) of the central and western Pacific (Figure 1).

Most of the islands are small (less than 2 km wide) and little more than 1.8 meters (on average) above sea level. Kiribati is one of the smallest, most remote, geographically dispersed, and climate change vulnerable countries in the world.

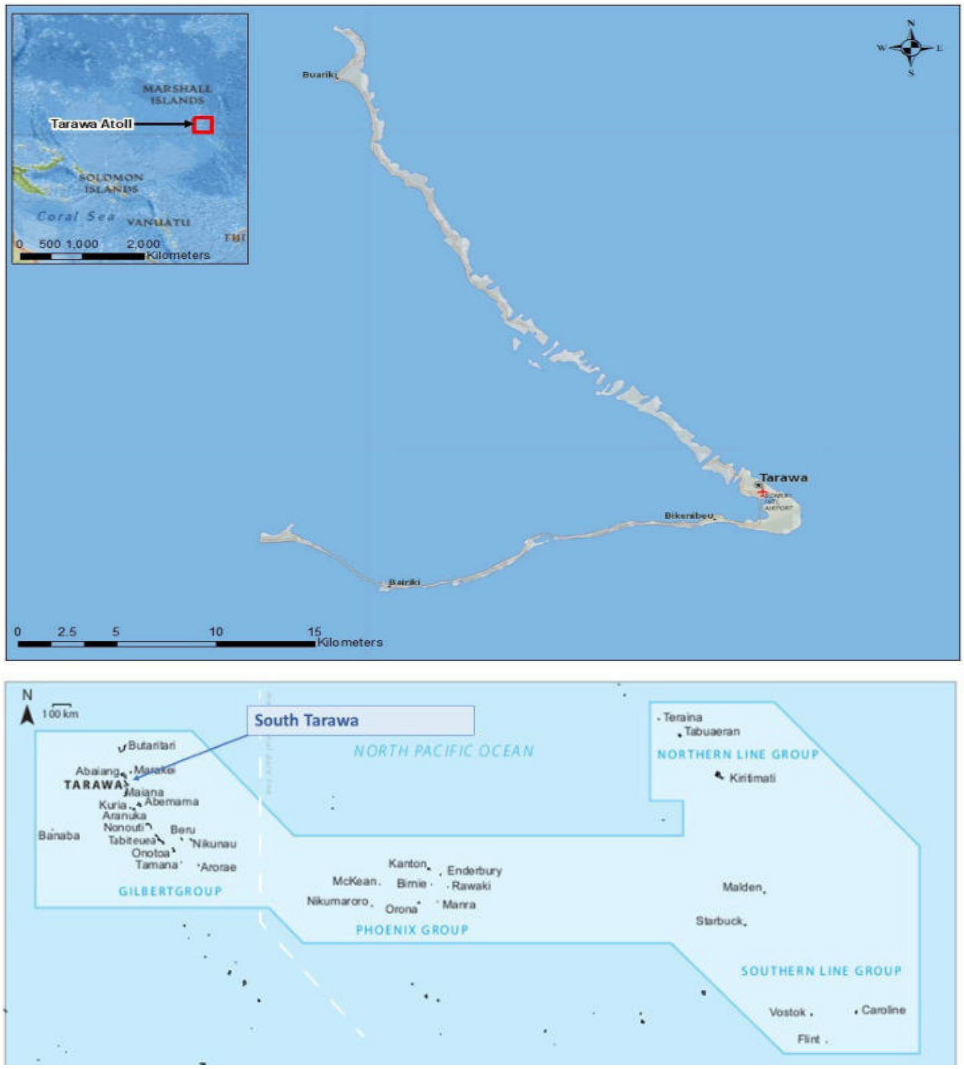


Figure 1 – Location of Tarawa atoll and South Tarawa

Twenty-one of the 33 islands are inhabited. The bulk of the Kiribati population resides in the Gilbert Islands, which have a land area of 286 sq. km and contains the capital on Tarawa Atoll. South Tarawa is located approximately 150km north of the equator and is composed of a number of isolated islands that are connected by causeways.

STWSP project is located on South Tarawa, which is the main atoll in the Republic of Kiribati and is the government and economic centre. It is made up of many small islets joined to form a long, thin atoll with elevations mainly less than 3 m of current sea level. The geographical characteristics of South Tarawa, coupled with it having one of the highest population densities in the world, make water shortages an ever-present threat for its inhabitants.

Official population censuses show the population of Kiribati has increased from 92,533 in 2005 to 110,136 in 2015 and is expected to reach approximately 156,000 in 2040 (UN 2017). The

Tarawa atoll (comprising both North Tarawa and South Tarawa) accounts for more than half of the population and is growing at a faster rate than the rest of the country, increasing in population by approximately 41% between 2005 and 2015. Over the period 2015-2041, South Tarawa's population is projected to increase by approximately 62.5%.

Population projections suggest that the population of South Tarawa will continue growing rapidly. Due to increase of per capita demand and population growth, the demand for water on South Tarawa is projected to grow significantly in coming years. Depending on the scenario adopted, the demand will grow to reach between 6,000 – 14,000m3/day by 2041.

c) Background – Environmental Impact Assessment Procedure

The Ministry of Infrastructure and Sustainable Development (MISE) submitted an environment license application for the STWSP project in October 2017. As a response, the Ministry of Environment, Lands and Agricultural Development (MELAD) informed in November 2017 that an environmental impact assessment study is required.

ESIA is a tool to guide for the environmental management of the project. It examines the potential impacts of proposed project activities and identifies mitigation measures to avoid adverse impacts. This ESIA has been prepared in accordance with the safeguards policy requirements of the development partners (ADB and WB), with the country safeguards system (CSS) as per the Environment Act with the latest amendment in 2017, and other requirements of the Republic of Kiribati. Furthermore, it has been prepared in accordance with Secretariat for the Pacific Regional Environment Programme (SPREP) Environmental Impact Assessment (EIA) guidelines[1].

The first version of the ESIA for STWSP was prepared in during the project preparatory phase (PPTA) in 2018, and it has gone through ADB and WB approval process in August-September 2019. That "general ESIA" covers the entire project. During the Project Design Advance (PDA) phase, the ESIA was split into three separate documents – for 1) desalination, 2) water distribution network and 3) solar PV components, to fit in to different bidding documents.

This document is the ESIA for the **desalination plant establishment**. An UXO survey and a drilling study have taken place at the project site (details described later in this document). An environmental license was obtained for the drilling study (see Appendix 2/2-2/4). A brine dispersion study was carried out for the outfalls of the desalination plants (Appendix 3).

d) Objective of The Proposed Activity (STWSP)

The government recognises the magnitude of the limited water resource and associated socio-economic impacts and has taken the initiative to work with ADB and WB to address the water supply situation in Kiribati through the project.

The project is committed to supplementing existing water shortages, undertaking infrastructure improvements, and improving public health by offering an opportunity for all residents on South Tarawa to have access to safe water. The project reflects the complexity of the water problem in South Tarawa and uses a mix of approaches to provide additional water, reduce water leakage, institutional strengthening and a behavioural change program.

[1] SPREP publication "Strengthening Environmental Impact Assessment: Guidelines for the Pacific Island Countries and Territories"

The project comprises of physical infrastructure improvements and behavioural change through a WASH program. The physical improvements of water supply services include a desalination plant in West Betio and a smaller unit in McKenzie, an expanded and modernized water supply network, and a Solar photovoltaic power plant. The objectives are:

- To improve access to safe potable water supply services in South Tarawa
- To increase resilience of the services to climate change
- To improve health and sanitation of the residents of South Tarawa

e) Analysis of the Need for the Proposed Activity

I-Kiribati have always recognised that freshwater is a vital and limited resource. For the past 4,000 years I-Kiribati have faced major natural challenges and have adapted to large variations in climate with limited supplies of freshwater. However, over the last 50 years, demographic and socio-economic factors have changed dramatically, particularly in the urban parts of Tarawa. These have propelled residents in South Tarawa from a largely low-density, subsistence lifestyle to a high-density, urban situation and one in which traditional adaptation strategies are largely ineffective in coping with the demands of a highly urbanised society living under a highly variable climate.[2]

Water management in Kiribati is amongst the most complex and challenging in the world. Not only because of the pressures on the physical resource itself in terms of water quality and quantity, but also because of the increasing social pressures applied to the resource. Water resources are fragile, and vulnerable to drought, over-extraction and contamination. This is further complicated by issues of land ownership and water rights, and in the urban area of South Tarawa, a rapidly increasing population.

Many of the issues related to WASH in Kiribati are centred on South Tarawa. The population of South Tarawa is growing rapidly and projected to continue doing so (from 60,700 in 2015 to over 100,000 in 2040), while at the same time more people are moving from the outer islands to South Tarawa. Studies have shown high faecal coliform levels in household groundwater wells, water in the lagoon and intertidal platform close to the shoreline, and in edible shellfish. Kiribati has a high incidence of waterborne disease and extremely high infant mortality rate of almost 5% that can be partly attributed to infant diarrhoea.

Even without the projected population growth, as a result of high physical losses in the water supply system (estimated at 67%), the average available per capita water supply from the piped water system operated by the PUB is 11 L/day. This is far less than the actual estimated demand of between 57 and 112 L/day and, in the context of disaster response, is considered the absolute minimum quantity required for basic drinking, cooking and personal hygiene needs. Consequently, people are required to use unsafe alternative water sources, with a high proportion of the South Tarawa population using contaminated well-water for bathing.

The existing water supply in South Tarawa is sourced from infiltration galleries located at Bonriki and Buota, from which water is abstracted and treated with a chlorination and aeration system and distributed along the chain of islets. Due to high production and non-revenue water (NRW) losses and the limited supply, customers are provided with water intermittently i.e. for a few hours every 2-3 days. This inadequate water supply is compounded by other challenges of climate change and variability, urban encroachment, poor infrastructure management, high non-revenue water, little-no cost recovery, low institutional capacity and

[2] White, I. 2010. Tarawa Water Master Plan 2010-2030. Ministry of Public Works and Utilities. (KAP II)

lack of funds. South Tarawa is also strongly influenced by the El Nino Southern Oscillation (ENSO) cycles and during La Nina periods often experiences dry or drought conditions.

According to the survey done during the PDA in 2019, there are 12,122 households on South Tarawa. In 2015, 36% of the households obtained their drinking water from PUB's reticulated water supply system, 49.5% depend on rainwater, and 12% relied on groundwater (mainly shallow wells). In addition to these sources, seawater is also used for bathing, washing clothes and flushing toilets. The three public reticulated sewerage systems in South Tarawa all use seawater for toilet flushing because of the scarcity of freshwater in South Tarawa.

Water shortage is one part of the problem in South Tarawa. Further problems are related to water quality. The principal pollution threat to household wells, whether closed or open, and human health is from faecal contamination. There are two sources of faecal contamination in Tarawa, humans and animals (including birds).

The future availability of water supply and the demand for water is also influenced by climate change. Climate studies carried out under Kiribati Adaptation Program Phase Two (KAPII)[3] indicated that the main impact of climate change on South Tarawa water supply would be a 20% reduction in the size and sustainable yield from Bonriki and Buota lenses approximately by the year 2030. Further analysis as part of the ADB Climate Risk Vulnerability Study determined a more nuanced situation: that future sea overtopping and/or droughts, rendered far more probable by climate change, could lead to a sudden, significant but temporary reduction in the freshwater available from the lenses.

The analysis undertaken as part of the project preparation also validated two pathways through which projected climate change affects water demand:

- Rising temperatures will lead to higher per capita demand, rising by an estimated 2 liters per capita per day;
- Climate change will contribute to projected higher population growth on South Tarawa (relative to the national average growth), contributing an estimated incremental increase of 2,114 persons by 2040.

In addition to the need for the additional source of water (desalination plant), due to the current condition of the water distribution network and due to the increased water volumes, improvements of water network are urgently needed.

f) Profile and Contact Details for the Project Proponent

The government as project proponent plans to implement the project with assistance from the ADB and the WB. The ADB and WB are supporting the government by providing technical assistance through the MISE and PUB to prepare in implementing the project. Part of this assistance is to address environmental and social safeguard issues documented in this report. Both ADB, WB and GCF funding is involved.

The contact details of the project proponent:

Government of Kiribati
Ministry of Infrastructure and Sustainable Energy (MISE)

[3] Climate Information for Climate Risk Management: Sea-levels, waves, fun-up and overtopping. Released 2008, updated 2010. New Zealand National Institute of Water and Atmospheric Research (NIWA). Available at www.climate.gov.ki

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g) This Report

This ESIA document is prepared for the **construction and operation of the desalination facility** for South Tarawa. It has been developed and updated from the earlier ESIA version (draft October 2018, with minor changes by WB in August 2019). The previous version has been split to three separate ESIA documents – desalination (this document), water distribution network and solar PV.

The document is based on the EIA outline given in the latest Kiribati environmental legislation for an environmental impact assessment study and aims to give guidance for the contractor to include necessary environmental management measures in the project implementation.

The document contains the policy and legal framework, details of the proposed project component, baseline environmental and social data, potential environmental and social impacts of the project and their mitigation measures. It also introduces the environmental management measures, environmental management plan (EMP) and TORs for environmental specialists/officers of the contractor as well as the methods and results of the community engagement process during the different stages of the project planning. A grievance redress mechanism is also described.

2 POLICY AND LEGAL FRAMEWORK

2.1 National Laws and Regulations

a) Kiribati Constitution and Environment Act

The constitution of the Republic of Kiribati vests the natural resources of Kiribati in the people and Government, who through various ministries and agencies provide the protection to public health, the health of animals and plants and the conservation of the environment. The country safeguard system (CSS) requires compliance with the environmental assessment regulations for all projects is embodied in the Environment Act 1999 (No. 9 of 1999), which states it is an "Act to Provide for the Protection Improvement and Conservation of the Environment of the Republic of Kiribati and connected purposes".

The Environment Act was amended in 2007 to reflect the needs of better appraising, monitoring and to provide the means for the inclusion of the Environmental (General) Regulations (latest 2017, see Appendix 1), in which activities are 'scheduled' according to their environmental significance. Activities that are considered to create a significant environmental impact require application for environmental license. Some activities further require an EIA report. The decision to grant the license and the provision of conditions are set out in Section 38 of the Environment Act 2007, are made according to the principles of sustainable development and with any international obligations or agreements to which Kiribati is bound, and any other prescribed requirements.

Following review of the application submission, an EIA report is required by the Principal Environment Officer (PEO) of the Ministry of Environment, Lands and Agricultural Development (MELAD) for the project.

b) Other Relevant Legislation

Other legislation that is relevant to this Project include: (i) the Public Utilities Ordinance of 1977, which vests responsibility for the protection and security of water resources in the Public Utilities Board, and includes regulations for the protection of water reserves, (ii) the Public Health Ordinance of 1926, (iii) Public Health Regulations of 1926, both of which provide for public health measures including sanitation, solid waste collection and drainage, (iv) the Foreshore and Land Reclamation Ordinance of 1969, which regulates extraction of material such as sand, gravel, reef mud and rock, (v) Land Planning Ordinance 1972 (amended 1973, 1974, 1977, 1979, 1980 (2), 2000), the objective of which is to apply controls over land use and developments within designated areas; (vi) the Local Government Act, 1984 which empowers local government bodies to issue bylaws relating to environmental protection, and (vii) Penal codes (Cap 76 1977) having some offences in the Code that are relevant to environmental protection and enforcement.

Kiribati has ratified the International Labour Organisation *Minimum Age Convention 1973* (no.138) and *Worst Forms of Child Labour Convention 1999* (No.182). The *Employment and Industrial Relations Code 2015* includes provisions supporting these two ratifications including the definition of a child meaning "*a person under the age of 18 years*".

c) Administrative Framework for Safeguards Implementation

Requirements of the country safeguard system (CSS) are set out in the Environment Act of 2007 and Environment (General) Regulations, 2017. The act assigns primary responsibility

for undertaking environmental assessment of projects to the project developer. The Ministry of Environment, Lands and Agricultural Development (MELAD), under the direction of the Principal Environment Officer (PEO), is responsible for review and approval of environmental assessment reports, prescription of requirements for publication and disclosure environmental assessment reports, issuance of environment licenses, and prescription of any conditions to the licenses.

Environment licenses are required from the MELAD, for all activities that are deemed environmentally significant. These include activities to be undertaken by the Project, including instalment and operation of a desalination systems and solar PV system, and rehabilitation of the existing water supply system that may require land clearance and excavating activities.

The Act requires the applicant for the environment license (in this case the MISE) to submit an application with an application fee to the PEO. On consideration of the application, the PEO determines whether to issue an environment license or require an EIA or refuse the application. Appendix 2 includes environmental licence related documentation for the project so far.

When an EIA report is required, the applicant undertakes the assessment according to the required format and is required to hold public consultations. This is compatible with the development partners' requirements, which requires that consultation is meaningful, commences early in the project preparation cycle, provides timely disclosure of relevant and adequate information that is understandable and readily accessible to affected people, is inclusive of the views of women, men, and vulnerable groups, and is carried out in a non-coercive manner.

Once the EIA report is received by MELAD, the PEO will determine the appropriate form of its publication and disclosure to interested parties, and the deadline for receipt of comments. Comments received must be shown to the applicant and taken into consideration. Concurrently the report is also reviewed by the Environment and Conservation Division (ECD), where regional and international expert views may be sorted. In accordance with ADB policy, revisions should be made in response to comments.

On receipt of comments, the PEO decides whether to grant a license and if a license is to be granted, whether it will include any conditions. Conditions may include duration, location, prescribed methods, emission limits, monitoring and reporting requirements, lodgement of bonds and payment of fees, and preparation of plans and specific mitigations.

The ECD is responsible to monitor the activity's progress to ensure compliance with the license conditions.

2.2 Multilateral Environmental Agreements

In addition to local regulations, the following conventions, protocols and regional agreements are relevant to Kiribati:

i. Convention on Biological Diversity
ii. Cartagena Protocol
iii. World Heritage Convention,
iv. Framework Convention on Climate Change
v. Regional Seas Convention
vi. Convention to Combat Desertification

vii. The Vienna Convention and Montreal Protocol on Ozone Depleting Substances
viii. Basel Convention and Waigani Convention to control the trans-boundary movements and disposal of hazardous wastes
ix. CITES (International trade in endangered species)
x. Stockholm Convention International,
xi. Convention for the Protection of World Cultural and National Heritage.

2.3 Health, Safety, Hazard and Risk Management Standards

a) Kiribati Occupational Safety and Health Act

The Kiribati Occupational Health and Safety Act 2015 intends to achieve the intended purposes inherent in the Occupational Safety and Health Convention 1981, the 2002 Protocol on Occupational Safety and Health, and the Promotional Framework for Occupational Safety and Health Convention 2008.

The 2015 Occupational Health and Safety Act set the country's first comprehensive framework for occupational safety and health standards for the workplace. The Ministry of Labor and Human Resources Development is responsible for enforcing the standards. Employers are liable for the expenses of workers injured on the job. By law workers may remove themselves from situations that endanger their health or safety without threat to their employment.[4]

b) IFC Environmental, Health and Safety Guidelines

The project will follow the IFC EHS guidelines include relevant construction related guidance and standards for noise and vibration, soil erosion, air quality, solid waste, hazardous materials, wastewater discharges and contaminated land as well as occupational health and safety and general community site hazards and traffic safety.

For noise level standards relevant to this project are: one-hour noise at daytime maximum 55 dBA and night-time 45 dBA. The IFC guidelines will also be used for lighting.

Table 1 – Noise Level Guidelines of IFC[5]

Table 1.7.1- Noise Level Guidelines[54]		
	One Hour L_{Aeq} (dBA)	
Receptor	Daytime 07:00 - 22:00	Nighttime 22:00 - 07:00
Residential; institutional; educational[55]	55	45
Industrial; commercial	70	70

[4] United States Department of State Bureau of Democracy, Human Rights and Labor, 2017

[5] IFC Environmental, Health and Safety General Guidelines, 2007

c) Water Quality Standards

The PDA has adopted both the World Health Organisation (WHO), 2011 edition, and the guidelines the Australian Drinking Water Guidelines, 2011 edition. Depending on parameter concerned, whichever guideline is stricter, shall be used. The WHO and ADW Guidelines are both available as free downloads from their respective web sites.

WHO guidelines express a concern about the low mineral contents in the desalinated water (see
Figure 2).

Desalinated water contains lower than usual concentrations of dissolved solids and essential elements such as calcium and magnesium, which are commonly found in water (see the supporting document *Calcium and magnesium in drinking-water*; Annex 1). Drinking-water typically contributes a small proportion to the recommended daily intake of essential elements, with most of the intake occurring through food. Fluoride would also be missing from desalinated water unless it were added prior to distribution, which may be considered by countries in which sugar consumption is high (WHO, 2005b).

Stabilization practices should ensure that the overall process does not significantly reduce total intake of nutrients such as calcium, magnesium and fluoride. Based on local circumstances, public health authorities may wish to set a requirement to further modify final drinking-water composition in light of overall mineral nutrition.

Figure 2 - Extracts from WHO Drinking Water Guidelines

2.4 Environmental Policies of Financing Institutions Involved in the Project

The project is being co-financed by the ADB and WB and therefore in addition to the country safeguard system (CSS), the safeguard requirements of the Asian Development Bank (ADB) and the World Bank (WB) will also be complied with.

a) ADB Safeguards

The objectives of ADB's safeguards are to: (i) avoid adverse impacts of projects on the environment and affected people, where possible; (ii) minimize, mitigate, and/or compensate for adverse project impacts on the environment and affected people when avoidance is not possible; and (iii) help borrowers/clients to strengthen their safeguard systems and develop the capacity to manage environmental and social risks. Through its Safeguard Policy Statement 2009 (SPS) ADB establishes policy objectives, scope and triggers, and principles for three key safeguard areas of environment, involuntary resettlement, and Indigenous People. The SPS sets out the process to be applied from screening, through due diligence and assessment to monitoring and reporting.

The SPS requires project screening and categorization at the earliest stage of project preparation. Screening and categorization are undertaken to (i) reflect the significance of potential impacts or risks that a project might present; (ii) identify the level of assessment

and institutional resources required for the safeguard measures; and (iii) determine disclosure requirements. ADB uses a classification system to reflect the significance of a project's potential environmental impacts. A project's category is determined by the category of its most environmentally sensitive component. Each proposed project is scrutinized as to its type, location, scale, and sensitivity and the magnitude of its potential environmental impacts. Projects are assigned to one of four categories. The category determines the level of assessment required.

ADB's safeguard due diligence emphasizes planning, environmental and social impact assessments and safeguard documentation. Through such due diligence and review, ADB will confirm (i) that all key potential social and environmental impacts and risks of a project are identified; (ii) that effective measures to avoid, minimize, mitigate, or compensate for the adverse impacts are incorporated into the safeguard plans and project design; (iii) that the borrower/client understands ADB's safeguard policy principles and requirements and has the necessary commitment and capacity to manage the risks adequately; (iv) that, as required, the role of third parties is appropriately defined in the safeguard plans; and (v) that consultations with affected people are conducted in accordance with ADB's requirements.

b) WB Safeguards

The WB has operational policies relating to environmental and social safeguards. OP 4.01 – Environmental Assessment, states that the WB requires environmental assessment of projects proposed for WB financing to help ensure that they are environmentally sound and sustainable. Like ADB SPS, OP4.01 sets out the process to be applied and commences with environmental screening which is undertaken to determine the appropriate extent and type of environmental assessment. WB uses the same classification system for projects as the ADB with Category A projects having the greatest potential for significant environmental impacts (i.e. that are sensitive, diverse or unprecedented) and an environmental assessment report must be prepared by the borrower. Category B projects have potential impacts that are site-specific, less adverse than Category A and likely reversible, and mitigation can be provided readily. The scope of environmental assessment for Category B projects is less than Category A (but the level of detail will vary from project to project based on what is potentially at risk). Category C projects are unlikely to have any adverse environmental impact and no further environmental assessment is required.

WB appraises and, if necessary, includes components to strengthen the capabilities of the implementing agency to a) screen sub-projects, b) obtain the necessary expertise to carry out EIA, c) review all findings and results of EIA for individual sub-projects, d) ensure implementation of mitigation measures and e) monitor environmental conditions during project implementation.

Other World Bank Operational Policies that are relevant to this project include OP 4.04 Natural Habitats, OP. 4.11 Physical Cultural Resources (PCR), and OP 4.12 Involuntary Resettlement:

- OP 4.04 Natural Habitats policy aims to support the protection, maintenance and rehabilitation of natural habitats and promotes the conservation of natural habitats for long-term sustainable development through a precautionary approach.
- OP. 4.11 Physical Cultural Resources (PCR) addresses physical cultural resources which are defined as movable or immovable objects, sites, structures, groups of structures, and natural features and landscapes that have archaeological, paleontological, historical, architectural, religious, aesthetic, or other cultural significance. This policy

aims to assist countries to avoid or mitigate adverse impacts on physical cultural resources from development projects that it finances.

- OP 4.12 Involuntary Resettlement policy aims to restrict the involuntary taking of land or any form of economic displacement of populations affected by or participating in World Bank financed activities; and where displacement is unavoidable, to assist persons to improve (or at least restore) their incomes and standards of living; and to identify and accommodate the needs of vulnerable groups. Land related issues are managed by the Resettlement Framework and Resettlement Plan which have been prepared for the project.

c) Social Safeguards and Social and Gender Assessment

Social Safeguards Due Diligence as part of the ADB PPTA projects research and analysis culminated in a series of social assessment documents pertaining to the circumstances in Kiribati with particular reference to project impacts. The documents prepared in the PPTA phase (2018) of the project included:

1. The poverty and social assessment (PSA);
2. A gender action plan (GAP)
3. Stakeholder analysis, participation plan and communication strategy and consultation and communications plan (CCP);
4. A resettlement framework (RF);
5. A resettlement plan (RP); and
6. The summary poverty reduction and social strategy (SPRSS)

During the PDA phase (2019), a stakeholder engagement and management plan (SEMP) was prepared and the resettlement framework and resettlement plan have been updated.

d) Public Consultation

For all projects the borrower consults affected groups and local non-governmental organisations (NGOs) during the EIA process about the project's environmental aspects and takes into account their views. Consultations undertaken during the PPTA and PDA of this project are described later in this document.

e) Disclosure

To facilitate meaningful consultation, the borrower provides relevant materials in a timely manner and in a form and language that are understandable and accessible to groups being consulted.

3 DESCRIPTION OF THE PROPOSED ACTIVITY

3.1 Introduction – Details and Schedule of Desalination Component

The proposed activity includes construction and operation of two desalination facilities, a 3,500 m^3/day seawater reverse osmosis system in Temakin, Betio and another one 2,500 m^3/day in McKenzie, upgradable to 3,500 m^3/day.

Table 2 – Engineering details

Item	Betio	McKenzie	Unit
Capacity	3,500	2,500	kl/day
Recovery	43%	43%	
Intake	8,140	5,814	kl/day
Product Water	3,500	2,500	kl/day
Brine Stream	4,640	3,314	kl/day
Raw Water TDS	28,200	28,200	mg/l
Brine Stream TDS	65,500	65,500	mg/l
Bores Active	6	5	Number
Bores Standby	3	2	Number
Bore Flow Rate	17	17	l/s
Bore Depth	33	31	m
Raw Water Tank	500	350	kl
Pre-Treatment	1	1	Number
Capacity of Containers	1,200	1,200	Number
Number of Containers	3	2	
Generator	1,000	1,000	kW
Chlorination	1	1	Number
Product Water Tank	2,100	1,000	kl
Product Water Pump Station	1	1	Number
Outfall	90	35	m
Sump	1	0	Number
Brine Pump Station	4,640	0	
Power (total site)	3.5	3.5	kWh/m3

A noise limit of 55 dBA measured as the equivalent continuous sound pressure for one hour for the hours of 7:00 am to 10:00 pm (same noise level as a refrigerator) and 45 dBA for the balance (same noise as a background suburban area) as measured at the desal site boundary has been specified. This means the plants will need sound absorption materials which we will specify. Within the plants PPE (noise) will be required.

The schedule of the works depends on the start date of the work of the contractor, the bidding process starts around February-March 2020.[6]

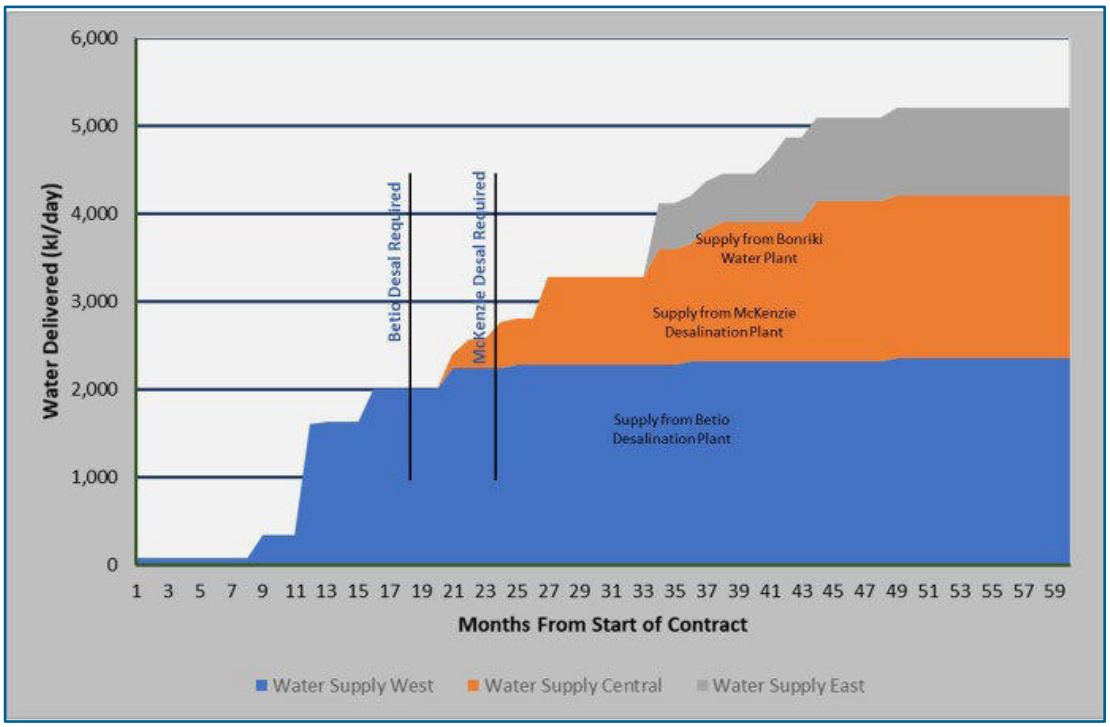


Figure 3 – Schedule of works

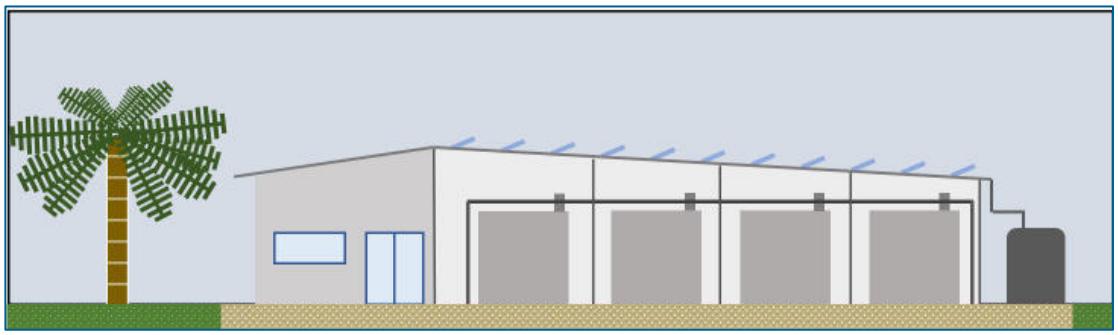


Figure 4 – Likely structure of the desalination plants

The following figure illustrates the water transmission and distribution system from the two new desalination plants.

[6] The detailed designs and bidding documents were still under work during the preparation of this ESIA document.

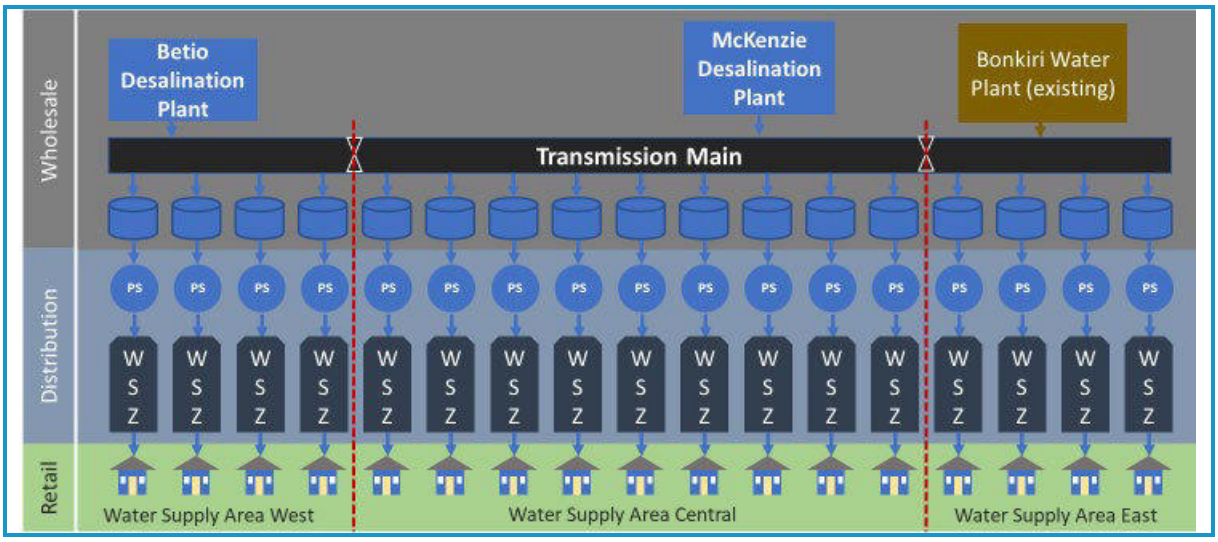


Figure 5 – Wholesale – Distribution - Retails

3.2 Location of the Desalination Plants

The following figures shows the locations of the two new desalination plants in South Tarawa – one in Temakin in Betio and other one in McKenzie.

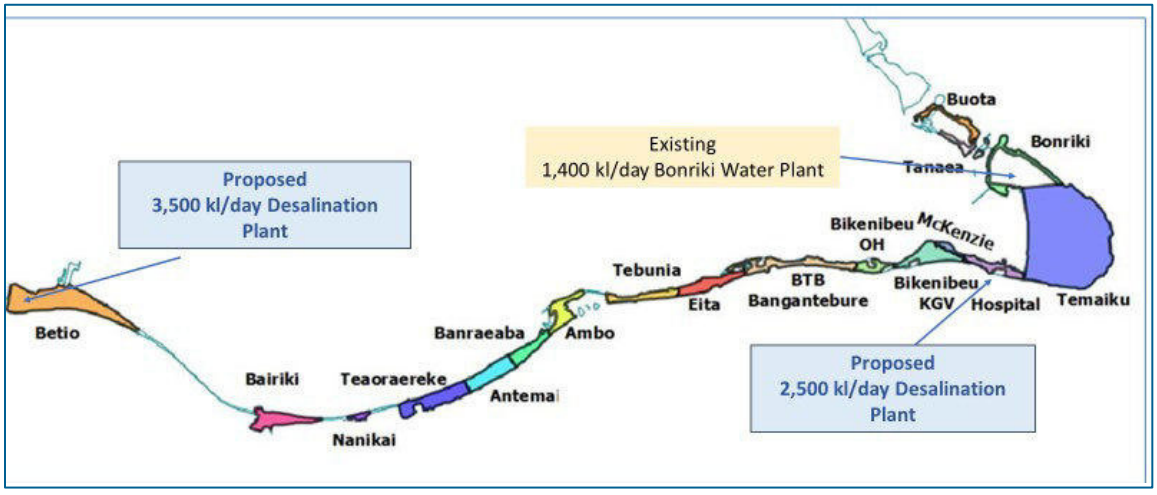


Figure 6 – Locations of the two desalination plants

The following layout plans are being finalized together with the final detailed designs. Thus, minor changes may occur.

Desalination plant in Temakin, Betio - site previously used by Nippon Causeway Contractor in Betio western area:

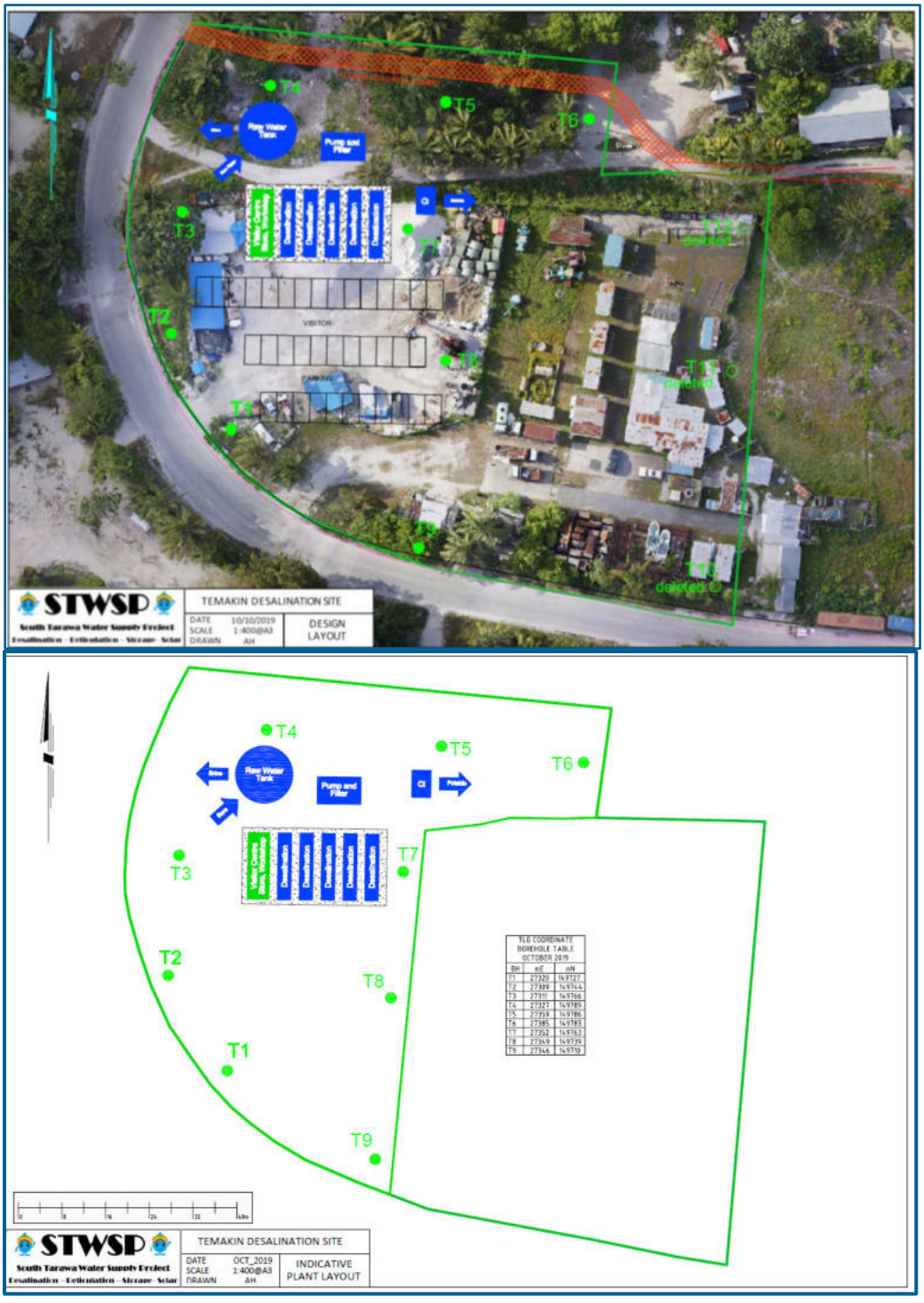


Figure 7 – Betio indicative site layout maps

McKenzie site - at the proposed OTEC system site:

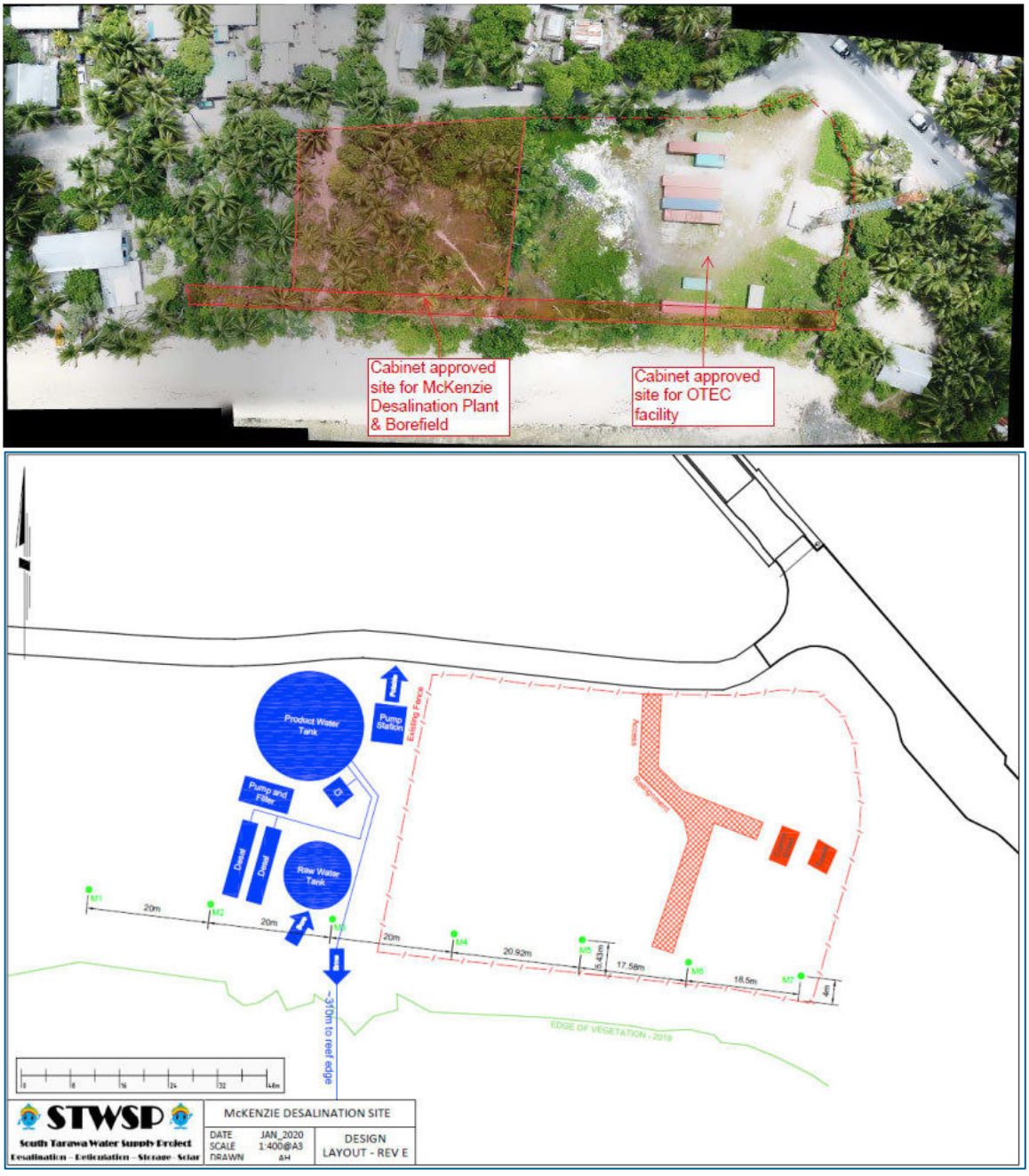


Figure 8 – McKenzie site indicative layout maps

3.3 Background about the Desalination Plant Sites

a) Selection of Betio site

During PPTA phase (2017-2018) of the project, twelve alternative locations for the desalination plant sites were assessed as described in the PPTA reports of 2018 and the first ESIA draft 2018.

Table 3 – Alternative locations for desalination plants during PPTA[7]

Reference	Location
1	Vacant land opposite the Parliament in Ambo
2	Abaokoro on the ocean side in Ambo
3	Land to the west of the Nanikai landfill site
4	Land on the eastern end of the Bairiki causeway
5	Land in Betio, on the ocean side between the WW2 heritage artefacts and Taiwan Park
6	Land in Betio, eastern area used by Nippon Causeway contractor
7	Some of the land currently occupied by the meteorological office
8	Land currently occupied for container storage
9	Land in Betio, western area used by Nippon Causeway contractor
10	Location at Bonriki

The decision in 2018 was to establish one desalination plant to be located in Temaikun Betio (no 9). It is located more than 100 meters from the shoreline and therefore will not be exposed to coastal wave events which might cause local inundation. The ocean outfall pump station that can provide a means of brine disposal is located across the road, saving approximately more than US$2 million from building an independent outfall system for the plant. Furthermore, the site is already significantly disturbed so additional construction activities will not significantly impact flora or fauna. Community consultations have been carried out for the surrounding communities, as described in chapter 7.

As there will be a new hospital in future on the same location, that requires that during operation the desalination plant activities shall not cause excessive noise. IFC guidelines shall be followed.

b) Selection of McKenzie site

During the PDA phase, after lengthy discussions, it was decided in September 2019 to have an additional site in McKenzie. The main reason for having two desalination plants instead of the one in Betio only, was that the updating of the hydraulic models showed that it is very difficult to transfer the water from Betio to as far down as Bikenibeu. The transmission pipeline was designed to flow in the other direction, and it is only 200mm in diameter by the time it reaches Betio (it is 225mm further upstream). The flow would be too high for the pipe resulting in high friction losses and eventually turbulent flow. Pumping heads over 100m would be required which would destroy the pipe and thus it would have required to duplicate the pipeline for 10km from Betio towards Bikenibeu. As a better alternative, it was decided to split the desalination plant across two sites placing one component (3.5 MLD) at Betio and a

[7] Source: PPTA Output 8 – Concept Design for Desalination Plant, October 2017

second component (2.5 MLD) at McKenzie, where an available area was identified at the proposed OTEC system site. This has been referred to as the decentralised option and the following graph shows the cumulative power consumption over time for the two options. The decentralised option will result in a saving of 6,312 MWh over 20 years, worth $4.1 million on today's electricity tariffs.

The following figure illustrates the energy savings of the decentralised (two plants) option compared to the centralised (one plant) option.

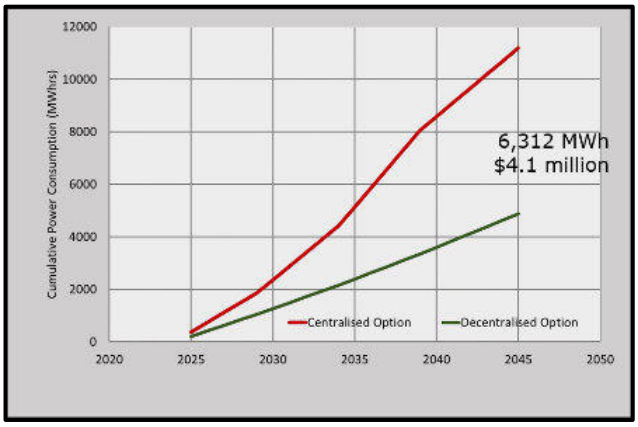


Figure 9 - Cumulative Power Consumption for the Options

In June 2019, MISE commenced investigation of potential sites for a second SWRO Desalination Plant. FCG used computer modelling to confirm that McKenzie, Bikenibeu is the preferred location.

A separate Environmental Impact Assessment was prepared for the OTEC facility in 2016[8]. Some relevant quotes of that EIA study are presented in Appendix 4, including results of bathymetry study, geological survey, physics survey, water quality analysis and marine biology life survey.

MISE has consulted with MELAD Land Management Division (LMD) to ascertain the list of native landowners and to confirm the existence of Government lease over the land. Community consultation was conducted with the surrounding community in McKenzie in November 2019 and consultation and liaison with landowners between December 2019 and January 2020 (see chapter 7). There will be no impacts on structures, nor will there be any physical displacement of people. An initial survey indicates that up to 47 coconut trees and 2 breadfruit trees may need to be cleared. Minor loss of income will be compensated as addressed in the Project's Resettlement Framework (RF). Detailed designs will be completed by the selected contractor who will confirm the full extent of land clearing. Legal landowners will be compensated for losses of trees, plants and crops prior to commencement of construction.

c) Brine disposal

For the outfall, for brine disposal, in Betio the plan is to connect the brine disposal to the existing sewerage submarine outfall nearby the desalination plant, which has recently been

[8] Environmental Impact Assessment 2016. 1 MegaWatt Ocean Thermal Energy Conversion (OTEC) Facility, Kiribati.

upgraded under STSISP, to diffuse sewage 30 meters deep, beyond the reef edge (a separate environmental study was carried out for the outfall in 2015 [9]).

At McKenzie, a new outfall pipe will take the brine beyond the reef edge (which is some 310m from the plant) and discharge via a 12.5m long diffuser. The pipe length and depth of the diffuser will be determined by the Design and Build Contractor. .

3.4 Description of All Activities Involved

a) Technical process of desalination plant

The proposed desalination facility comprises a 3,500 m^3/day seawater reverse osmosis system in Temakin, Betio and another one 2,500 m^3/day in McKenzie, upgradable to 3,500 m^3/day. The feed water to the facility comes from a series of deep bores that abstract saline water from a depth of approximately 30 metres below ground level, far below the level of the groundwater lens. It is estimated that this water will have a salinity close to that of seawater, namely 36,000 mg/L.

The following chapters give some details about the desalination system. Some minor changes may occur still once the detailed designs are finalised. There are two options under discussion for desalination plants – to be decided for the detailed designs:

- Option 1: Fully containerised desalination plants constructed and tested offsite and imported an installed on concrete footings and connected to the raw water bores and the product water tank
- Option 2: Skid mounted desalination units constructed and tested offsite and imported and installed in an airconditioned and purpose build building and interconnected to form a single desalination plant which in turn is connected to the raw water bores and the product water tank

There is no big difference in environmental impacts of these two options. Both options will require the construction of a building:

- option 1 to house the containers, which will (a) improve the visual amenity of the site and also provide space for a visitor centre, (b) dampen the noise by lining the walls with sound absorbing material and (c) permit solar panels to be mounted on the roof, and
- option 2 to house the skids, which will (a) permit the skids to reside in an air-conditioned environment, (b) permit a viewing window from the attached visitor centre and (c) provide for noise dampening.

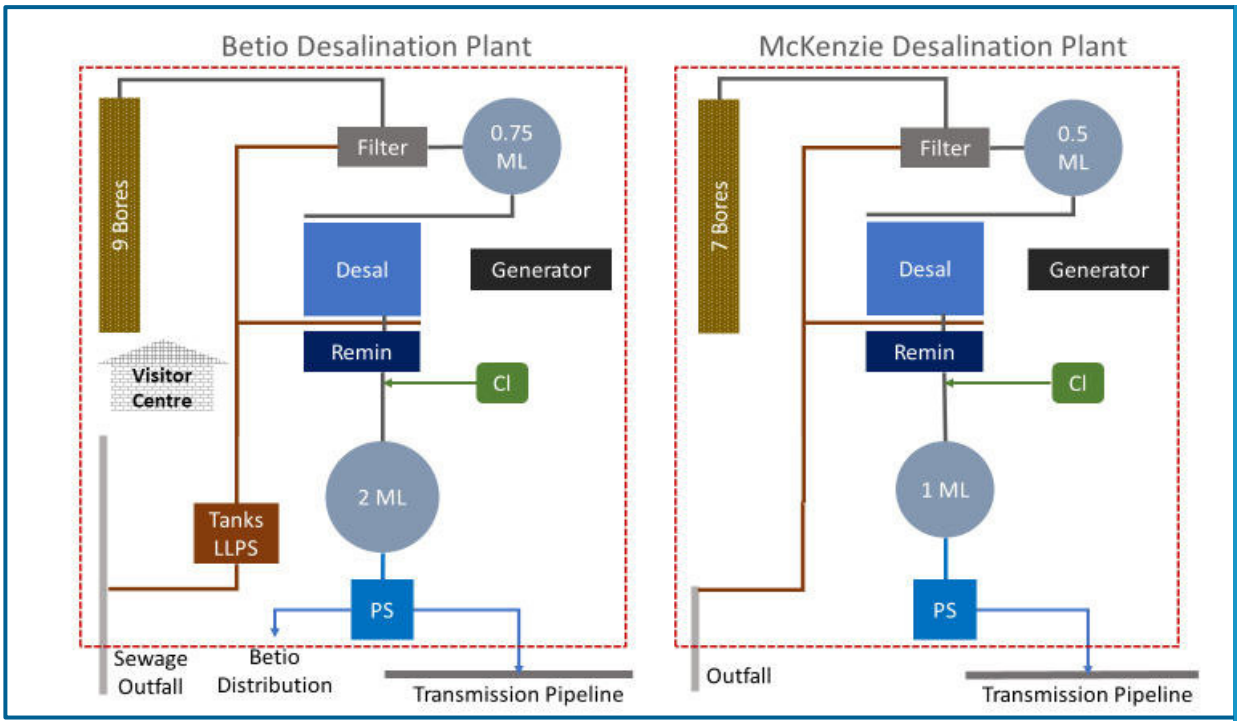
The following table gives some statistical data about the intake boreholes and the desalination plants, which also do not depend on the options mentioned above.

Table 4 – Statistical data – intake boreholes & desalination plants

[9] STSSIP:
- BEIA for the Sewer system and Ocean Outfalls Rehabilitation 2013,
- BEIA for the Replacement of Three Sewage Outfall Pipe and Diffuser Assemblies 2015 and
- BEIA for the Sewer System Rehabilitation 2017

Works	STWSP Site 1: Betio	STWSP Site 2: McKenzie
Bore Field		
Number of active bores	6	5
Number of standby bores	3	2
Approximate bore depth	32m	30m
Base Bore Flow Rate	17 l/s	17 l/s
Desalination Plant		
Delivery Capacity	3,500 kl/day	2,500 kl/day
Upgradable	No	3,500 kl/day
Approximate Recovery	44%	44%
Approximate Volume of Water Extracted	8,000 kl/day	5,700 kl/day
Approximate Volume of Brine Discharge	4,500 kl/day	3,200 kl/day
Other Works		
	Visitor (Education) Centre	

The processes will be same in both options – as illustrated in the following figure for both Betio and McKenzie.



Desal= desalination, Remin = remineralisation, Cl = Chlorination, PS = permeate supply

Figure 10 – Diagrams of desalination plant processes in Betio and McKenzie

The reverse osmosis system is reducing the salinity of the ground water supplied from the bores. The upstream filter system is responsible for removal of any suspended solids in the bore water that could possibly foul the reverse osmosis membranes.

Permeate is the low salinity water produced by the reverse osmosis system, the ratio of permeate to feed water is 43%, the balance of 57% of the feed water is discharged as a brine stream which will have a salinity almost twice as high as the incoming feed water.

Saline groundwater from the bores is pumped through the media filters into a filtrate tank. The filtrate from the tank is then pumped by low pressure forwarding pumps through cartridge filters into the suction of the reverse osmosis high pressure pumps.

It will be periodically necessary to backwash the filters to remove any captured solids from the filter bed. This is achieved by backwashing with filtrate from the filtrate tank. The backwash from the filters is discharged into the brine disposal line.

Chlorine is used to provide residual disinfection of the permeate before it enters the drinking water tank. Chlorine dosing is flow paced to maintain the desired free chlorine residual. An on-line chlorine analyser advises the plant operator of the chlorine concentration in the water that flows into the drinking water tank. It is also able to provide a residual trim for control of the dosing system.

b) Effluent disposal

The effluent is disposed in Betio through the existing sewage outfall. In McKenzie a new outfall pipe will be needed for brine alone.

The brine flows from the reverse osmosis systems is the major component of the total waste flow from the process. The other components that are intermittently discharged are:

- Backwash and maturation flow from the filter backwash sequence. This stream will have the salinity of the groundwater and will flow intermittently each day. The expected daily volume is 290 m^3.
- Neutralised water from CIP sump. This stream will be discharged intermittently at approximately monthly intervals. It will be a low salinity stream and the expected quantity will be about 20 m^3 per CIP operation.
- Seawater flush in the final stages of a CIP operation. This stream will be discharged intermittently at approximately monthly intervals. Discharge cannot occur when all installed reverse osmosis systems are operating. The flow rate will be 27 L/s for a period of around 10 minutes.

The chemicals used in the reverse osmosis process which will report to the brine stream are:

- Antiscalant. This is a phosphate-based chemical used on a continuous basis for injection into the feed stream to the reverse osmosis system. Antiscalants with low Eco toxicological impact are available and will be used.
- Alkaline detergent. This chemical will be used to clean the reverse osmosis membranes on an intermittent basis. The estimated time between cleaning operations is 1 month.
- Citric acid. This chemical is sometimes used after an alkaline detergent clean, it is also used to remove calcium carbonate scaling from the membranes.

The final selection of chemicals will be decided by the supplier of the reverse osmosis systems. It is not expected that there will be significant changes.

The typical and peak flows from Betio are estimated in the following table:

Table 5: Combined flow rate and salinity for wastewater and brine outflows (Betio)[10]

Flow situation		Wastewater component		Brine component		Combined	
		Flow rate l/s	[salt] mg/l	Flow rate l/s	[salt] mg/l	Flow rate l/s	[salt] mg/l
With brine discharge	Typical situation	64	16,000	57	50,000	121	32,017
	Peak situation	104	16,000	57	50,000	161	28,037
Without brine discharge	Typical situation	64	16,000	-	-	64	16,000
	Peak situation	104	16,000	-	-	104	16,000

For McKenzie point, the expected daily production is 2.5 million L/Day which will produce clear water permeate and brine in similar proportions to those of the Betio plant, and with a similar resultant salinity of the brine. The expected discharge is therefore 66 L/S at a salt concentration of 50,000 mg/L. As the outfall is yet to be designed, and the expense of constructing a brine outfall to the depth used for the sewerage outfall will be a consideration, 30m is unlikely to be justified and a depth of 15m is assumed.

Backwash and cleaning wastewater are flows that would add to the brine discharge on an intermittent basis. The effluent assessment – and the brine dispersion study (Appendix 2019) shall be updated on completion of the design.

Effluent disposal in Temakin, Betio

In Betio, the waste brine will be combined with the effluent of the current sewage system, immediately after the sewage outfall pump station prior to discharging.

Other than primary screening, there is no sewage treatment facility at the pump station, so the brine will not interfere with any biological treatment process as the sewage is raw. The combined effluent will exhibit an estimated salinity greater than seawater, thus making the effluent discharged at the Betio outfall denser than the ambient seawater level. The effect of brine and associated sewage plume on the marine environment depends on the dilution factors attained when discharged.
The brine waste from the proposed SWRO plant is predicted at 7,030 m^3 per day and peak operation at 9,681 m^3 per day in future operation. However, it is expected that there will be very rapid dilution due to the small volume of output and use of diffusers.

According to hydraulic analysis is the brine from a desalination plant located in west Betio can be discharged through the sewage outfall and it will not be necessary to construct a new brine outfall to specifically manage brine disposal.

[10] Source: Brine Dispersion Study of STWSP, Fraser Thomas, December 2019

Existing sewage outfall system in Betio

The sewage outfall is located at the western end of Betio on the other side of the road to the proposed site of the desalination plant.

The sewage disposal system consists of a number of sumps and pumping stations within Betio that transfer sewage to a final sump and pumping station located at the western end of the island. The design average day flow from the Betio community is 20 L/s with a peak flow of 60 L/s. Two pumps are installed in this sump, each capable of a flow rate of 32 L/s. Each pump transfers sewage from a below ground sump to an above ground screen with a collection compartment for screened sewage. The invert level of the outlet from this compartment is approximately 3.5 metres above ground level and the height of this compartment relative to sea level provides the static head to transfer screened sewage through the outfall pipe. The pumps are not directly coupled to the offshore pipeline. A schematic on the final pumping and screening is shown on next page. The offshore pipeline consists of 1,000 metres of PN10 polyethylene pipe with an internal diameter of 312 mm. The pipe terminates outside the reef in 30 metres of water depth. Various environmental studies have been carried out about the outfalls over the years[11].

Upgrading work on the Betio sewage outfall was completed in 2019. Part of the upgrading was the addition of diffuser ports (with 14 ports) at 30 m depth. The ports altered the way in which the effluent is introduced into the ocean water and level of dilution (see dispersion study, Appendix 3). At the depth of the outfall opening (30 m) coral cover has been found to be less than 5%, and most of the surface is comprised of sand and rock outcrops. No seagrass habitat is present. There will not be additional significant impacts on the reef, sediments or algae.

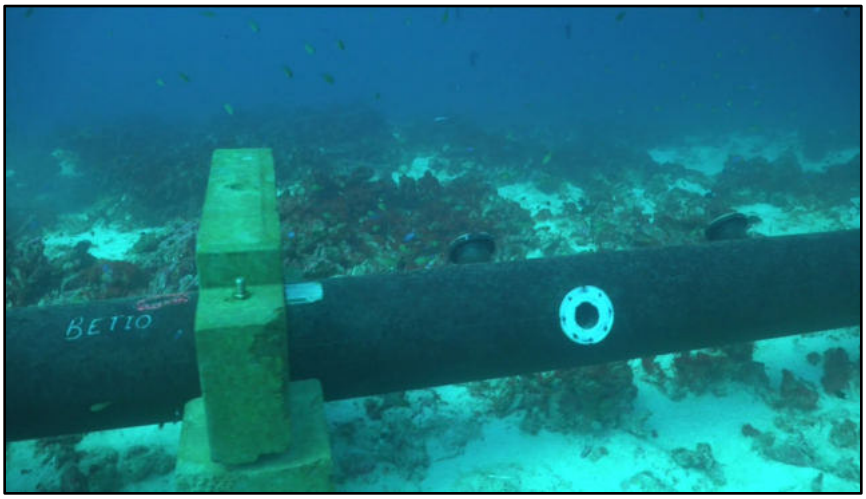


Figure 11 – Photo of outfall opening with diffuser ports, Betio (30 m depth)

[11] STSSIP:
- BEIA for the Sewer system and Ocean Outfalls Rehabilitation 2013,
- BEIA for the Replacement of Three Sewage Outfall Pipe and Diffuser Assemblies 2015 and
- BEIA for the Sewer System Rehabilitation 2017

Changes to the existing sewage pumping station in Betio

In order to discharge brine through the sewage outfall pipeline it will be necessary to convert the current gravity flow system into a pressurised system. The works required for the sewage pumping station will consist of:

- Installation of a new sump downstream of the existing screen to accept screened effluent
- Procurement of two additional submersible pumps
- Mechanical and electrical installation of the submersible pumps in the new sump
- Control system to maintain controlled flow from new pumps, irrespective of the brine flow rate
- Modification of existing outfall piping to accept sewage inflow from pumping station and brine from desalination [plant
- Connection of brine into the modified outfall pipeline

Additional work will be to develop a cut over procedure in order to carry out the works whilst retaining the ability to discharge sewage from the Betio community

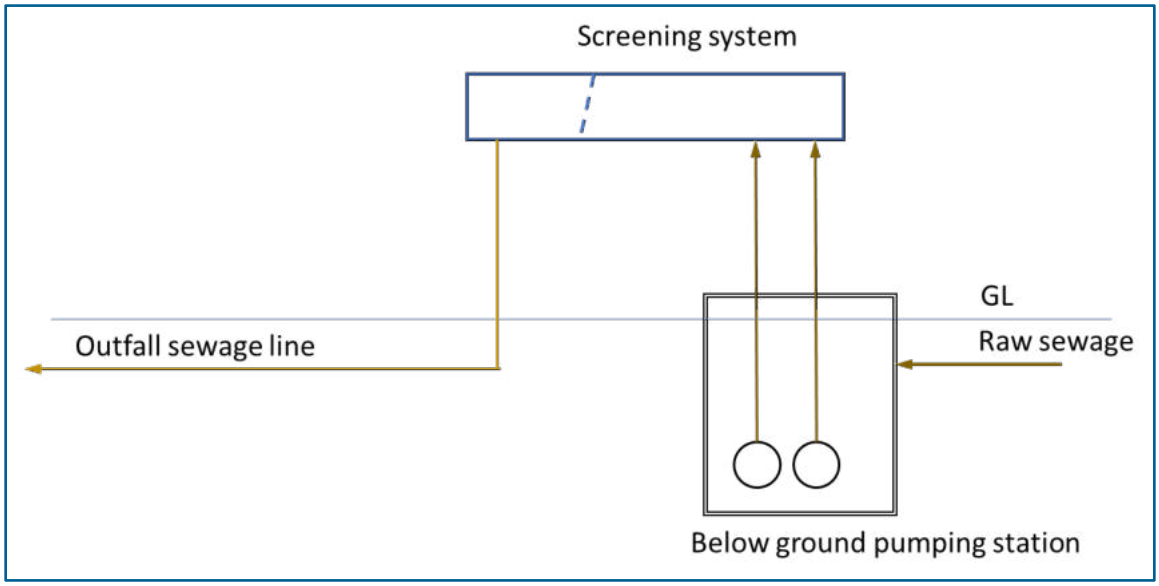


Figure 12 – Existing sewerage screening and outfall system

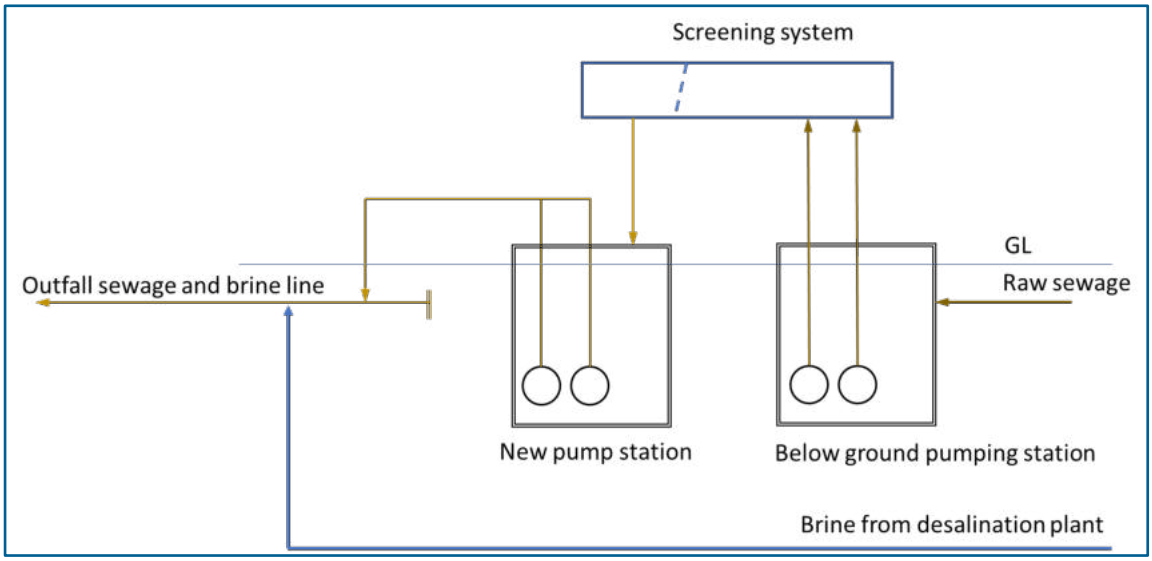


Figure 13 – New works required for sewage pumping station

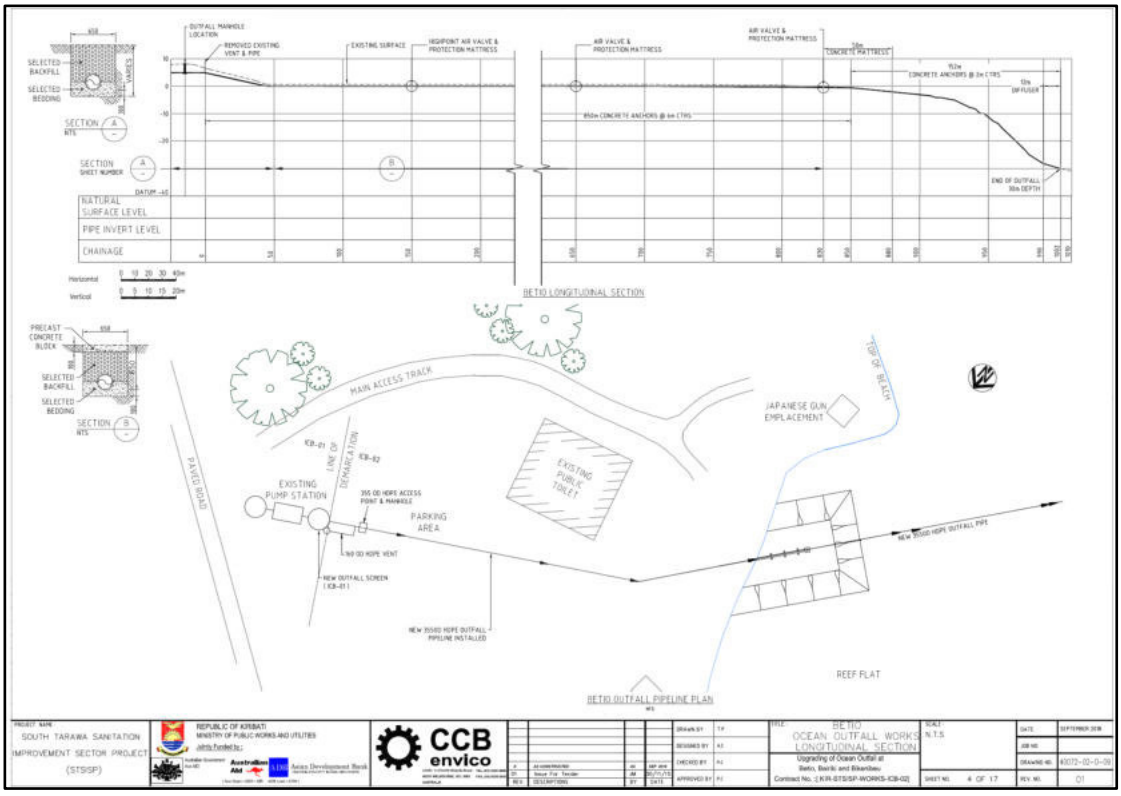


Figure 14 – Betio – existing sewage outfall pipeline layout map

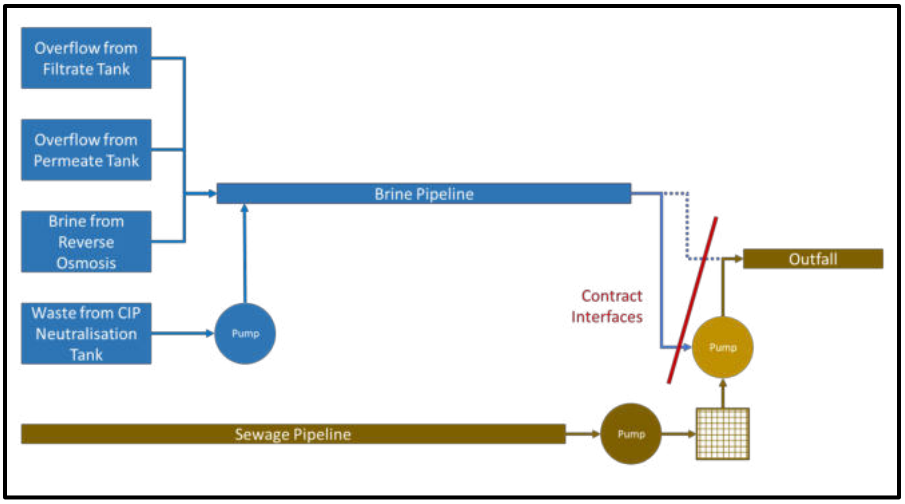


Figure 15 – Disposal of wastewater from the desalination plant in Betio

Figure 16 – Temakin desalination site showing brine pipeline

Environmental considerations of mixing two types of effluents

The environmental considerations of mixing the two type of effluents relate to a different effluent quality and flow rate which would require investigation and a change to the current application of the Operating License.

The reverse osmosis system will operate at a recovery of 43%. As the feed water passes through the reverse osmosis system it will become progressively concentrated and the final brine discharge will be around 1.75 times the concentration of the feed water. This brine water quality is independent of the drinking water production from the desalination plant. The temperature may be assumed to be the same as that of the feed water.

Effluent disposal in McKenzie

In McKenzie the brine will be disposed directly to the sea (not mixed with sewage) with a pipe that takes it over the reef edge. The composition of the sea floor immediately seaward of the site has been studied by the EIA team for the OTEC project in 2019. The general state of coral health was also studied in 2000 by the South Pacific Applied Geoscience Commission. Sea floor coverage includes live coral, dead coral, sand, rubble. The reported proportion of live coral varies. However, at least some live coral could be disturbed by the construction of the outfall pipe and thus the contractor needs to take into account necessary safety measures as stated in the ESMP.

Chapter of this documents describes more about the marine environment and chapter 5 about the environmental impacts.

c) Climate Change and Water Public Education Center

The project incorporates some major activities to create an enabling and successful environment through (i) a comprehensive and intensive WASH awareness training that includes developing and supporting local CSOs on Kiribati; (ii) the O&M contracts for the desalination plant and water supply network, and overall institutional strengthening activities that will help to build the capacity of PUB staff and change attitudes towards O&M; and (iii) the climate change and water public education centre at the desalination plant.

The purpose of the education center is to improve the level of climate change and water resources understanding on Kiribati and is therefore entirely a climate adaptation activity.

Total (cumulative) number of visits to visitor education centre will be tracked by PUB and reported to the PMU.

3.5 Relevant Surveys and Studies during STWSP PDA

a) Topographic and Cadastral Survey

Topographic survey, through aerial photogrammetry, and cadastral review have been produced to support the detailed designs of the project. A cadastral review was undertaken in order to review the rights relating to land ownership in the areas affected by the STWSP. This review focussed on the specific land required for tank storage, the desalination plant, and the solar array. The following methodology was used to ensure the best understanding of information was achieved. The topographical and cadastral specification requirements were:

- Intermittent ground levels across the island (height accuracy +/- 200mm (preferable)),
- Location of buildings
- Cadastral information pertaining to storage site, desalination plant and solar PV locations
- Aerial imagery

Two separate reports were produced in Jun-Sep 2019. Layout plans used in this report are partly resulting from that survey.

b) UXO Survey

An UXO survey was carried out prior to drilling tests in Betio desalination plant. No UXO was detected.

c) Hydrogeological Survey (including drilling and water quality test)

The purpose of this hydrogeological survey was to:

1. Determine the safe yields from the groundwaters below the two study sites;
2. Identify any adverse impacts of extracting the bore water on nearby shallow wells at each site; and
3. Identify any tidal influences and rainfall influences on the groundwater level at each site.

Drilling tests and water quality analyses were carried out in the desalination plant sites in Betio and McKenzie. Water samples from boreholes of both locations as well as shallow wells in Betio (see chapter 4.3).

A risk assessment determining mitigation measures for potential risks and responsibilities in various stages of the study was done prior the survey as presented in Appendix 5.

A separate report exists about the survey.

d) Dispersion Modelling for Outfall Emissions

A dispersion model study was conducted (December 2019, as part of PDA) by using VPLUME software in order to assess the environmental impacts of the brine discharge from the SWRO plants.

The key variables required to run the model are discharge depth, outlet port details (number, size and spacing), port diameter, effluent flow rate, effluent temperature, water temperature

and salinity. Of these, flow rate and salinity are examined under typical and peak scenarios, using data from the design report for the South Tarawa Water Supply Improvement Project, undertaken as part of this Project Design Advance assignment. With regard to effluent quality, information was obtained for the preparation of the Sanitation, Public Health and Environment Improvement (SAPHE) project, under which ocean outfalls were constructed in 2001 – 2003 (although later replaced). Figures for current speed, salinity and temperature were obtained from the quarterly ocean outfall monitoring report for STSISP, of November 2019[12]. For the analysis, a nominal current speed is used, as well as the current measured during November 2019 to reflect periods of calm winds (and therefore currents) that occur in the area, characteristic of the Intertropical Convergence Zone, which periodically occurs over Tarawa. The still conditions at these times will affect the rate of dispersion.

With the input parameters used, the model shows salinity declines rapidly as water flows away from the diffuser, reaching a value close to the expected ambient level of 21,000 mg/L within approximately 4m or less. The situation is broadly similar at both typical and peak flows.

Impacts related to brine concentration in ambient seawater

Dispersion modelling shows that, while salinity levels within the plume decrease rapidly on release from the diffuser, there is a zone immediately surrounding the diffuser that has very high salinity levels. However, this reduces to close to ambient levels within two or three metres under the modelled low current scenario and will reduce more rapidly under normal conditions. While the higher salt concentrations are likely to affect benthic communities, the total affected area is small, representing some 75 m^2 of sea bed at depth (30m in Betio, likely 10 – 15m at McKenzie Point). At these depths however, coral cover has been found in recent studies to be sparse. Relevant information is provided in prior surveys undertaken to assess benthic conditions for proposed outfalls, including one done in 2000 as part of a major study on coral health around South Tarawa, in March 2011 at Temaiku in connection with proposed residential developments and more recently, at the three outfall sites in 2015. The latter investigations found limited coral coverage at shallow depths, while coverage by algae is more extensive. At increasing depth the coverage of coral declines further, and at the outfall discharge point in Betio the substrate is mainly sand and rubble. Comparison with the abundance of coral formations found in 2000 shows a significant decline over time, while coverage by algae has increased. In view of the limited extent of coral communities and the rapid return of salt concentrations to ambient levels, only a very small area of colonized sea bed may be affected. The effect on brine release on ocean ecology is therefore not significant.

Impacts on dispersion of effluent

Introducing brine to the sewerage outfall creates a less buoyant plume, which in fact is predicted to sink, and not rise to the surface. The inclusion of brine in the wastewater stream is therefore likely to enhance the effect of dispersion of effluent, and further reduce the concentration of contaminants at the surface of the water. The impact is positive, though not significant as concentrations of contaminants at the surface when brine is not included in the outfall are very low due to mixing with water as the plume rises and die-off with exposure to ultra violet light.

See Appendix 3 for full report of the dispersion study.

[12] SMEC International (2019) South Tarawa Sanitation Improvement Sector Project: Quarterly Ocean Outfall Monitoring – Technical Note (DRAFT)

4 DESCRIPTION OF THE BASELINE ENVIRONMENT

4.1 Current Climate and Climate Change Predictions

Kiribati has a hot and humid tropical climate. Kiribati's climate varies considerably from year to year, driven largely by the El Niño-Southern Oscillation (ENSO).

Air temperatures are closely related to the temperature of the surrounding oceans. Average temperatures are relatively constant year-round, with changes in the temperature from season to season no greater than approximately 1°C (PACCSAPP 2015[13]).

Rainfall in Kiribati is affected by the movement of the South Pacific Convergence Zone and the Intertropical Convergence Zone. These bands of heavy rainfall are caused by air rising over warm water where winds converge, resulting also in thunderstorm activity. Mean annual rainfall at Betio (South Tarawa) over the period 1947-2016 was estimated to be 2,063 millimeter (mm). These observations show a slight upward trend during this period. However, there is significant inter- annual variability - from a minimum of 398 mm in 1950 to a maximum of 4,356 mm in 1993.

Monthly rainfall is also characterized by extreme variability with monthly rainfall ranging from 0 to 825 mm. The overall monthly mean is 171 mm. The mean monthly rainfall varies from between approximately 116 mm for October to 277 mm in January. Typically, there is a wet season from December to about April and a longer, drier season from May to November (White 2011).

Drought. White (2011) provides a definition of drought in the Tarawa context as a function of rainfall in the preceding 12 months. Using this definition, a drought period may be sustained over several months or even years. There were 9 severe droughts between 1947 and 2010 with an average duration of 23.6 months. The most severe drought occurred in April 1974 when only 217.0 mm of rain had fallen in the preceding 12 months. The time between successive severe droughts also varies widely, with the shortest gap being 2.8 years and the longest 16.3 years.

Wind-waves in Kiribati are strongly influenced by both north-easterly and south-easterly seasonal trade winds, and the location of the South Pacific Convergence Zone, and by the El Niño–Southern Oscillation from year to year. In Tarawa, waves consist of locally generated trade wind waves from the east and northeast from December to March, and from the east and southeast from June to September. In this latter period there are also trade wind induced swell waves, and some swell propagating from extra-tropical storms in the North Pacific and Southern Ocean (PACCSAPP 2015).

A key parameter is over-topping – whereby seawater flows onto the island and ultimately into the island's groundwater, damaging freshwater resources, contaminating water in the lenses.

[13] *Pacific-Australia Climate Change Science and Adaptation Planning Program* PACCSAPP) 2015. Current and Future Climate of Kiribati. BOM (Government of Australia)/CSIRO.

Sensitivity of Project Component(s) to Climate or Weather Conditions and the Sea Level

Climate risk classification of the project is *high*[14]*.* The most recent comprehensive assessment of projected climate change on Kiribati was undertaken in 2015 within the context of the PACCSAPP project (2015). PACCSAP considered three representative concentration pathways (RCP): RCP2.5, RCP6 and RCP8.5.

Projections relevant for determining the sensitivity of the project, particularly the design capacity of the desalination plant, to climate change include:

- Sea level is projected to rise by between 13 to 33 centimeters (cm) by 2050, depending on the scenario adopted;
- Air temperatures will continue to rise with a projected increase ranging between 0.6°C and 2.2°C by 2050;
- The number of very hot days and hot nights will continue to rise;
- Sea surface temperature is expected to rise albeit slightly less than the projected increase in ambient air temperature;
- Average annual rainfall and seasonal rainfall will increase, as will the number and intensity of extreme precipitation events;
- Ocean acidification is expected to increase. The aragonite saturation state has declined from about 4.5 in the late 18th century to an observed value of about 3.9±0.1 by 2000 and is expected to decline to under 3 in the 2030's (RCP8.5);
- Wind wave height is projected to decrease during the months of December to March. Wind driven waves may be more directed from the south the month of October. Wind wave height is projected to increase slightly in the month of September;
- The wave climate is also affected by swells caused by distant typhoons, and so is affected by the path and intensity of the distant typhoons. There currently is no consensus on how these paths and intensity will change with climate change.

Several factors contribute to the risk of **coastal floods and sea overtopping**. These include (i) storm surges, where low atmospheric pressure leads to a temporary rise in sea level, possibly exacerbated by local winds; (ii) swells, or forms of large low-frequency waves driven by winds from distant weather formations (including cyclones); (iii) tide level– with the possibility of very high tides in certain seasons; and (iv) long-term sea level rise, such as that caused by climate change. At any given time, the risk of flooding/overtopping is a function of all these factors in combination – if all four factors drive a high sea there is a very high risk of flooding/overtopping. However, over time, due to climate change, there is an increasing trend in the risk level, particularly due to sea level rise. By the year 2050, most land should be considered vulnerable to overtopping and seawater flooding.

The areas currently exposed to shoreline change and frequent high tide and wave-related flooding, have been mapped by NIVA (2018)[15].

[14] ADB 2019
[15] Long Term Coastal Security Strategy for Kiribati. GOK 19201.

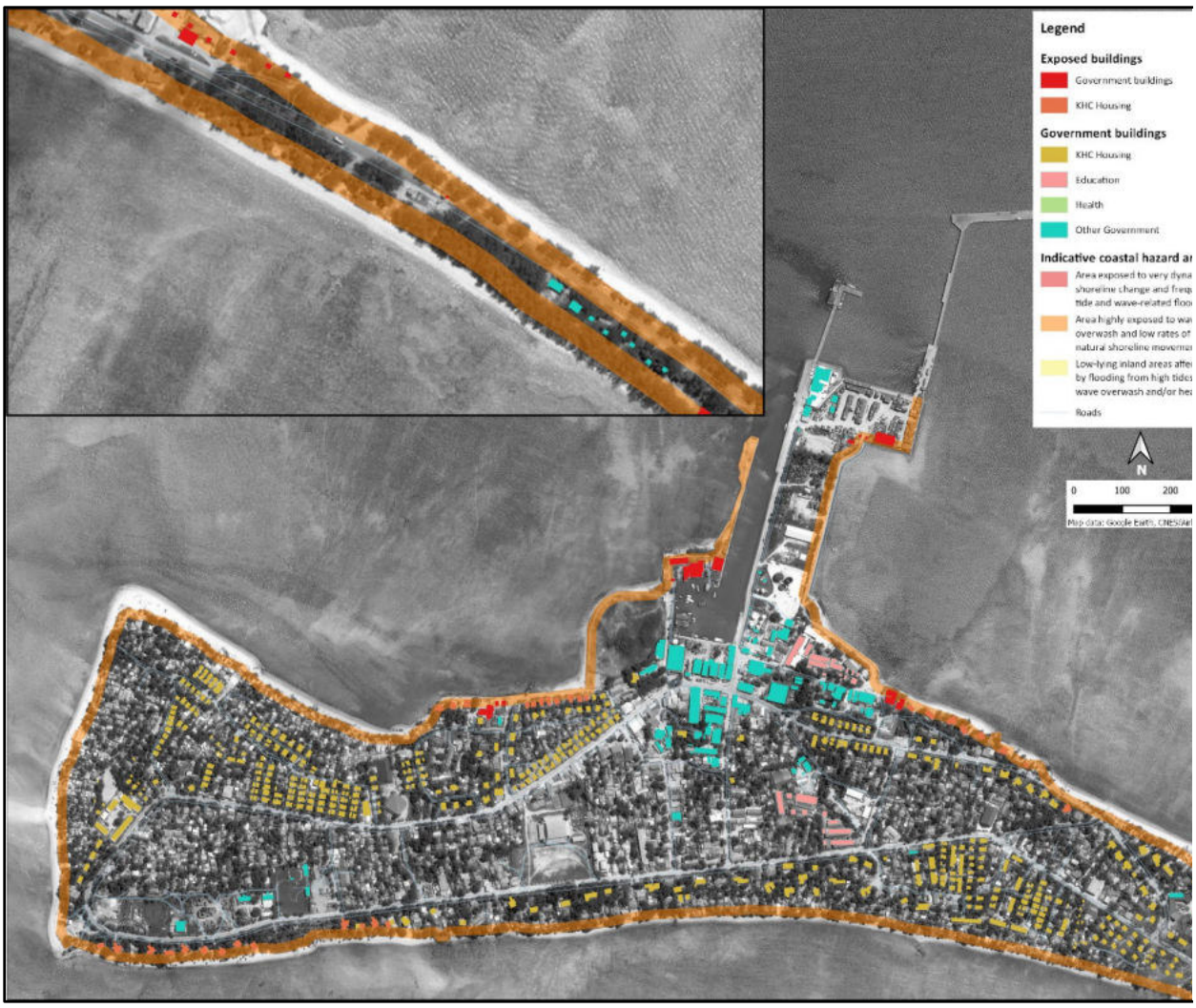


Figure 17 – Example of Coastal Hazard Area Flood Map (Betio)

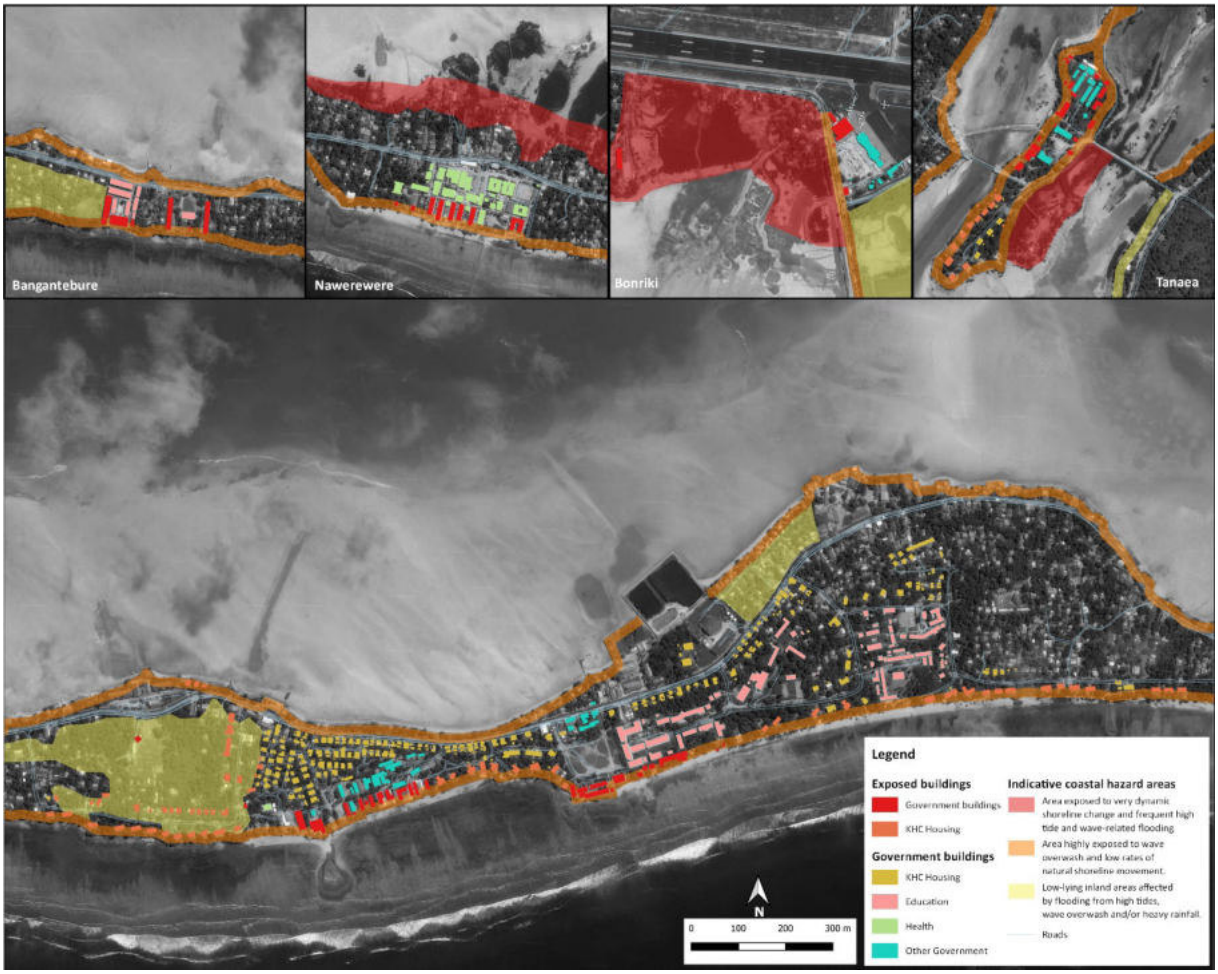


Figure 18 – Example of Coastal Hazard Area Flood Map (Bikenibeu et al)

There is far less certainty with regards to the occurrence and intensity of future **droughts**. Although the models project a lower frequency of short and medium-term droughts, there is generally low confidence in these projections. Further, long-term droughts – lasting over one year - on Tarawa are understood to be almost entirely driven by ENSO, and there is no consensus or agreed understanding of how climate change will impact ENSO. There is the possibility that some droughts will be longer or more intense even if the average length and intensity of droughts is reduced.

4.2 Topography, Geology and Soils

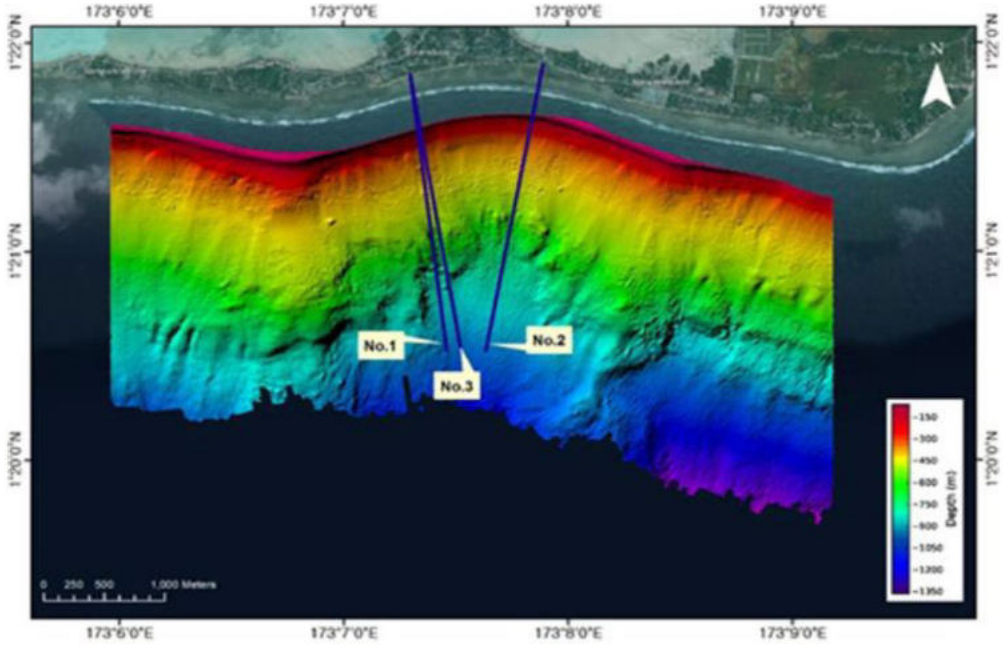
The Tarawa atoll developed from a volcano which appeared between 55 million and 65 million years ago (during the Paleocene geologic epoch). Over time, the peak of the volcano sank below sea level due to subsidence of the ocean floor. The island surface is formed by successive coral deposits around the old and now submerged volcano. Atolls originate as coral reef formations at the tidal level at the rim of the original volcano, these formations rise in successive layers of dead coral. The atolls of North and South Tarawa, and surrounding reef delineate the edges of the lagoon which occupies the site of the former volcanic core. Most of the land is less than 3 meters above sea level, with an average width of only 430-450 meters.

Like other coral atolls and islands, the nature of the soil is derived from limestone which has been formed due to coral formation over thousands of years. The soil is alkaline, porous and lacks essential elements and therefore it does not support the growth of certain plants and trees. The topsoil which comprises decaying or composted organic matter mainly decaying leaves and plant materials is thinly spread over most of the area with plant cover and other areas covered with wild bushes.

Beneath the buried coral reef, some of the bores encountered interbedded limestone and sand; others had a limestone sequence extending to 30 m below surface which was the maximum depth of drilling. The total thickness of the limestone sequence is unknown.

A review of investigations into the soil profiles on Tarawa indicates that there is a layer of reef deposits of Holocene age of about 15 to 20 m in thickness. The deposits consist of heterogeneous layers of sand, gravel, cobbles and boulders of coral that vary from loose gravelly sands to indurated coral fragments. In places there are slabs of cemented coral fragments referred to as "beach rock". Typically, test pits reveal a soil of about 0.3 m which is a black to grey organic gravelly sand. This passes into a cream coloured sandy gravel to gravelly sand with some coral pieces to 2.2 m. Below this depth are gravel and coral boulders and fresh white coral. The groundwater level is quite shallow and can be intersected between 0.5 and 2.5 m depth.

The EIA of OTEC facility in McKenzie describes the submarine topography in front of the OTEC site, which also will be the site of the desalination plant. It states that the reef is made of hard limestone, but underneath the limestone seems to be soft gravel and sand of already dead corals. Therefore, it is expected that finding an environmentally friendly method to lay down pipes won't be too difficult.



Source: EIA of OTEC Facility 2016

Figure 19 – Seafloor topography in front of McKenzie site

4.3 Water Resources and Water Quality

There are no fresh surface water resources available on South Tarawa. Shallow groundwater is the principal source of fresh water in Kiribati. South Tarawa's water supply originates from the water reserve areas in the villages of Bonriki and Buota where water is extracted and reticulated through a water supply system. Climatic conditions have a major influence on fresh water resources in Kiribati. Underground freshwater lenses are recharged by rainfall and households frequently use rainwater catchments to supplement other water sources. Thus, for many reasons, prolonged periods of low rainfall or even droughts have had serious implications in the past. The droughts associated with well-developed La Niña conditions are evident.

As mentioned earlier, in addition to the shortage of water at Bonriki and Buota water reserves, further problems are related to water quality. The principal pollution threat to household wells is from faecal contamination. There are two sources of faecal contamination in Tarawa, humans and animals (including pigs). Shallow groundwater systems are also vulnerable to seawater intrusion.

Water quality in shallow wells

As part of the hydrogeological study during the PDA (2019), **water quality of shallow wells** in Betio near the desalination plant site were tested by using field test kits. All except one of 11 wells were found bacteriologically polluted (the one without coliforms was close to the sea with highly saline water). See Table 6 and Figure 20.

Table 6 - Water Analysis Results of Shallow Wells in Betio (2019)

Private Well No.	Easting	Northing	Time	Conductivity	pH	Temperature	Water Level	Coliforms
1	713499	149719	9:20	56.0 mS	6,78	27,2		No
2	713506	149703	9:30	26.3 mS	6,95	32,3		Yes
3	713539	149704	9:40					
4	713555	149704	9:50					
5	713602	149693	9:55	2.50 mS	7,41	31,9	1,47	Yes
6	713636	149677	10:00	3.15 mS	7,36	31,8	1,76	Yes
7	713513	149768	10:15	7.17 mS	7,32	33,2	1,47	Yes
8	713513	149811	10:20	2.37 mS	7,55	31,3		Yes
9	713520	149827	10:30	1.81mS	7,7	33,5		Yes
10	713569	149835	10:35	1.759 mS	7,55	30	1,83	Yes
11	713592	149835	10:35	1.837 mS	7,48	29,9		Yes
12	713613	149834	10:40	1.597 mS	7,52	29,9		Yes
13	713627	149836	10:50	1.930 mS	7,69	31,2		Yes

Water quality in test boreholes

During the drilling study (PDA 2019) water samples were taken from the bore holes in September-October 2019 during test pumping at 24 hours, then 12 hour intervals to ascertain the water quality and the stability of water quality parameters including: pH, Conductivity, TDS, Ca, Mg, Na, K, Total Hardness, Alkalinity Bicarbonate, Carbonate, Hydroxide, Total, Sulphate, Chloride, Fluoride, Ion Balance, Bromide, Ammonium as N, Nitrate as N, Si as SiO2, TSS, Turbidity, Total Metals, Boron, Barium and Selenium.

Supplementary testing was carried out in December 2019 from test bore T2 in Betio and M5 in McKenzie site, including also silt density index (SDI) analysis.

The depths Betio bores are about 30 m and McKenzie 24 m.

The samples were analysed at an accredited laboratory in Australia, the results (those done before November 2019) are summarised below and laboratory result sheets attached to Appendix 6.

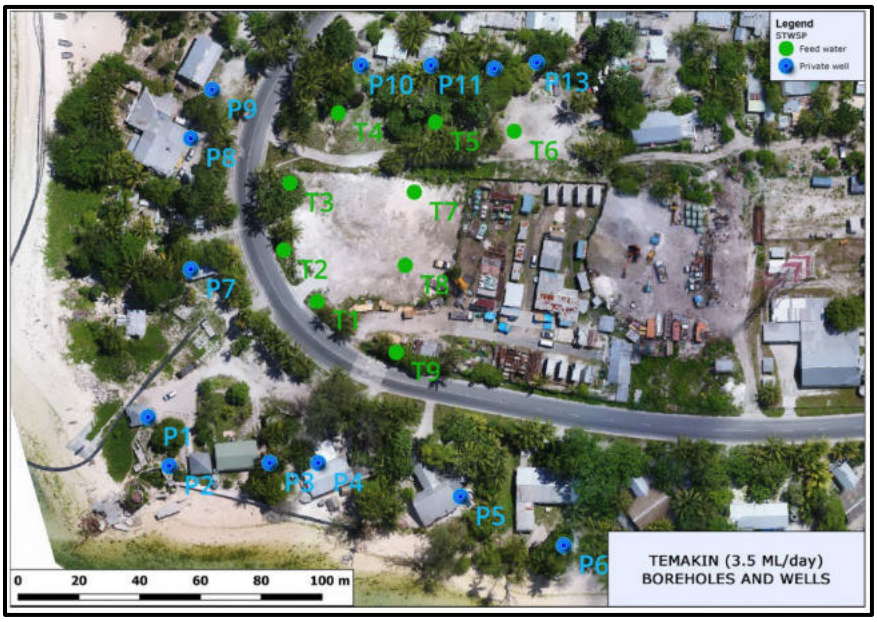


Figure 20 - Desalination Plant Site at Betio Showing Bore Locations and Private Shallow Wells

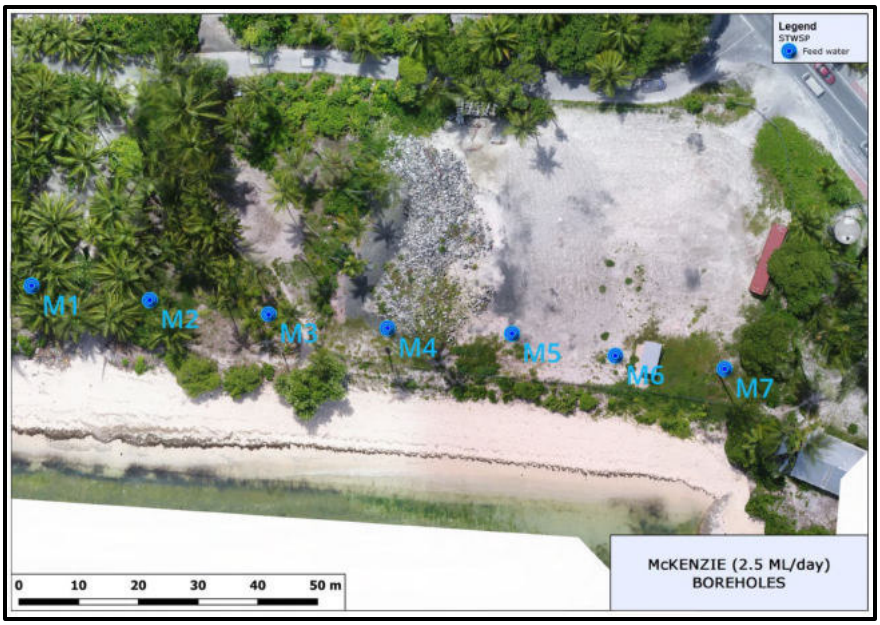


Figure 21 - Desalination Plant Site at McKenzie Showing Bore Locations

Table 7 - Water Analysis Results of Drilling Test Boreholes (Sep-Oct 2019)

Parameter	Units	24 hours	36 hours	48 hours	60 hours	72 hours	M5 airlift
pH		7.69	7.70	7.68	7.68	7.69	7.06
Conductivity	mS	40.8	39.6	39.4	39.2	39.2	40.0
TDS	mg/l	26,500	25,700	25,600	25,500	25,500	
Calcium	mg/l	424	417	412	424	434	
Magnesium	mg/l	1,120	1,080	1,080	1,080	1,120	
Sodium	mg/l	9,170	9,230	8,910	9,290	9,250	
Potassium	mg/l	335	328	lk330	336	338	
Total Hardness	mg/l	5,670	5,490	5,480	5,510	5,700	
Bicarb.	mg/l	180	179	177	176	177	
Carbonate	mg/l	<1	<1	<1	<1	<1	
Hydroxide	mg/l	<1	<1	<1	<1	<1	
Total Alkalinity	mg/l	180	179	177	176	177	
Sulphate	mg/l	2,200	2,150	2,130	2,150	2,150	
Chloride	mg/l	15,400	15,900	15,900	16,000	16,000	
Fluoride	mg/l	1.6	1.4	1.6	1.6	1.6	
Ion Balance		3.68%	2.23%	0.90%	2.26%	2.40%	
Bromide	mg/l	50.8	51.4	51.6	51.6	52.2	
N (Ammonium)	mg/l	0.68	0.73	0.82	0.65	0.61	
N Nitrate	mg/l	<0.01	<0.01	0.01	<0.01	<0.01	
Si as SiO2	mg/l	2.1	2.2	1.9	1.9	1.9	
TSS	mg/l	<5	<5	<5	<5	<5	
Turbidity	NTU	0.2	0.2	0.2	0.2	0.3	
Boron	mg/l	3.84	4.09	4.07	4.00	3.98	
Bromide	mg/l	50.8	51.4	51.6	51.6	52.2	
Strontium	mg/l	8.00	8.23	7.97	8.41	8.24	

Table 8 - Supplementary Water Quality Testing of Drilling Test Boreholes (Dec 2019)

Parameter	T2 (Temakin)	M5 (MacKenzie)
Oxidation Reduction Potential (ORP)	+ 60.6 mV	+ 80.6 mV
Iron (dissolved) mg/l	<0.05 mg/l	Not tested
Manganese (dissolved) mg/l	<0.005 mg/l	Not tested
Total Organic Carbon (mg/l)	<10 mg/l	Not tested
Oxygen (% sat, mg/l)	2.4 %, 0.16 mg/l	11.3 %, 0.74 mg/l
Silt Density Index (SDI)	4.0	6.8 and 11.54
E-coli	0 counts	0 counts

The ORP was at M5 was indicating a mildly oxidizing environment. Dissolved oxygen was low as expected in a groundwater environment. The oxygen content drifted slightly as the tide level increased as a result of the pump becoming more immersed.

The SDI for T2 was 4.0 at 15 minutes which is on the boundary of pre-filtering requirement. At M5 the flow rate through the filter rapidly reduced so two indices were calculated both at 5 minutes. A note of caution suggests that the water at M5, although very clear may still contain liquid polymers from the drilling. This is likely to diminish over time and during initial operating pumping rates.

No E-coli (faecal coliform bacteria) was encountered in boreholes.

4.4 Marine Characteristics

a) Coastal Erosion, Inundation and Storm Surges

Although Tarawa lies outside the main cyclone belt, storm surges and seawater inundations do occur, particularly during El Niño–Southern Oscillation (ENSO) events. Storm surge impacts include the loss of coral reefs, the loss of land due to coastal erosion, and the loss of land and infrastructure due to inundation. Seawater inundations have been recorded for 2014 and 2002 in Tarawa, the former led to evacuation and 44 houses being damaged, the later was estimated to cost around USD 50,000 (approx. 60,000 AUD) in damage.[16]

b) Bathymetry

Figure below provides a perspective view of the reef/intertidal platform to the reef slope, typical of reef front in Kiribati atoll islands.[17] The reef/intertidal platform is the section located between the beach shoreline to the reef margin with the distance ranging between less than 10 meters to more than a kilometer.

[16] Rios Wilks, Anna. March 2015.

[17] Zann, L.P.1986. The Marine Ecology of Betio Island, Tarawa Atoll, Republic of Kiribati. CCOP/SOPAC Technical Report 23.ICB-02

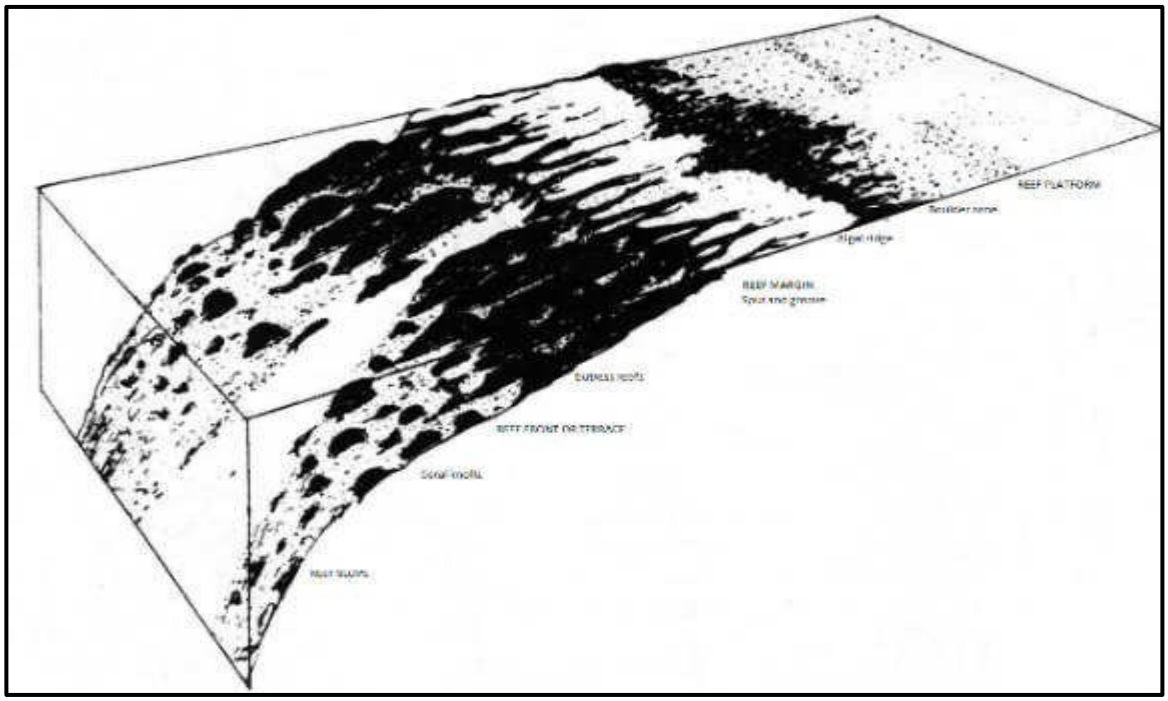


***Figure 22 - Seaward Reef Front Perspective** (Source: Zann, L.P.1986)*

Specific bathymetric data about McKenzie site is presented in Appendix 4 (source: EIA of OTEC facility, 2016).

c) Ocean Currents

A 2015 study shows that the direction of the nearshore ocean current changes to an eastward direction according to the tide, but currents are generally moving in a westward direction.[18] The currents velocity measured at different depth, 15m, 25m and 30m was variable, depending upon tidal conditions, the velocity ranges between 0.2 – 1.0 m/s. Wind driven set-up on the windward ocean reef and wind stress on the surface are also the driving mechanism of water circulation and flushing.[19] The dredged ship and boat channels over the reef also contribute to the magnitude of water movement at the reef intertidal zone around the atoll islands. [20] The main shipping channel at Betio is located about 6.5 km from the outfall pipeline.

d) Marine Water Pollution

The coastal area of South Tarawa is polluted and littered with rubbish due to illegal rubbish disposal, open defecating practices, and animal wastes. Furthermore, effluent from sewage outfalls that have not yet been rehabilitated continue to pollute the intertidal zone. The Environmental Health and Laboratory Units under the Ministry of Health and Medical Services have facilities to test water quality. Currently they have a program established to undertake

[18] SMEC 2015. Rehabilitation and Upgrading of Ocean Outfalls at Betio, Bairiki and Bikenibeu. STSISP.

[19] Callaghan, D.P. et al. 2006. Atoll lagoon flushing forces by waves.

[20] Lelaurin, J. 2000. Hydrodynamic simulation with MIKE21 of Abalang atoll, Kiribati.

water quality measurements. The capacity of the Water Division under the MISE is limited to some features of water quality only such as salinity, by the type of machine and testing probes currently available on hand. The coastal water quality on South Tarawa was tested by the New Zealand Institute of Water and Atmosphere (NIWA) in 2014 and shows varying degrees of pollution (see figure below).[21]

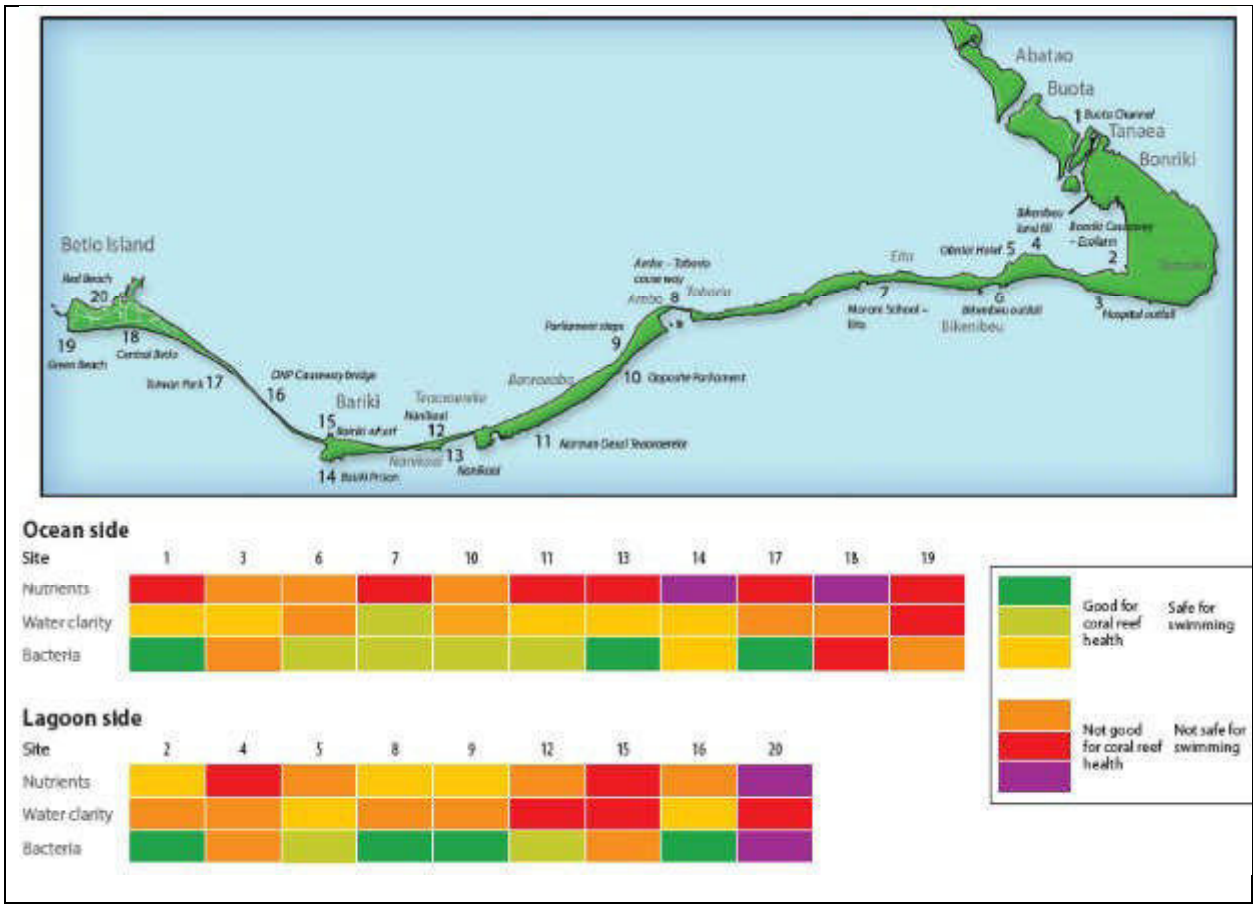


Figure 23 - Pollution Level Along the Coastal Areas of South Tarawa

4.5 Flora and Fauna

a) Coastal Flora and Fauna

Mangrove and coral ecosystems have substantial ecological significance. Mangroves occur on reef mud flats at the lagoon margins at certain areas and provide a coastal protection function as well as an important habitat for marine organisms. Mangroves have been subject to depletion, but mangrove forest areas are being rehabilitated by the government under the World Bank funded Kiribati Adaptation Program – Phase 3 (KAP III). Seagrass beds, which provide an important habitat for shellfish and other organisms, occur extensively within the lagoon particularly toward the southeast. No mangroves or seagrass are located within the vicinity of the sewerage outfall to be used for Brine Disposal, as the outfall is located on the ocean side reef flat.

[21] NIWA 2014. Water Quality Report Card Kiribati. NZAID/GOK.

b) Marine Flora and Fauna

Coral reefs surrounding the atoll and within the lagoon provide habitat to reef fish species and other marine species, including turtles, supporting a complex and bio-diverse community. Common fish species found at the site include surgeon fish (Acanthurus *lineatus*, A. *triostegus*, A. *xanthopterus*), soldier fish (Myripristis *species*), parrot fish (Scarrus *species*), and Red snapper (Lutjanus *gibbus*). L. *bohar* (known to be ciguatoxic) are also commonly caught by local residents fishing in the area.

Betio

The marine life assessment survey completed at the Betio Outfall site in 2015 found the substrate and algae that is representative of the outer 100m of the intertidal reef flat is comprised of negligible sand, with about 70% cover of turf algae. On the reef flat adjacent to the Betio outfall pipeline route (where brine from the desalination plant is to be discharged) the odoriferous and fast growing red macro-algae, Hypnea *sp*. is predominant.

Table 9, extracted from the marine life assessment survey report completed at the Betio Outfall site, gives the average percent cover for substrate and benthic categories on the subtidal reef flat. All invertebrates other than coral and zoanthids are absent. The survey found that whilst there is no baseline comparison available for this outfall, it is likely that the low coral cover, lack of coralline algae, high turf algae, and the high rubble, debris, and rock cover across the reef flat, crest, and slope can be attributed to both the 2009 Crown-of-Thorns sea star infestation and to nutrient loading conditions since the outfall pipes broke in the shallows a half decade ago. The heavy siltation combined with limited variety in coral growth forms is consistent with the transition towards an algae-dominated reef.

Table 9 - Betio Subtidal Reef Flat Substrate and Benthic Categories

Total Substrate		Stony Coral Growth Form		Algae		Invertebrates	
% cover		% cover within *		% cover on substrate**			Incidence
mud	0	massive	30	crustose coralline algae	0	sponge	0
silt	20	submassive	50	*Halimeda* sp.	0	anemone	0
sand	5	encrusting	15	*Caulerpa* sp.	0	ascidian	0
rubble	20	table	0		0	gorgonian soft coral	0
debris	10	digitate	5	**algae+silt+sand+coral = 100		sea cucumber	0
rock	25	branching	0			sea urchin	0
dead coral formation	5	foliose	0	fleshy coralline algae	5	giant clam	0
dead coral debris	4	mushroom	0	turf algae (microalgae)	60	oyster	0
live stony coral	10*	fire	0	other macroalgae	0	COTs sea star	0
zoanthid corallimorph	1			blue-green algae***	0	other sea star	0
soft coral	0				65		
	100		100	***filamentous & mat cyanobacteria			

Source: STSISP 2015[22]

The marine life assessment survey also found that coral cover on the outer reef crest is less than 5% to the east and about 15% to the west of point 14 of the Betio sewerage outfall

[22] STISP 2015. Benthic morphology and marine life assessment for the siting of ecean outfalls on South Tarawa. MPWU Kiribati.

pipeline. It is mainly *H. coerulea* with some encrusting varieties. There was also less silt than was observed on the subtidal reef flat.

There are slightly less turf algae at 50% cover, consistent with lower energy on the crest than on the subtidal reef flat yet with a significant nutrient load. Fleshy coralline algae are present at 15%. Crustose coralline algae are absent.

Table 10 and **Table 11** extracted from the post-installation survey report completed at the Betio Outfall site[23] give the average percent cover for substrate and benthic categories on the reef crest and reef slope, respectively. The crest has the same 65% undesirable algae and 10% coral cover as for the subtidal reef flat. The slope has less of both, although blue-green algae are at 10%. In contrast with the subtidal reef flat, the positive attributes of the reef crest are that it has less turf algae and more coralline algae, albeit the fleshy variety. It has more submassive coral, but with limited species richness beyond H. *coerulea*. The negatives include that it has less rock and more rubble, and therefore less-stable surfaces available for re-growth.

Table 10 - Betio Reef Crest Substrate and Benthic Categories

Total Substrate		Stony Coral Growth Form		Algae		Invertebrates	
% cover		% cover within *		% cover on substrate**			Incidence
mud	0	massive	10	crustose coralline algae	5	sponge	0
silt	15	submassive	80	*Halimeda* sp.	0	anemone	0
sand	10	encrusting	10	*Caulerpa* sp.	0	ascidian	0
rubble	29	table	0		5	gorgonian soft coral	0
debris	20	digitate	0	**algae+silt+sand+coral = 100		sea cucumber	0
rock	15	branching	0			sea urchin	0
dead coral formation	0	foliose	0	fleshy coralline algae	10	giant clam	0
dead coral debris	0	mushroom	0	turf algae (microalgae)	50	oyster	0
live stony coral	10*	fire	0	other macroalgae	0	COTs sea star	0
zoanthid corallimorph	1			blue-green algae***	0	other sea star	0
soft coral	0				60		
	100		100	***filamentous & mat cyanobacteria			

Source: STSISP 2017

In contrast with the reef crest, the positive attributes of the reef slope are that it has less turf algae. The negatives are that it has less rock and more debris, and therefore minimal stable surfaces available for re-growth. This is in part mitigated by the lower energy environment.

Table 11 - Betio Reef Slope Substrate and Benthic Categories

Total Substrate		Stony Coral Growth Form		Algae		Invertebrates	
% cover		% cover within *		% cover on substrate**			Incidence
mud	0	massive	0	crustose coralline algae	5	sponge	0
silt	15	submassive	95	*Halimeda* sp.	0	anemone	0
sand	30	encrusting	5	*Caulerpa* sp.	0	ascidian	0
rubble	15	table	15		5	gorgonian soft coral	0
debris	20	digitate	0	**algae+silt+sand+coral = 100		sea cucumber	0
rock	5	branching	0			sea urchin	0
dead coral formation	7	foliose	0	fleshy coralline algae	5	giant clam	0
dead coral debris	1	mushroom	0	turf algae (microalgae)	30	oyster	0
live stony coral	<5*	fire	0	other macroalgae	0	COTs sea star	0
zoanthid corallimorph	1			blue-green algae***	10	other sea star	0
soft coral	1				45		
	100		100	***filamentous & mat cyanobacteria			

Source: STSISP 2017

[23] STSISP 2017. Betio Outfall Post-installation Survey Report. Fellenius Consultants/Maritime Constructions Inc.

The nearest diffuser (discharge point) for the sewage, that will also be used for brine disposal, is located at a depth of 30 meters and is about 47 meters away (south) from the shallower and nearest live coral (Hypnea *coerulea*).

Corals near the ocean outfalls on South Tarawa, including Betio outfall, were studied more specifically by a monitoring team in 2005. The team used a line intercept transect methodology, which involves placing a tape along a contour on the sea floor and noting the substrates beneath the tape and length at which they change. Transects were taken 100 m either side of each outfall opening and at a control site. The results showed a greater coverage of dead coral and of macro algae at the sites near the outfalls, compared with the control site. Nearer the outfalls themselves, reduced diversity of coral species was observed.[24]

McKenzie

A marine biology life survey was done in McKenzie site for the OTEC EIA in 2016[25] using scuba diving and filming. The figures below illustrate the underwater conditions off McKenzie Point(referred to in the OTEC EIA as the "McDow site", presumably because McKenzie Point was occupied by McConnel Dowall, the Contractor for the rehabilitation of the main road and feeder roads, between 2013 and 2018).

The survey identified several different coral species and estimated their coverage within a sample quadrat at 5, 15 and 20m depth (see figures below). Only one species was identified to the species level (Pahythoa ceresina) while the remainder were simply identified as Coral 1, Coral 2, Acropora 1 and Acropora 2 etc. These species, in sum, made up approximately 75% of the sample area at 5m depth and 90% at 15m. The estimated coverage at 20m was not provided.

The substantial cover observed by the OTEC EIA team is in contrast to the level of coral assessed in a survey carried out on the Bikenibeu Reef, which includes the area studied for the OTEC EIA team, in 2000 by the (then) South Pacific Applied Geoscience Commission, SOPAC[26]. The SOPAC study team employed a different technique – a manta tow and found 7% hard coral cover, 12% algal cover, and 78% non-biotic cover and described the area as "sparsely colonised… the least luxuriant of all the seaward sites [on South Tarawa]". Monitoring reports at the outfall site, some 2.5km to the west of the McKenzie Point / McDow site have been done in 2005 (for the Sanitation, Public Health and Environment Improvement Project, SAPHE) and in 2015 for STSISP. These studies found limited coral cover and more abundant algal cover, consistent with higher nutrient status attributable to the presence of the outfall.

[24] Tonganibeia, K. 2005. Impact assessment of Betio, Bairiki and Bikenibeu Sewage Outfalls on Coral Reef.

[25] Environmental Impact Assessment 2016. 1 MegaWatt Ocean Thermal Energy Conversion (OTEC) Facility, Kiribati.

[26] Lovell, E. (2000) Coral Reef Benthic Surveys of Tarawa and Abiang Atolls, Republic of Kiribati. SOPAC Technical Report 310.

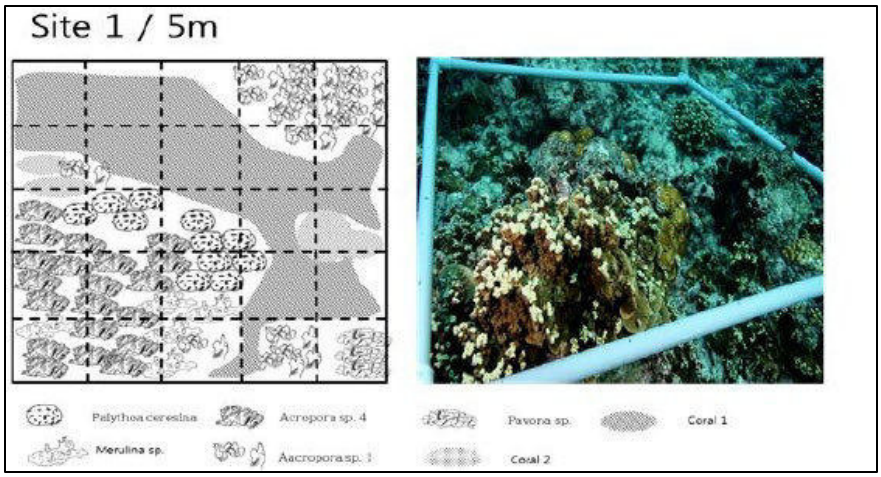


Figure 24 – Marine life at McDow site in 5 m

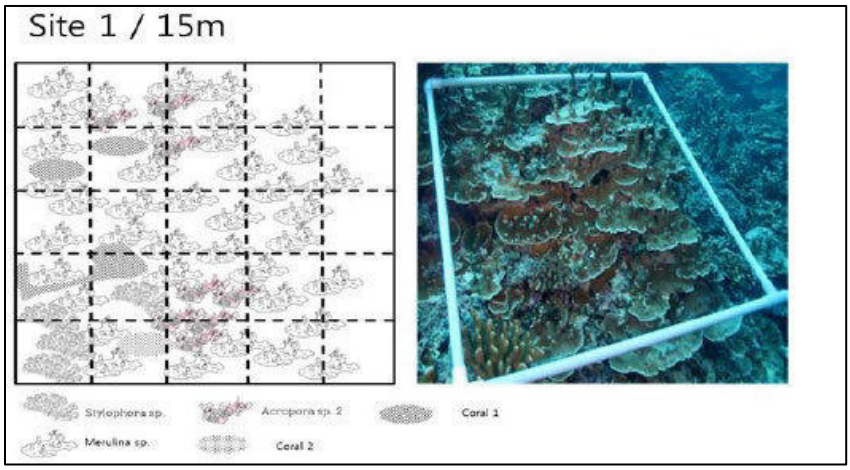


Figure 25 – Marine life at McDow site in 15 m

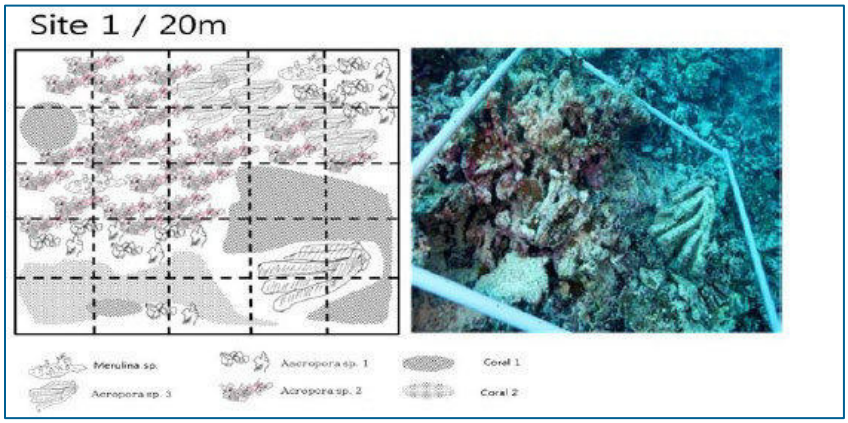


Figure 26 – Marine life at McDow site in 20 m

c) Protected and Conservation Areas and Species

While Kiribati has several protected areas, there are currently no actively managed conservation areas in the Gilbert Islands. There have, however, been efforts in the recent past, including the North Tarawa Conservation Area which was officially established in 1996 and the North Tarawa lagoon was also proposed as a key biodiversity area due to its habitat for endangered species; Green Turtles (Chelonia *mydas*), Big Eye Tuna (Thunnus *obesus*), Humphead Wrasse (Cheilinus *undulates*), Giant clam (Tridacna *gigas*). Mangrove, coral, and sea-grass ecosystems, which occur around South Tarawa, are of conservation significance. Mangroves of the species Rhizophora *stylosa*, and Brugulera *gymnorhiza* occur predominantly at the eastern corner of South Tarawa lagoon. Replanting of the mangroves along the coastal areas in Kiribati including South Tarawa is on-going as part of the KAP III project. Corals occur adjacent to the Betio outfall.

The 90 species in Kiribati that are classified on the IUCN Red List as threatened species include 72 corals, nine marine fish, two turtles, a giant clam and a mammal.

d) Terrestrial Flora and Fauna

Indigenous flora and vegetation of Kiribati is among the least diverse and poorest on earth. In the Gilbert Islands, including Tarawa, and some locations in other inhabited islands, this flora has been severely modified or removed. Generally, terrestrial vegetation in Kiribati is limited to coastal strand vegetation, mangroves and coastal marsh vegetation (limited), inland forest, and pinnacle vegetation on limestone escarpments. The vegetation on South Tarawa is substantially influenced by human habitation and has little biodiversity conservation significance. The selected sites for the proposed the project are located at areas with varying degrees of disturbance to natural vegetation but is dominated by ferns, coconut palm, saltbush, breadfruit and te ango (Permna *serratifolia*), pandanus (Pandanus *fanning enosis*) and starbuck island daisy (Bidens *kiribatiensis*).

There are no endemic mammals or avifauna (birds) on Tarawa. Two avifauna species are included in the 90 species classified on the IUCN Red List as threatened species. Species of seabird that are commonly sighted on South Tarawa include a black tern (Anous *minutus morcusi*) and white tern (Gygis *microrhyncha*). The sparse number of avifauna may be influenced by the high population on South Tarawa and probably the impact of the invasive ship rat (Rattus *rattus*). The rat is a nuisance in almost every household on the island.

4.6 Land Tenure, Zoning and Use

a) Land Tenure, Zoning and Use

This section provides an overview of property rights issues in South Tarawa. Land related issues associated with the project are managed by the project Resettlement Framework and Resettlement Plan.

The total land area in Kiribati is 811 square kilometres comprised of 32 atolls and reef islands dispersed over 3.5 million square kilometres. This means the land area of each of the atoll islands is significantly limited. Two main types of land tenure are present in Kiribati – private ownership and state ownership. A significant majority of land (95%) is under traditional private ownership.

In South Tarawa, State lands are predominantly confined to Temaiku Bight, an area of reclaimed land of approximately 200 hectares at the apex of the island between South and North Tarawa. The remaining lands in South Tarawa are privately owned, except for small parcels of land that have been reclaimed from the sea.

Gaining access to land is one of the major constraints for economic development in Kiribati. In the Gilbert Islands land is unevenly distributed among the people and owned either on an individual or kin basis. Women as well as men can inherit or own land in i-Kiribati tradition, however, kin land is normally registered in the name of the oldest male member of the kin group. Individually owned land, including land which have been purchased, is normally registered in the name of the individual or individuals.

The Government leases land on South Tarawa from traditional landowners for administrative and public use. Under this agreements, traditional landowners surrender use of the land for a yearly fee.

b) Property Rights Relating to the Desalination Plants Sites

Land to be used for the Betio and McKenzie desalination plants is currently under long term government lease. As such, landowners have been treated as lessors and paid annual "lease". This practice continues to date. Land for the desalination plant sites in Betio and McKenzie are under government lease until 2053.The PDA team has obtained confirmation from the Land Management Division (LMD) on the currency of the leases. At the time of the last review of this ESIA, copies of the lease agreements were requested to the LMD, however were not available at the time when this ESIA was finalised.

4.7 Human Communities

a) Population

From the 2015 Population and Housing Census, the total population of Kiribati is 110,136 comprising 54,096 males (49%) and 56,040 females (51%). The ethnic composition of Kiribati is primarily people of Kiribati descent (I-Kiribati) who make up 96% of the population. The remaining population report themselves as being of mixed I-Kiribati descent with others being immigrants from Tuvalu as well as a smattering of other ethnic groups (i.e. Australians, British, etc.). South Tarawa mirrors the national norm, with 96% of its population being I-Kiribati. 56,388 (51%) people live in urban areas in South Tarawa, with the other 53,548 (49%) living in rural areas throughout the country. Females make up 52% of the urban population. Life expectancy at birth in 2013 was 64 for males and 69 for females, the second lowest in the Pacific.

South Tarawa is densely populated, with inhabitants originating from islands throughout the group as well as South Tarawa itself. Even between the main urban areas of Bonriki, Bikenibeu, Bairiki and Betio, land is almost entirely taken up by residential, commercial and communal buildings and their surrounding compounds. According to the 2015 census the population of South Tarawa stands at some 56,388 people representing an average population density of around 3,524 people per square kilometer (km2) over 16 km2 of land area. Within the urban areas, such as Betio, it reaches 10,377 people/km2 which is very high among Pacific Island Countries capitals. The high density in South Tarawa means that 51% of Kiribati's population lives in 2.2% of the Countries' land.

While measures were taken in the past to encourage migration to outlying atolls, at present extensive in-migration occurs and the population of South Tarawa is growing by 4.4% per year (figure below).

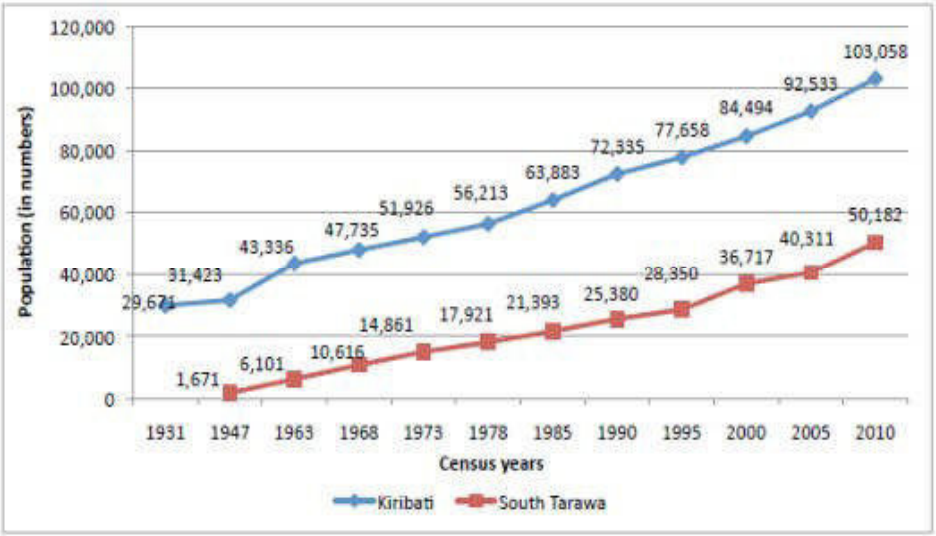


Figure 27 - Population of Kiribati and South Tarawa 1930 – 2010 [27]

According to the 2010 Census the population of Kiribati was 103,058 and South Tarawa 50,182, by 2015 the population increased by 6.9%, however in South Tarawa the growth was significantly higher (12.4%) during the same period. In 2010 South Tarawa accounted for 48.7% of the Country's population compared to 51.2% in 2015. The average household size is large, at seven people per household and households with 15 or more inhabitants are not uncommon. Due to this overcrowding effect, South Tarawa faces serious environmental and social problems including but not limited to pollution of ground water, polluted lagoon and beaches due to open defecating, scarcity of freshwater, poor health outcomes and short life expectancy and high unemployment. South Tarawa, similar to Kiribati, has a young population with almost one third (32.5%) of the people in 2015 under 14 years old and 39% are minors under 18 years of age while only 13% of the population is 50 years and older.

b) Social/Cultural Resources and Heritage

Ancestral shrines and te maneaba (meeting house) are the two important cultural resources on land. Fishing traps, typically built on the reef flat on the ocean side of the island, by overlaying reef boulders and stones, are of equal importance. None of these structures are present at the proposed project sites. However, sustenance is from the coconut and breadfruit trees, and the ocean. A limited amount of coconut trees and breadfruit trees will be impacted by the project, particularly in the installation of water tanks.

Tarawa was the scene of significant combat between Japanese and American forces during WWII. The large guns and bunkers installed by Japanese forces remain in place and provide a strident reminder of the events in the 1940s. Unexploded ordinance (UXO) is a public

[27] *Source: GOK-MFED, 2012*

concern as several UXO have been found buried underground at several locations on South Tarawa (i.e. Betio).

Kiribati is characterized by its retention of traditional beliefs and customs. Land ownership is one of the key customs that determines much of the cultural structure. Families are organized by utu, a group of relatives and family. A single person may be part of more than one utu, depending on their familial ties. These utus are the root of the society and dictate ownership of local land and property. Parents may leave property and utu membership to their children when they pass away. The centre of the utu is referred to as the kainga. Whoever occupies the kainga space has more decision-making power about how the familial property may be used.

c) Health

In Kiribati, health services are provided by the Ministry of Health and Medical Services. The Ministry has three core departments, the Health (Curative) Services, Public Health and Nursing Services. On South Tarawa there are several clinics and two hospitals, Tungaru Central Hospital and Betio Hospital providing health services to the public.

Amongst several duties of the Public Health Department one of its responsibility under the Environment Health Section is to monitor the quality of water from the well-water, rain water, PUB reticulated water, ocean water and lagoon water. Samples of water sources are collected and tested once every 8 weeks from the specified established sites. PH, Conductivity, Dissolved Oxygen, Salinity, Turbidity, Temperature, Chemical test (nitrate/nitrite, chlorine, lead) are tested on site or at the mini lab while micro-biological testing (Coliform and Faecal Coliform) is done in the hospital laboratory. Testing of water from private water sources can also be arranged. However, there is currently no systematic monitoring of the quality of local, household well water quality.

Over the period 2014–2016 there were 80,000 reported cases relating to deficiencies in water supply and poor sanitation on South Tarawa. The cases include diarrhoea, dysentery, conjunctivitis, and fungal infections including ringworm. In 2016 alone, there was an excess of 10,000 reported cases across South Tarawa. Also, numerous cases of other water related disease such as scabies, tinea corpis, tinea versicolor and worm infections have been reported and have continued to increase over the 2014 – 2016 indicating people are using unsafe water for bathing. However, the actual number of cases could be more as it is estimated that many cases go unreported or their result in other health complications that are not reported as sanitation related.

More recent data from the Ministry of Health collected through the hospital and health care clinics indicate that diarrhoeal cases across South Tarawa continue to fall in absolute numbers. The incidence of diarrhoeal and dysentery cases in children below one year of age and from 1-4 years of age has decreased significantly (50% and 56% respectively) in the period between 2014 and 2018.

Figure 28 sourced from the South Tarawa Sanitation Improvement Sector Program final report presents reported diarrhoea and dysentery cases of children four years old and under in South Tarawa. The figure describes a significant annual reduction in reported cases over the last five years, however, the number of reported cases is still significantly high considering the population of five years old and younger is in South Tarawa was 8,654 in 2015.

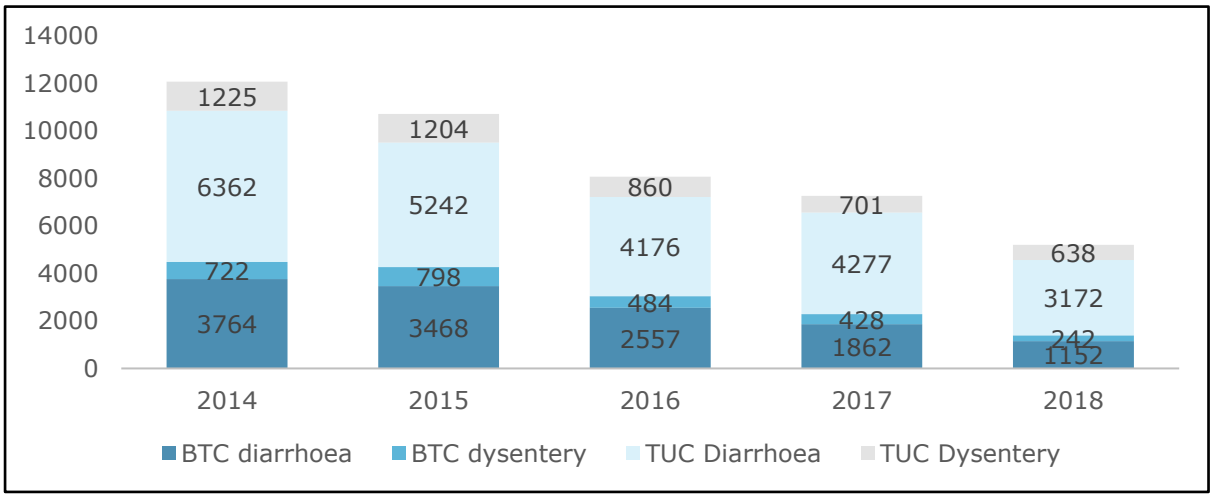


Figure 28 - Reported Diarrhoea and Dysentery Cases of Children 4 and under in South Tarawa, 2014-2018

Figure 29 presents the reported cases of diarrhoea and dysentery by age across health facilities in South Tarawa. The data demonstrates not only the high incidence, but also how in more densely populated areas such as Betio where the sanitary conditions are more challenging due to water access and quality and connections to the sewerage system are still low, the incidence is significantly higher.

BTC & TUC: Diarrhoeal and Dysentery Cases by Health Facility, Jan-Jul 2019.									
Council	**Health Facility**	**<1yr**	**1 to 4**	**5 to 14**	**15-44**	**45-54**	**55-64**	**65+**	**TOTAL**
BTC	BETIO HOSP	105	470	110	284	73	42	28	**1112**
	TEMAKIN	61	355	95	67	20	13	14	**625**
	TEMANOKU	59	369	92	191	42	25	32	**810**
	TAKORONGA	50	309	77	110	29	23	17	**615**
TUC	BAIRIKI	163	678	276	349	113	66	79	**1724**
	NANIKAI	15	41	13	37	7	10	6	**129**
	TEAORAEREKE	37	173	43	81	31	14	19	**398**
	BANRAEABA	27	156	57	39	16	12	21	**328**
	AMBO	31	181	22	69	14	12	15	**344**
	EITA	39	234	56	54	21	9	18	**431**
	BIK.E	67	228	73	96	34	14	21	**533**
	BIK.W	23	139	54	48	27	13	6	**310**
	TEMWAIKU	23	162	39	54	17	9	12	**316**
	BONRIKI	25	130	29	40	14	11	6	**255**
	BWENTEKOTA	6	35	6	9	2	2	2	**62**
	BUOTA	11	54	6	10	3		1	**85**
	TCH-IMCI	40	170	4					**214**
	TCH-OPD	181	729	146	188	79	55	89	**1467**
	TOTAL	**963**	**4613**	**1198**	**1726**	**542**	**330**	**386**	**9758**

Figure 29 - Reported Diarrhoeal and Dysentery Cases by Health Facility and Age in South Tarawa, Jan-Jun 2019

To address this situation, a range of interventions focusing on the immediate water supply infrastructure improvements, improvement of a water treatment system, and a continuous awareness to encourage practice change to better hygiene and sanitation practices and

management of free roaming animals (dogs and pigs) are required. The project's WASH Awareness Program will aim at contributing to an improvement in the health of South Tarawa community.

d) Education

Kiribati achieves almost universal access to primary education. Education is free and compulsory for children between the ages of 6 and 14. I-Kiribati receive seven years of primary education and five years of secondary education. On South Tarawa, 9 primary schools and 10 secondary schools provide primary and secondary education. Data from the Kiribati Ministry of Education indicate that in 2013, gross secondary school enrolment rates of 86% for junior secondary school students (Forms 1 to 3), and 44% for senior secondary school students (Forms 4 to 7)[28].

While schooling is free up to Junior Secondary level and attendance is compulsory, enforcement is difficult. The Government covers the cost of school fees but there are many other fees that the family must cover to educate their children such as the cost of uniforms and school supplies.
Protestant and Catholic churches are the main providers of senior secondary education in Kiribati. Church schools educate approximately three quarters of senior secondary school students while Government schools educate around a quarter. Generally, church-based schools did not offer financial support to students.

The overall (weighted) gross secondary school enrolment rate (with 7,038 junior students and 4,745 students in that year) is estimated at 69.1%.

Kiribati has a high literacy rate with about 97% of both the male and female population able to read and write.[29] A total of 71% (72,237) of the population over the age of 3 years old answered "yes" to the literacy question in the 2015 Census (whether this person could read and write in English). Of those, 48% were female, the remaining 52% were male.

Some of the challenges faced by children completing school education in South Tarawa is inadequate English skills prevent I-Kiribati from obtaining jobs overseas. This is a major disadvantage compared to other Pacific Islanders. This is partly due to the fact that many teachers tend to teach in the Kiribati language even though the secondary school curriculum is in English[30].

Kiribati is the home of several tertiary institutions, the Institute of Technology, (formerly known as Tarawa Technical Institute), The Marine Training Centre, and the Kiribati Teachers College based in South Tarawa offering training for primary teachers. Kiribati is a partner in the regional University of the South Pacific, which has its main campus in Suva, Fiji Islands, and a campus in Tarawa, Kiribati, with a wide range of courses using the university's distance learning facilities. However, financial access to tertiary education is difficult for most.

A significant challenge with tertiary education is that it may not provide skills demanded by employers in Kiribati or the wider region. Once educated there are limited public/private sector jobs and opportunities for self-employment.

[28] GHD, 2017b. PPTA – South Tarawa Water Supply Project (49453-001), Output 41, Poverty and Social Assessment
[29] ADB 2016. Gender Statistics in the Pacific and Timor Leste
[30] DFAT, 2018.

e) Poverty and Marginalized Groups

Poverty in South Tarawa is the highest in Kiribati with around 22.4% of the population below the basic needs poverty line. Food poverty was estimated to be around 5% of the population. Poverty in Kiribati is linked to a number of trends including the exclusion of certain groups e.g. people with disabilities and unemployed youths. The Economic Costs of Poor Water and Sanitation South Tawara study conducted by the ADB in 2014, found that female children have a higher likelihood of suffering from diarrhoea and dysentery than males, and that age influences the likelihood of suffering from these diseases.[31] The study goes on to state that women, children, the elderly, vulnerable and disabled bear a disproportionate share of the burden of inadequate water and sanitation services in South Tarawa.

People in South Tarawa consider not being poor if they are able to maintain a subsistence living by obtaining basic needs from the land and ocean. Being poor is understood a lacking anything to eat. However, poverty in South Tarawa does not mean hunger or destitution but struggle to meet basic living expenses. This is particularly unmistakeable on expenses that require cash payments. Often households have to make decisions on what bills to pay such as buying nutritional food or paying school related expenses.

Some of the more noticeable impacts and symptoms of poverty are reflected in the housing. Those most disadvantaged in Kiribati live in unregulated, low-quality and semi-permanent housing without access to sanitation, water, electricity or other basic services. These conditions have direct impacts on health and educational outcomes and employments prospects.

f) Infrastructure, Public Services and Utilities

Transport

There are only two paved roads in Kiribati, on South Tarawa and Kiritimati. A program to construct causeways between North and South Tarawa was completed in the mid-1990s. The road throughout South Tarawa (except Tanaea) has been rehabilitated to a quality standard with funding support from ADB and World Bank. The causeway connecting the rest of South Tarawa to the main shipping port located at Betio is now rehabilitated and provides all weather access.

Kiribati has 21 airports; two of them (Bonriki and Kiritimati) served by international flights, only four of them with paved runways. The country has domestic fleets to serve the outer islands.

Water supply

The existing public water supply system is operated by Public Utilities Board (PUB) for the entire population on South Tarawa. Overall the water supply infrastructure is in poor condition with numerous water leakages in the reticulated system. Fresh water is supplied from fresh groundwater reserves extracted from a total of 28 galleries in Bonriki and Buota, with a total sustainable yield from the groundwater lenses of 2,010 m3/day. An estimated fresh water demand for South Tarawa by 2020 is 3,735 m3/day projected under the high population growth and conservative leakage control scenario. Although rainwater is harvested by

[31] GHD, 2017b. PPTA – South Tarawa Water Supply Project (49453-001), Output 41, Poverty and Social Assessment

residents, this is not enough to augment supplies from the reticulated system in South Tarawa. Supplementing water supply by Seawater Reverse Osmosis as proposed in this project will provide a sustainable freshwater supply to meet the growing demand.

Electricity supply

PUB is responsible for the electrical power supply on South Tarawa. There are approximately 6,331 households connected to grid with a contracted power per household of about 500 to 700 watts. The average monthly consumption of electricity lays between 150 and 200kWh; with monthly bills for electricity of AUD 60 to 80 per household. The number of illegally connected households is not known. Beside the domestic connections, there are 897 commercials and 408 industrial companies connected to the grid. Yearly there are 10 to 12 black-outs, caused by technical problems and with an average duration of 1-2 hours. In addition, customers suffer eventual short shutdowns of the energy supply, caused by failures of the distribution system, the poor state of wiring or the deficient internal electrical installation. The addition of a solar PV system in this project will have a positive impact on the energy supply in South Tarawa to increase general grid stability.

4.8 Local and National Economy

a) Local and National Economy

Kiribati is one of the poorest and most remote microstates in the Pacific and one of the 47 countries classified by the UN Department of Economic and Social Affairs as least developed[32]. Three indexes measuring economic vulnerability, income and human assets and are used in considering a least develop country (LDC). The Economic Vulnerability Index (EVI) measures the structural vulnerability to economic and environmental shocks, Kiribati has the highest index (73.7)[33] of the LDCs with indicates major structural impediments to sustainable development. The gross national income (GNI) per capita provides information on the income status and the overall level of resources available to a country, Kiribati has a relatively high GNI (2,986)[34] compared to other LCDs, however low compared to other Pacific Island Nations. Lastly, the Human Assets Index (HAI) measures levels of human capital, low levels of human assets indicate major structural impediments to sustainable development. Kiribati has the third lowest HAI (88.7)[35] in the Pacific, however one of the highest among the LDCs.

Some of the compounding issues making Kiribati to be one of the four LDCs in the Pacific have to do with its location, geographic dispersion, scarcity of natural resources and distances to international markets. Kiribati expands over 3.5 million square kilometres but with a total land area of 800 square kilometres comprised of 32 atolls and reef islands and one raised coral island. The two gaps between the three island groups are both approximately 1,000 km. The above reflects the distances within islands for internal trade, but also with major international trading partners, hence the challenges for growing national and local economies.

[32] United Nations Department of Economic and Social Affairs website: https://www.un.org/development/desa/dpad/least-developed-country-category/ldc-criteria.html accessed September 2019.
[33] Ibid, 2019. The EVI is calculated as 1/2 of the Exposure index and 1/2 of the Shock index.
[34] Ibid, 2019. Statistics Division, based on National Accounts Main Aggregates Database (available at http://unstats.un.org/unsd/snaama), using currency conversion rate based on the World Bank Atlas method and adjusted to calendar year, where applicable, (received 18 Jan 2017). Data is the 2014-2016 average.
[35] Ibid, 2019. The HAI is calculated as 1/2 of the Health index and 1/2 of the Education index.

Kiribati has a substantial trade deficit because it consumes more than it produces and imports significantly more than it exports. It virtually has no commodity exports with the principal exports being seaweed, fish, and copra. Kiribati's trade deficit is sustained via income from abroad including tuna vessel fishing licenses, seafarers' remittances and investment earnings and grants received by government, churches and other non-government organizations. Additionally, the country is highly reliant on imports of fuel for transport and power generation requirements.

The very limited natural resource base and infertile soil of atoll islands constrain agricultural development. Kiribati does, however, possess abundant ocean resources – principally fish, seaweed, manganese nodules and cobalt-rich crusts. Fishing licenses, copra and seaweed provide some international revenue. A large proportion of the budget is funded by access license fees paid by foreign fishing vessels to catch tuna in Kiribati's exclusive economic zones and by earnings of Kiribati's reserve fund invested in overseas financial markets. The maritime and fisheries sector offers strong employment opportunities for I-Kiribati. In addition, I-Kiribati are developing expertise and reputations as merchant seafarer with over 600 employed abroad. Much of this income is volatile (largely affected by the global economy and global weather) and creates challenges for the Government to long term plan.

The public sector dominates the Kiribati economy, 34% of the paid labour force is employed by government and the government sector accounts for almost 31% of the gross domestic product (GDP). Agriculture and fishing account for 25% followed by real estate with 12% of the GDP (real GDP in 2006 prices).

The private sector is poorly developed and is characterised by low wages and productivity. Lack of jobs in Kiribati means employment as seamen is an important and well-paid livelihood. Many families depend on remittances for survival and a seaman may support numerous families. Kiribati has around 4,000 trained seamen although only a minority have jobs.

While the current Government is trying to focus on tourism, some tourism takes place. War relicts from World War II on South Tarawa in particular Betio, game fishing and the millennium islands, (whose proximity to the international dateline provides them with the distinction of being the first to celebrate each New Year) encourage visitors. Visitors number between 3,000 and 4,000 each year and bring some significant revenue.

b) South Tarawa

The economy of South Tarawa reflects its function both as the nation's capital and the main sea and international airport. There are significant differences in the livelihood between those living on the outer islands and in urban South Tarawa. The main livelihood options in South Tarawa are in employment, however relatively few jobs are available. A large proportion of the population are unemployed -unable to engage in paid labour or gain adequate cash income from self-employment-. The service sector accounts for most employment and 80% of jobs are with the public sector. Calculating un-employment in South Tarawa is difficult, the general concept and definition of unemployment is "people not employed but actively seeking work", however, this is difficult to apply in South Tarawa because of the dominant subsistence and informal sectors. According to the 2015 Census in South Tarawa only 36.1% of the people were employed and 22.2% of those 15 years and older stated they were income earners.

As South Tarawa is an urban environment with a high population density, subsistence agriculture is limited and fishing resources have been severely depleted. The Government

rents land from traditional landowners reducing the available land for subsistence activities such as farming.

South Tarawa faces several constraints for economic growth including: limited land area, remoteness from major markets with associated high external transport costs, fragile environment, high vulnerability to natural forces including climate change and rising sea levels, scarce natural resources, infrastructure deficits, small-scale economy limiting economies of scale in many activities, economy dominated by government and/or government owned companies, limited private sector development as well as foreign direct investment, and shortages of skilled workers and management skills. The above are augmented by customs that are still alive of borrowing (tangobwai) and asking (bubuti). The sharing of wealth and property amongst close relatives is quite common. Bubuti can reduce willingness to invest in business and has impacts on economic growth.

5 ENVIRONMENTAL AND SOCIAL IMPACTS

5.1 Pre-construction and Design Phase

a) Environmentally responsible procurement

Environmentally responsible procurement shall be guaranteed through proper planning of activities during pre-construction and design phase, ensuring environmental management plans and necessary environmental personnel are included in the design and bidding phase documents, as well as contractors' documents.

b) Survey and Clearance/Disposal of UXO

Unexploded ordinances (UXO) are a risk in Kiribati as Betio was the scene of the Battle of Tarawa during World War II. Prior to commencement of any activities on the desalination site in Betio, a survey for UXO (unexploded ordinances) was done in August 2019 in the test drilling area (12 water bore sites across a 5m x 5m radius). No UXO was detected.

In McKenzie site UXO are not a risk. It was clarified during the PDA that there were no battles on this part of the island.

The following is the statement of the company (Milsearch) carrying out the UXO survey during the PDA:

> *The Battle of Tarawa (US code name Operation Galvanic) was fought from November 20 to November 23, 1943. It took place on Tarawa Atoll in the Gilbert Islands, located in what is now the Republic of Kiribati. Nearly 6,400 Japanese, Koreans, and Americans died in the fighting, mostly on and around the small island of Betio. As a result of this battle, the island of Betio and the surrounding reef is heavily contaminated with Unexploded Ordnance (UXO) and Explosive Ordnance Waste (EOW). Since 2012, UXO Clearances during other projects on Betio have uncovered over 600 items of UXO that have been safely removed from site and destroyed. No UXO clearance has been undertaken on any other island in the South Tarawa chain as these were not subject to assault or bombardment during WWII. As such the risk from UXO is considered at or below ALARP[36] for these areas.*
>
> *As the majority of the remaining UXO is subsurface (with the exception of the reef which does contain surface UXO) the contractor must consider the possibility of UXO encounter prior to and during any intrusive works on Betio. In order to reduce the risk of such an encounter, UXO Clearance must be conducted by an experienced and accredited UXO Contractor in any area where intrusive activity will take place. No intrusive works should commence in that area until either a verbal UXO Clearance or a UXO Clearance Certificate has been issued by the UXO Contractor. Any verbal UXO Clearance should be confirmed within 72 hours by a UXO Clearance Certificate for that site or area.*
>
> *In the event that heavy metal contamination or nearby structures hamper or prohibit the conduct of UXO Clearance and hence the issuance of a UXO Clearance Certification (verbal or otherwise), a UXO Technician must be in attendance in a safeguarding role during the excavation. Regular checks must be conducted of the sides and base of the*

[36] As low as reasonably practicable

excavation utilising appropriate UXO detection technology until either terminal depth has been reached or the excavation extends beyond the assessed depth of penetration for the ordnance items known to have been used during the conflict.

Regarding the possibility of human remains, the following is stated:

In the aftermath of the battle, many bodies were entombed in mass graves or buried in craters in order to prevent the spread of disease. These graves were not marked and are scattered across the island and many have since been lost. Locals and building contractors unearth remains on a regular basis. Various US and Japanese teams have, on occasion, visited Betio to repatriate any remains found and search for further evidence of burial sites.

Should human remains be uncovered during UXO clearance activities, the following procedure must be followed:

1. *Confirm remains are human. Many bodies have been found with ID discs, clothing buttons, webbing remnants and the like. Should there be any doubt consider the remains human until proven otherwise.*
2. *Cease all excavation works, mark the site and contact the Project Manager. Works may continue elsewhere on site.*
3. *Project Manager to contact Police, inform the client and contact Dr Arpad Vass, Forensic Anthropologist or Kautebiri Kobuti, his assistant (phone numbers TBI)*
4. *Human remains removed from site by Forensic Anthropologist or assistant.*
5. *Work returns to normal. Client informed.*

Should the removal of remains be a protracted affair, the client will be informed and works will shift to another portion of the site until such a time as the burial site has been cleared of human remains. Often, UXO is encountered with the human remains. Should UXO or EO be encountered along with the human remains, safety of the exhumation team will take precedence over respect for the dead. The UXO item(s) will be removed by the UXO Technician before exhumation can continue. Every effort will be made by the UXO Technician to minimise disturbance to the remains whilst removing the item(s).

c) Impacts of Establishing Working Areas

Available space on South Tarawa is limited and laydown sites to store containerized building materials are required at the project sites. The sites for the desalination plants in Betio and McKenzie have been confirmed to be government leased land and the size of the land is sufficient for construction activities.

A geotechnical and hydrogeological survey was conducted in the desalination plant sites. A risk assessment was prepared for the study (Appendix 5) and an environmental audit was carried out by MELAD during the drilling survey.

d) Climate Change and Natural Hazards Risks

Planning for the potential impacts of climate variability, and natural hazards, will help to mitigate against potential impacts which may include sea water inundation resulting in failure of water and electrical systems infrastructure, and subsequent loss of public water supply.

The risks that are associated with climate change and variability are related to sea level rise, sea surge risks, temperature rise, decreases in rainfall (whether long term or in terms of extreme dry years or season) and storm severity.

The main vulnerabilities faced by the people of Tarawa can be summarized as:

- Sea-level rise which exacerbates the severity of sea surges, increased rates of coastal erosion and heightened risks to public and private infrastructure;
- More intense and more frequent storms which increase risks of damage from sea surges, high winds and strong inundation on public and private infrastructure; and
- More frequent and longer periods of drought: which cause both intense short-term difficulty and, of greater concern, long term damage to the freshwater lenses that exist beneath the islets.

In addition, the energy consumption from the desalination facility presents a risk to enhancing climate change through increased energy consumption and resulting increased greenhouse gas emissions. That is why a solar PV array will be installed to provide energy for the desalination plants (a separate ESIA is being prepared for the solar system).

Risk assessment of climate change and natural hazards risks

Mitigation	Extent	Intensity	Duration	Consequence	Probability	Significance	Confidence
Without	Island or national	High	Long-term	Massive	Probable	Very high	High
Mitigation measures: • Planning new infrastructure at a suitable elevation above the current high tide level (utilizing accurate topographic survey); • Ensuring new infrastructure is designed to withstand extreme weather events, such as sea water inundation; • Design system to provide treated, safe water to reduce the requirement for consumers to boil water for treatment using green-house gas emitting heating sources.							
With	Island or national	Medium	Medium-term	Major	Possible	Medium	High

e) Land and Resettlement impacts

As identified in Section 3.8 Land tenure, zoning and use, there are two main types of land tenure in Kiribati – private ownership and state ownership. 95% of land is under traditional private ownership, while 5% is State-owned. The project is expected to have minimal involuntary resettlement (IR) impacts. The desalination plants will be constructed on government long-term lease land, leased until 2053. No relocation of housing or settlements or income restoration will be required.

f) Summary

In summary, the significance of the impacts from the pre-construction phase are expected to be low or very low, provided that the mitigations outlined in this section and Section 6 – Environmental and social management are followed. The exception is the climate change and natural hazards risks which are still considered a medium significance risk even with mitigations because of the extent of the potential impact (Island) and the consequences of the impact (massive).

The risks for the pre-construction phase, before and after mitigation are summarized in Table 12.

Table 12 - Impact Assessment Ratings for Pre-construction Phase

Impact – Pre-construction	Consequence	Probability	Significance	Confidence
Survey and clearance of UXO	Moderate	Possible	Low	Low
With mitigation	Minor	Improbable	Very Low	High
Impacts of establishing working areas	Moderate	Possible	Low	Medium
With mitigation	Minor	Improbable	Very Low	High
Climate change and natural hazards risks	Massive	Probable	Very high	High
With mitigation	Major	Possible	Medium	High
Resettlement impacts	Moderate	Possible	Low	Medium
With mitigation	Minor	Improbable	Very Low	High

5.2 Construction Phase

a) Well Construction Impacts

The work will include drawing water from 9 borehole wells in Betio and 7 in McKenzie (boreholes that were drilled during the hydrogeological study, and which are located far below the freshwater lens, 32 m in Betio and 30 m in McKenzie), in phases, for plant feed water and has the potential to contaminate the fresh water lens with high saline water. Adequate planning for well-depths below the freshwater lens and proper procedures for well-casing installation will prevent lens contamination. Monitoring of freshwater lens salinity levels, near the well-field should be planned for. Erosion and sedimentation control plans should be developed for the plant site to avoid impacts to marine waters.

Risk assessment of well construction

Mitigation	Extent	Intensity	Duration	Consequence	Probability	Significance	Confidence
Without	Wider catchment	Medium	Medium-term	Moderate	Possible	Low	Medium
Mitigation measures: • Planning for well-depths below the freshwater lens; • Proper procedures for well-casing installation; • Monitoring of freshwater lens salinity levels; and • Erosion and sedimentation control plans.							
With	Local	Low	Short-term	Minor	Improbable	Very low	High

b) Aggregate and Construction Materials Impacts

The pipes that are associated with the desalination plant will be prefabricated and purchased by the project and will be either stainless steel or plastic, to be decided by the contractor. However, the plant will require some concrete for the pouring of a facility base and the plinth needed for all the reverse osmosis skids. Risks include lack of available materials, and the possibility of weeds and invasive species.

Depending on the design specification and contractor's decision the local aggregates if required can be sourced from Te Atinimarawa Company Limited, the GOK aggregate company. No additional mining for aggregate will be conducted by the project.

Risk assessment of impacts from aggregate and construction materials

Mitigation	Extent	Intensity	Duration	Consequence	Probability	Significance	Confidence
Without	Wider catchment	Medium	Medium-term	Moderate	Possible	Low	Medium
Mitigation measures: • Source aggregates from Te Atinimarawa Company Limited							
With	Local	Low	Short-term	Minor	Improbable	Very low	High

c) Impacts Associated with Brine Disposal Pipe and Permeate Delivery

The installation of pipeline requires excavation and may potentially affect underground power cables, tar sealed main road, concrete private driveways, permanent structures and living plants. Range of methods for construction should be considered (to be confirmed by contractor during detailed design). Trenchless construction techniques such as directional drilling are possible but mixed ground conditions (ie. very hard coral layers and sand/gravels) are difficult and would complicate drilling.

Risk assessment of brine disposal pipe, permeate delivery and upgrading of reticulation system

Mitigation		Extent	Intensity	Duration	Consequence	Probability	Significance	Confidence
Without		Wider catchment	Medium	Short-term	Moderate	Probable	Medium	Medium
	Mitigation measures: • Contractor to appoint experienced site supervisor for each works site; • Contractor to undertake a condition survey prior to any works and planning works to avoid damage to property and plant to the extent practicable. At the start of works the contract supervisor will file a checklist confirming that necessary pre-planning was completed; • Contractor to engage an experienced marine ecologist, to guide (i) a survey of coral formations in the path of the outfall and (ii) removal and relocation of live coral • Contractor to ensure that the Contractor's Environmental Management Plan, prepared as part of the design for the facility includes (i) engaging an experienced marine ecologist to guide the survey of coral formations in the path of the outfall and process of removal and relocation to thrive at a nearby site, (ii) marking the work area with buoys (iii) use of a light weight, rubber tracked excavator for trench formation, (iv) particulars for removal of construction waste including provision for hazardous materials and prohibition of sea dumping and (v) a site safety plan, to include, in additional to general requirements, specific measures that reflect the hazard posed by the high energy environment at the intertidal platform edge, such as specification of an appropriate vessel with adequate anchor or spud for such environments. • Adoption of the construction methodology specified in the bid documents							
With		Wider catchment	Low	Short-term	Minor	Probable	Low	High

d) Impacts Associated with Upgrading (Betio) and Constructing (McKenzie) of Outfall for Disposal of Brine

The existing sewage outfall pipeline will be utilized for brine disposal in Betio, therefore no impacts to the coral reef, fish, and other marine fauna and flora are anticipated from the

Project construction phase. The brine discharge as per sewer outfall pipeline route will follow the recommended alignment to minimize impacts to the lagoon marine ecology.[37]

Likewise upgrading the sewage system at the outfall pump station from gravity feed to a pressurized system will pose no effect on the biological environment around the pumping station as there are no fruit bearing trees on the site. However, overflow and spillage of raw sewage from the sump at the outfall pump station could occur during the upgrading work when the brine pipeline is linked with the sewage outfall pipe.

In McKenzie the laying of the new brine outfall pipeline will potentially have impact on live coral in the direct path of the pipeline trenches. The bathymetric data and geological, physical and biological survey data for McKenzie (Appendix 4) collected for the OTEC EIA report[38] states: *"the reef is made of hard limestone, but underneath the limestone seems to be soft gravel and sand of already dead corals. It is therefore expected that finding an environmentally friendly method to lay down pipes won't be too difficult".*

Risk assessment of upgrading and constructing of outfall for disposal of brine

Mitigation	Extent	Intensity	Duration		Consequence	Probability	Significance	Confidence
Without	Wider catchment	Medium	Short-term		Moderate	Possible	Low	Medium
	Mitigation measures: • Accounting for the likely overflow and spillage problems in the CESMP; and • Having qualified personnel on site to oversee the upgrading and construction work. • Finding environmentally friendly method for laying pipes; avoiding excessive disturbance to marine life (McKenzie) (see c) above)							
With	Wider catchment	Medium	Short-term		Moderate	Improbable	Low	High

e) Site Clearance Impacts

There are no trees to be removed at the proposed location for the desalination plant in Betio, but in McKenzie, according to an initial survey, around 47 coconut trees, two breadfruit trees will need to be cleared. All trees that are affected will be compensated for in accordance with local policy. Consultation with the community will be undertaken before the trees are cleared in order to determine compensation arrangements (if required). GOK has a pricing list for all tree crops and other plants to be cleared. This guide the consultation process and compensation will not be lower than the Government rates.

No burial and other cultural heritage sites are affected by the desalination plants.

The PIU and supervision team will use the survey plans, government rates, negotiation documentation and consultation outcomes to regularly monitor effective implementation.

[37] Fellenius,K. and Hess, D.2015.
[38] Environmental Impact Assessment 2016. 1 MegaWatt Ocean Thermal Energy Conversion (OTEC) Facility, Kiribati.

Earthworks associated with the project have the potential to result in increased sediment runoff entering the coastal marine environment, impacting marine water quality. Earthworks will be required for the construction of the water plant.

Risk assessment of site clearance impacts

Mitigation	Extent	Intensity	Duration	Consequence	Probability	Significance	Confidence
Without	Wider catchment	Medium	Short-term	Moderate	Probable	Medium	Medium
Mitigation measures: • Erosion and sediment control plan will be completed prior to the commencement of civil works and mitigation measures implemented accordingly. • Use of sediment retention fencing, berms, and sandbags around excavations to restrict the release of sediment from the construction site; • Use of siltation curtains to contain the site area around trenching works on the near shore reef to prevent the release of sediment onto the surrounding reef area; • Immediately re-vegetate and/or stabilize exposed surfaces and stockpiles of excavated materials; and • Monitor water quality for near shore waters adjacent to land base earthworks • Compensation for lost trees							
With	Local	Low	Short-term	Minor	Probable	Low	High

f) General risks associated with all construction activities

Climate Change Impacts

Construction vehicles, equipment, and generators will emit greenhouse gases during the period of construction but will not be a significant contributor to overall greenhouse gases.

Risk assessment of climate change impacts

Mitigation	Extent	Intensity	Duration	Consequence	Probability	Significance	Confidence
Without	Wider catchment	Low	Short-term	Minor	Probable	Low	High
Mitigation measures: • Construction vehicles, equipment, and generators will be serviced regularly to reduce emissions. • locating construction plant and equipment inland away from the shoreline is required to minimise risk of loss or damage from ocean inundation							
With	Wider catchment	Low	Short-term	Minor	Probable	Low	High

Noise Impacts

Noise will be generated at constructions sites during site preparation, delivery, trenching, and work procedures that are required for each component such as metal works, welding, and general carpentry work.

Risk assessment of noise impacts

Mitigation	Extent	Intensity	Duration	Consequence	Probability	Significance	Confidence
Without	Wider catchment	Medium	Short-term	Moderate	Highly probable	Medium	High
Mitigation measures:							

				• Restricting the working hours to between 0800 hrs. and 1700 hrs. from Monday to Friday, or Saturday if there is a need to work on the weekend, this is important, especially in areas where residential dwellings are located adjacent to the construction area, as in the desalination construction area and the upgraded water supply infrastructure; • Use of vehicles, plant and equipment, that comply with international standards for construction equipment noise emission, such as Part 204 of US Federal Regulations-Noise Emission Standards for Construction Equipment (40 CFR 204)). Verification of such compliance from the country of origin is required; • The CESMP will include measures to meet the requirements of the WB's Environmental Health and Safety Guidelines (EHSG); and Maintenance repair should also be routinely performed during the construction phase and making the record available whenever needed to the concerned authority.				
With	Wider catchment	Low	Short-term	Minor	Possible	Very low	High

Dust Generation and Nuisance Impacts

Dust will be generated on construction sites during the hauling, delivery, excavation operations, trench refilling and compaction works. To ensure that emissions from diesel generators, vehicles and other machinery are kept within acceptable measures, the Contractor will be required to provide equipment that conforms to international emission standards, verified by emission test certificates and maintenance records, as in the case of control of noise emissions.

Risk assessment of dust generation and nuisance impacts

Mitigation	Extent	Intensity	Duration	Consequence	Probability	Significance	Confidence
Without	Wider catchment	Low	Short-term	Minor	Probable	Low	High
Mitigation measures: • Daily spraying/wetting of the access roads, sites material and stockpiles; • Locations for stockpiles of materials or waste materials will be approved by the PMU/supervision consultant and by the ECD if required; • Loose materials hauled to/from sites will be secured with a tarpaulin to prevent debris; • Ensure emissions are minimal through standardized site management such as dust watering or stockpile covers; • Removal of spoil to stockpile sites or use as refill material; and • Contractor will provide equipment that conforms to international emission standards, verified by emission test certificates and maintenance records, as in the case of control of black smoke emissions.							
With	Local	Low	Short-term	Minor	Possible	Very low	High

Impacts on Terrestrial Ecology

Land-based earthworks will not have significant impacts on the existing topography, geology, and soils, or significant terrestrial habitat. The project design proposes that site works will be in the same footprint as the existing water, and electrical infrastructure. The terrestrial ecology has already been extensively modified by the built environment and introduced species, in all areas. There are no protected sites in the project area.

The majority South Tarawa community area is a built environment. Observed fauna consists mainly of introduced species such as dogs, cats, and rats. Resident and migratory shorebirds are common along the fringing reef, though typically found away from the residential areas. No surface water resources, or associated flora and fauna, exist on South Tarawa. Construction noise and dust will not have impact on any terrestrial habitat of value, and no mitigation is necessary. Clearing planting sites may cause permanent or temporary

disturbances to vegetation. While no known protected flora species have been identified on the project sites, disturbance of vegetation should be minimized.

The project will not introduce any alien species that are not yet established in the region of the Project or promote species that are known to be invasive in the given environments. All vessels carrying equipment and materials to the Project will be subject to inspection by agriculture quarantine inspectors and may be refused entry into Kiribati if they are known or suspected of being infected or infested with disease or pests. The project will not remove any mangroves.

Risk assessment of impacts on terrestrial ecology

Mitigation	Extent	Intensity	Duration	Consequence	Probability	Significance	Confidence
Without	Wider catchment	Low	Medium-term	Moderate	Possible	Low	High
Mitigation measures: • Prohibition of burning vegetation and residual bushes and grasses when clearing planting sites; • Only cutting flora which are a direct obstacle to project infrastructure works, no mangroves will be removed; and • All vessels carrying equipment and materials for the project will be subject to inspection by agriculture quarantine inspectors.							
With	Wider catchment	Low	Short-term	Minor	Improbable	Very low	High

Ecological Impacts Associated with Hazardous Materials Spills

The underground freshwater lens at the project sites could be contaminated from fuel and lubricants leakages.

Risk assessment of ecological impacts associated with hazardous materials spills

Mitigation	Extent	Intensity	Duration	Consequence	Probability	Significance	Confidence
Without	Wider catchment	High	Medium-term	Moderate	Possible	Low	Medium
Mitigation measures: • Regular checks for leaking oil or fuel from machinery; • Ensuring that any leaks are promptly repaired and/or parts replaced within two days as part of maintenance of vehicles and equipment to international standards; and • Contractor will implement the measures identified to mitigate the impacts from storage and spillage of hazardous substances and other chemicals and materials.							
With	Local	Low	Short-term	Minor	Improbable	Very low	High

Impacts from Solid Waste

Limited quantities of solid waste will be generated during the construction period by the contractors. If not properly secured or dispose of the solid waste could cause litter and marine pollution. The contractor is required to minimize the environmental impact of its work by adopting respectful waste management behavior and fulfilling national norms and regulations.

Risk assessment of impacts from solid waste

Mitigation	Extent	Intensity	Duration	Consequence	Probability	Significance	Confidence

Without	Wider catchment	Medium	Short-term	Moderate	Possible	Low	High
Mitigation measures: • Prepare a solid waste management plan; • Separate and store wastes with respect for health and environment. Identify any waste that can be reused or recycled; • Contain all stored wastes in secure receptacles within construction sites and the compound, avoiding littering and runoff; • No waste is to be burned; • Workers will be advised that littering will not be permitted. Waste generated by construction activities at sites will be cleared and disposed of as per the above; • Use recycled or renewable building materials (e.g. timber) where possible; and • Optimize and reduce waste production. Avoid mixing of different waste and minimize waste disposal into the approved dumping area or landfill.							
With	Local	Low	Short-term	Minor	Improbable	Very low	High

Impacts Associated with Hazardous Materials

Fuels, paints and lubricants will be used, which pose a soil contamination risk if leaked or spilled accidentally.

Risk assessment of impacts of hazardous materials

Mitigation	Extent	Intensity	Duration	Consequence	Probability	Significance	Confidence
Without	Wider catchment	Medium	Short-term	Moderate	Possible	Low	High
Mitigation measures: • All hazardous materials will be stored at secure and managed sites (bunded and concreted floor and walls), identified by the contractor and approved by the PMU/supervision consultant; • Fuel and oil to be stored in bunded and concreted areas with 110% capacity; • All chemicals will be clearly labelled; • Spill kit, appropriate to the hazardous materials being used, to be kept on-site and workers to be trained in its deployment; • Regular checks for leaking oil or fuel from machinery; • Ensuring that any leaks are promptly repaired and/or parts replaced within two days as part of maintenance of vehicles and equipment to international standards; • Any surplus hazardous materials shall be removed from the island when the contractor demobilizes. • The contractor's workshop will have clearly marked waste disposal bins to store filters, rags and waste oil, for disposal at the landfills; and • All asbestos concrete pipe disposal will be supervised by a competent person, trained in asbestos abatement. Pipe sections will be wrapped and marked with the cautionary statement "Danger Asbestos-Containing Material". The pipe sections will be buried at an authorized location.							
With	Local	Low	Short-term	Minor	Improbable	Very low	High

Impacts from Materials and Plant Haulage

The haulage of plant and materials to and from works sites and need to relocate services/utilities (and therefore dig up roads and accessways) will create temporary traffic disruptions and pose a potential risk to pedestrian safety.

Risk assessment of impacts from materials and plant haulage

Mitigation	Extent	Intensity	Duration	Consequence	Probability	Significance	Confidence

Without	Wider catchment	Medium	Short-term	Moderate	Probable	Medium	High
Mitigation measures: • Contractor to prepare a traffic management plan (TMP) for the duration of civil works as part of the CESMP; and • Advance notification (through radio and newspaper) to advise road closures, detours and the like to facilitate work activities.							
With	Wider catchment	Low	Short-term	Minor	Possible	Very low	High

Social Conflict Impacts

Social conflict between expatriate and local workers could arise due to cultural differences. In order to minimize this risk is essential that expatriates are provided with information on Kiribati culture, including dressing code, sexually transmitted diseases, and other essential social factors. The contractor will be required to prepare a code of conduct for bid submission consistent with World Bank bid document requirements and the employer's environmental, social, health and safety policy. The agreed code of conduct will be applied at all times.

The proposed code of conduct is detailed in the section Environmental and social management.

Risk assessment of impacts from social conflict

Mitigation	Extent	Intensity	Duration	Consequence	Probability	Significance	Confidence
Without	Island, national	Medium	Short-term	Moderate	Probable	Medium	Medium
Mitigation measures: • Contractor to provide information on Kiribati culture (obtained from PMU) to the expatriate workers; and • Develop and enforce code of conduct. • Maximise the use of local labour							
With	Island, national	Low	Short-term	Minor	Possible	Very low	High

Occupational and Community Health and Safety Impacts

Work on the desalination plant will pose some potential hazards to both workers and the public, resulting from construction works, excavation, vehicle movements and the use of electrical power. In order to minimize these risks, all health and safety requirements will comply with the EHSG. The Contractor will prepare a Health and Safety Plan covering all aspects of the work, including excavation, detecting and connecting to services, work at height, work in confined spaces and where gaseous contaminants are present. The plan will detail allocation of responsibility, training, safety procedures to identify hazards and steps to be taken to manage them, personal safety apparel requirements, first aid arrangements (including first aid supplies and ensuring that qualified first aiders among the Contractor's staff are available) emergency evacuation arrangements, warning signs and other measures to communicate hazards and how to avoid them with the nearby communities. The EHSG requires detailed more in the section on Environmental and social management.

Risk assessment of impacts from occupational health and safety

Mitigation	Extent	Intensity	Duration	Consequence	Probability	Significance	Confidence

Without	Wider catchment	Medium	Short-term	Moderate	Possible	Low	High
Mitigation measures: • Develop EHSG plan; and • Monitor compliance with EHSG. • Contractor must complete their own health and safety plans, including o involving personnel who are appropriately qualified on OHS; o training of workers; o identification of hazards and measures to avoid them at individuals worksites o first aid and evacuation / hospitalization procedures; o regular safety checks of vehicles and plants; o hazard warning signs; o proper transport of materials							
With	Wider catchment	Low	Short-term	Minor	Improbable	Very low	High

Impact on Underground Service Utilities and Other Disruptions

During construction, service outages may be necessary or occur due to accidental damage of underground service utilities and disruptions to the public due to impacts to local traffic. Whilst accidental damage cannot be entirely controlled the risk can be mitigated by ensuring the contractor has access to all information from PUB on underground service locations. Furthermore, any planned interruptions where services are required to be relocated or temporarily stopped during construction for safety of workers, consultation of local residents is required prior to commencing works. The contractor must also put in place measures to control traffic movement to avoid congestion. Metal detectors shall be used, but hand digging will be the only safe way to detect services and excavate on the island due to the randomly placed nature of the unchartered underground services.

Risk assessment of impacts on service utilities and other disruptions

Mitigation	**Extent**	**Intensity**	**Duration**	**Consequence**	**Probability**	**Significance**	**Confidence**
Without	Wider catchment	Medium	Short-term	Moderate	Possible	Low	High
Mitigation measures: • Ensure contractor has information on underground service locations; • Contractor puts in place measures to avoid congestion. • Hand digging to be used as a safe way to detect existing services and excavate							
With	Wider catchment	Low	Short-term	Minor	Improbable	Very low	High

g) Summary

In summary, the significance of the impacts from the construction phase are assessed to be low or very low, provided that the mitigations outlined in this section and in environmental management are followed. The exception is the risks from impacts associated with encroaching onto private property and permanent use of site which are assessed to be medium significance even with mitigation measures because the impacts are long-term. The risks for the construction phase, before and after mitigation are summarized in Table 13 - Impact assessment ratings for construction phase.

Table 13 - Impact Assessment Ratings for Construction Phase

Impact - Construction	Consequence	Probability	Significance	Confidence
Well construction impacts	Moderate	Possible	Low	Medium
With mitigation	Minor	Improbable	Very Low	High
Aggregate and construction materials impacts	Moderate	Possible	Low	Medium
With mitigation	Minor	Improbable	Very Low	High
Brine disposal pipe, permeate delivery and upgrading of the reticulated system impacts	Moderate	Probable	Medium	Medium
With mitigation	Minor	Probable	Low	High
Impacts associated with upgrading of outfall for disposal of brine	Moderate	Possible	Low	Medium
With mitigation	Moderate	Improbable	Low	High
Impacts from encroaching onto private property and permanent use of site	Moderate	Probable	Medium	Medium
With mitigation	Moderate	Probable	Medium	Medium
Site clearance impacts	Moderate	Probable	Medium	Medium
With mitigation	Minor	Probable	Low	High
Climate change impacts	Minor	Probable	Low	High
With mitigation	Minor	Probable	Low	High
Noise impacts	Moderate	Highly-probable	Medium	High
With mitigation	Minor	Possible	Very Low	High
Dust generation and nuisance impacts	Minor	Probable	Low	High
With mitigation	Minor	Possible	Very Low	High
Impacts on terrestrial ecology	Moderate	Possible	Low	High
With mitigation	Minor	Improbable	Very Low	High
Ecological impacts associated with hazardous material spills	Moderate	Possible	Low	Medium
With mitigation	Minor	Improbable	Very Low	High
Impacts from solid waste	Moderate	Possible	Low	High
With mitigation	Minor	Improbable	Very Low	High
Impacts associated with hazardous materials	Moderate	Possible	Low	High
With mitigation	Minor	Improbable	Very Low	High
Impacts from materials and plant haulage	Moderate	Probable	Medium	High
With mitigation	Minor	Possible	Very Low	High
Social conflict impacts	Moderate	Probable	Medium	Medium
With mitigation	Minor	Possible	Very Low	High

Impact - Construction	Consequence	Probability	Significance	Confidence
Occupational and community health and safety impacts	Moderate	Possible	Low	High
With mitigation	Minor	Improbable	Very Low	High
Impact on underground service utilities and other disruptions	Moderate	Possible	Low	High
With mitigation	Minor	Improbable	Very Low	High

5.3 Operation Phase

a) Impacts on physical environment

Risk of Increase of Greenhouse Gas Emissions from Operation of Desalination Plant

Desalination plants are an energy intensive process and hence contribute to global warming due to the greenhouse gasses emitted from the fossil fuels used to drive the system. The generators running on diesel fuel will still be utilized in the proposed desalination plants. However, to compensate for the energy used, a solar PV system will be installed to offset the energy consumed by the desalination plant. The use of solar PV system will reduce dependence on fossil fuel and contribute to the reduction of greenhouse gas emission. Furthermore, provision of safe, treated water to customers also reduces greenhouse gas emissions by reducing the requirement for boiling water using greenhouse gas emitting fuels as the energy source.

Risk assessment of increase of greenhouse gas emissions

Mitigation	Extent	Intensity	Duration	Consequence	Probability	Significance	Confidence
Without	Regional or global	Medium	Long-term	Major	Probable	High	Medium
Mitigation measures: • Install solar PV system; and • Reduce the need of burning of fossil fuels to boil unsafe water.							
With	Regional or global	Low	Short-term	Moderate	Improbable	Low	Medium

Risks from Generated Wastes

Wastes from the desalination plant include spent filters and general office wastes. If not properly stored and disposed of, these could contribute to litter and marine pollution. The operator of the desalination facility is required to minimize the environmental impact of its work by adopting respectful waste management behavior and fulfilling national norms and regulations. Spent filter cartridges and other solid wastes from the desalination plant will be disposed at the Betio landfill through routine collection by the Betio Town Council or by PUB whenever needed. Secure on-site waste bins will be provided.

Risk assessment of generated wastes

Mitigation	Extent	Intensity	Duration	Consequence	Probability	Significance	Confidence
Without	Wider catchment	Low	Long-term	Moderate	Probable	Medium	High
Mitigation measures: • Minimize waste; • Regular disposal of waste at Betio landfill; and • Securely store on-site waste in bins provided.							
With	Local	Low	Short-term	Minor	Possible	Very low	High

Risks to Marine Water Quality from Brine Outfall

Risks to marine water quality are related to the discharge of brine, if it is not properly disposed of. The Project's use of the new outfall pipeline for brine discharge is not expected to impact coastal marine water quality, especially in the near-shore zone.

The brine from the desalination process will be discharged to sea, resulting in locally raised concentrations of salt in the seawater. The process produces a clear water permeate accounting for approximately 43% of feed water, while the remaining 57% becomes the brine solution to be disposed. Salinity levels above or below ambient salt water levels can alter the species composition of benthic formations and affect the behavior of demersal and pelagic species. The significance of this effect is governed by the rate at which the brine is mixed with the surrounding waters and the movement of the plume on exit from the diffuser through which the brine is discharged. Brine from the SWRO plant at Betio will be discharged into the existing sewerage outfall, while a separate outfall specifically for brine, will need to be constructed at McKenzie point.

The sewerage outfall in Betio, constructed under the ADB funded South Tarawa Sanitation Improvement Sector Project (STSISP) in 2017, conducts effluent from a saltwater flushed sewerage network and some septage brought from sites outside the network, released via a multi-port diffuser at a depth of 30m. The rate at which effluent mixes with seawater and behavior of the effluent plume governs the concentration of harmful bacteria and other contaminants in the surrounding waters and at the surface. The effects on the effluent plume of introducing brine to the outfall therefore need to be assessed.

In the case of McKenzie point, there is no sewage outfall to release the brine into. The brine outfall for the McKenzie point facility will be designed by the contractor. The contractor's design is to be approved by the employer prior to commencement of works.

During the PDA, the environmental impacts of the brine discharge from the SWRO plants were assessed by dispersion model study by using VPLUME software, prepared and distributed by the United States Environment Protection Agency. With the input parameters used (see table below), the model shows salinity declines rapidly as water flows away from the diffuser, reaching a value close to the expected ambient level of 21,000 mg/L within approximately 4m or less. The situation is broadly similar at both typical and peak flows (see Appendix 3 for full report of the study). It is expected that there will be very rapid dilution due to the small volume of output and use of diffusers.

There is no sewage treatment facility at the pump station in McKenzie, so the brine will not interfere with any biological treatment process as the sewage is raw. The combined effluent will exhibit an estimated salinity greater than seawater, thus making the effluent discharged at the Betio outfall denser than the ambient seawater level. The effect of brine and associated sewage plume on the marine environment depends on the dilution factors attained when discharged.

The brine stream will be discharged beyond the reef at a depth of about 15m with a mixing zone of 10-15m after which ambient conditions will be experienced. A low toxicity antiscalant will be specified. An alkaline cleaner with low phosphorous content will be specified. It is proposed to use citric acid to neutralise the cleaning solution. These can only be confirmed after the detailed design (by contractor) is received. Given that there must be a disposal route for the brine stream and a very small mixing zone is specified the impact on local fauna and flora is minimal.

Table 14 - Model Parameters (Betio outfall)

Parameter	Value	Justification
Port Diameter	100mm	From STSISP as-built drawings (Indicative, as the dimension is not specifically shown on the drawings)
Number of ports	14	From STSISP as-built drawings
Depth of outfall opening	30m	From STSISP as-built drawings
Current speed	0.01 m/s	A near-zero value, likely to apply during stagnant conditions that repeatedly occur off South Tarawa
Concentration of faecal coliform	100,000 MPN/ 100 mL	Based on tests of effluent undertaken for the preparation of the SAPHE project
Ambient seawater salinity	35,000 mg/L	As measured during ocean outfall monitoring (Nov 19)
Effluent salinity	For Betio: 16,000 mg/L	Based on tests of effluent undertaken for the preparation of the SAPHE project (at McKenzie the effluent will comprise discharged brine from the desalination process only)
Effluent temperature	30°C	Assumed
Ambient seawater temperature	29 °C	As measured during ocean outfall monitoring (Nov 19)
Effluent discharge rate	64 l/s for normal conditions; 104 l/s for peak conditions	As quoted in design report
Brine discharge rate	57 l/s	Flow rate during normal operation, as quoted in design report
Salinity of the discharged brine solution	50 mg/L	As quoted in design report

Risk assessment of brine outfall on marine water quality

Mitigation	Extent	Intensity	Duration	Consequence	Probability	Significance	Confidence
Without	Wider catchment	High	Long-term	Major	Highly probable	High	Medium
Mitigation measures: • Dispose of brine at depth (30m via existing outfall at Betio; at a depth to be identified by the design/build contractor at McKenzie) so there are lower levels of nutrients and organic matter; • Upgrade sewage outfall including 12 diffuser ports to allow more rapid mixing; • Disposal in high energy environment; • Alignment of the pipeline; and • Salinity testing.							

With	Wider catchment	Low	Short-term	Minor	Possible	Low	High

b) Impacts on biological environment

Risks of Brine Disposal to the Marine Ecosystem

Brine effluent is known to have adverse effects on benthic ecosystem. Due to higher concentration of salt levels the effluent is denser and tends to sink to the bottom when discharged, directly impacting the benthic organisms around the discharged location. Brine discharge, associated with SWRO plants, has been found to alter the benthic community and reduce the diversity of organisms.

High salinity, if allowed to persist within the water column, can also influence water turbidity, disrupting primary production through the extinction of plankton species[39]. The results of experimental exposure of corals to high salinity varies widely depending on the species, the ambient salinity in experimental settings from which they were collected and the exposure period. Available information suggests that salinity tolerances in coral species depend on several factors including the speed, magnitude and duration of salinity increase, ambient salinities before the change, individual species tolerance levels, acclimatization abilities and whether salinity changes are occurring simultaneously to other stressors such as temperature and turbidity fluctuations.[40]
Beyond the demersal environment (i.e. close to the sea floor), concentrations of nutrients and particulate organic matter progressively decrease although the brine effluent with sewage plume provides a localized zone where salinity is higher and concentrations of nutrient from plume are higher than in surrounding waters. Fish are known to have acute chemical sensing capabilities and are therefore likely to perceive concentrations of soluble nutrients and higher salinity water. While it is not possible to predict what behavioural responses to these will be, fish can avoid the plume and saline water if it is perceived as harmful. At the depth of the outfall opening (30 m) coral cover was found to be less than 5%, and most of the surface is comprised of sand and rock outcrops. No seagrass habitat is present.[46]

Under the South Tarawa Improvement Sector Project, the upgrading work on the Betio sewage outfall has been completed in 2019. Part of the upgrading was the addition of 14 diffuser ports at 30 m depth. The ports alter the way in which the effluent is introduced into the ocean water and level of dilution. The relevant changes include: (i) more rapid mixing of effluent from the outfall with seawater, and (ii) introduction of effluent from the sewer systems at depth so there is lower levels of nutrients and organic matter than close to the surface that will prompt eutrophication.

[39] Munke, Frank: April 2008

[40] RPS Environment & Planning Pty Ltd. 2009.

[46] Fellenius,K. and Hess,D.2015.

In Betio, project design for the discharge of brine from the SWRO plant via the newly constructed wastewater outfall pipeline, considered the recommendations of the marine benthic habitat surveys, of the existing and proposed wastewater outfall pipelines, conducted for the prior wastewater improvements project. The surveys determined that overall reef health is impacted by sedimentation, macroalgae cover, and lack of suitable substrate for coral recruitment. This project is not expected to have further negative impact on marine ecology.

In McKenzie, all waste streams generated by at the Desalination Plant, including the plant concentrate, shall be discharged via an offshore outfall with appropriate designed diffusers after being neutralised. The discharge diffuser system shall be designed and constructed such that the plant discharge is released into the ambient seawater at velocity of 3 to 4 m/s, which modelling has shown will allow complete dissipation of the plant concentrate into the ambient seawater within a nominal 10 meters from the exit of a diffuser port. The configuration of the entire diffuser system, its minimum length and diffuser arrangements shall meet the environmental performance requirements of the Employer and those of the Environmental Management Plan. The outfall pipe shall be a single pipe with hydraulic capacity designed to discharge all waste streams generated by a SWRO Desalination Plant of ultimate plant freshwater production capacity for the future plant expansion (i.e. 3.5 MLD RO system, assuming a nominal recovery of 43%). In addition, if emergency discharge of any process liquid is required, this shall be allowed for in the sizing of the outfall pipework to ensure that the outfall system maximum design pressure is not exceed. The diffuser ports shall function effectively at recovery rates of 43% (or up to 50% recovery, should recovery rates increase in the future through improved RO technology). The final design will be done by the contractor.

Risk assessment of brine disposal on the marine ecosystem

Mitigation	Extent	Intensity	Duration	Consequence	Probability	Significance	Confidence
Without	Wider catchment	Medium	Medium-term	Moderate	Highly probable	Medium	High
Mitigation measures: • Dispose of brine at the Betio plant via the existing sewerage outfall, which is at 30m depth; • Upgrade sewage outfall including 14 diffuser ports allow more rapid mixing in Betio; • Require design and build contractor to install a diffuser that causes rapid mixing of the brine, returning to ambient levels within 10m from the point of discharge, as substantiated by dispersion modelling; • Disposal in high energy environment.							
With	Wider catchment	Low	Short-term	Minor	Possible	Very low	High

Risks Associated with the Failure of the Desalination Plant

Failure of the desalination plant, especially the desalination membranes or post treatment system, will result in the discharge of seawater and chemicals entering the water distribution system. Furthermore, the failure of the brine disposal transfer pipeline will affect the local salinity of the aquifer in the area directly affecting the local plants, especially fruit bearing plants.

The failure of chlorination system can also affect the quality of reticulated water. Water leakage is another long-term problem that is often associated with the water supply system on South Tarawa. These risks can be reduced with regular inspection and maintenance.

Risks of failure can be further reduced if the installations are properly protected to avoid accidents, and the damaging, or unauthorized removal of the technical equipment. It is proposed that unauthorized access to the RO plant (as well as the PV modules structures and exposed water supply infrastructures) is prohibited by means of fences with lockable gates, lockable manholes for underground water valves, and that visible signs indicating danger and no-go-areas are displayed visibly to the public.

The new plant will be designed by the desalination plant contractor to achieve performance reliability criteria defined in the Employer's Requirements. Alarms and metering will be designed by Contractor to achieve this.

The desalination plants will have full SCADA controls and associated alarms. They can be monitored both on and offshore. They are monitored 24/7 by experts. The network contractor has been asked to provide a tanker for each water supply zone to use in emergencies (water from Bonriki). The option of rationing the water from Bonriki is also there, as is done now by opening the valves along the transmission main. Adding the second desalination plant has gone a long way to mitigating the effect of a plant failure.

Risk assessment of failure of the desalination plant

Mitigation	Extent	Intensity	Duration	Consequence	Probability	Significance	Confidence
Without	Wider catchment	Medium	Medium-term	Moderate	Possible	Low	High
Mitigation measures: • Regular inspection and maintenance; • Install locked gates, lockable manholes to restrict unauthorized access to the plant PV modules structures, and exposed water supply infrastructures; • Install visible "danger" signs and no-go areas; and • Building contractor to provide a relevant training program to the operators. • Use of full SCADA controls and associated alarms. • Having tankers for emergency use (water from Bonriki).							
With	Wider catchment	Low	Short-term	Minor	Improbable	Very low	High

Impacts Associated with the Water Quality Supplied by the Plant

The quality of water produced from the desalination plant and extracted from the water reserve must still be routinely tested for consumption suitability to assure public health. In Kiribati, the salinity of the drinking water should not exceed 600 mg/L and should be free of pathogens as per the World Health Organisation guideline for pathogens[41] that is normally adopted as a national guideline. Samples from all storage tanks should be taken monthly for testing. PUB may also liaise regularly with the Ministry of Health and Medical Services on their routine water sampling and testing program to ensure that the results are shared. Where negative results are attained, PUB will promptly provide remedy to rectify the salinity of the reticulated water. Further, the public will be promptly informed to boil water when the chlorination system fails and the presence of pathogen is detected.

[41] WHO. 2008.

Water quality monitoring is undertaken by sampling from the product water and distribution tanks as well as from customer taps. Assets such as tanks and pump stations are to be regularly inspected to ensure the integrity of the system (that means there are no holes for bugs to get in). PUB also have to prepare a water safety plan with the assistance of the contractor.

Risk assessment of impacts of water quality supplied by the plant

Mitigation	Extent	Intensity	Duration	Consequence	Probability	Significance	Confidence
Without	Wider catchment	High	Short-term	Moderate	Possible	Low	High
Mitigation measures: • Regular inspection and maintenance; • Regular testing of the salinity of the drinking water from the plant to ensure it is safe for consumption; • PUB and Ministry of Health and Medical Services liaise on routine water sampling and testing; • Promptly provide remedy to rectify the salinity of the reticulated water; and • Inform public to boil water if chlorination system fails and the presence of pathogen is detected.							
With	Wider catchment	High	Short-term	Moderate	Improbable	Low	High

Risks Associated with Chemical Use and Disposal

Anti-scaling agents and cleaning chemicals such as citric acid and alkaline detergent will be used in the desalination plant. Chlorine gas will also be used to treat water from the desalination plant. Although the chemicals to be used are applied in small doses when applied into the system proper handling should be practiced to minimize health risks to workers and the public. Hazardous chemicals should be adequately labelled, stored safely and handling procedures should be visibly displayed at appropriate locations. Staff should be trained on how the chemicals are handled safely, specifically chlorine gas cylinders.

The wastewater from the chemical cleaning process will be discharged to a new 40m^3 sump. It is proposed to hold the spent cleaning solution in the sump and slowly bleed the neutralized solution into the continuous flow of brine so that the pH of the blended stream complies with environmental requirements. The brine does exhibit good buffering capability because of the high alkalinity and it is expected that the pH will not change significantly.[42]

For pH of the brine, it is proposed to use special purpose meter, see https://www.thermofisher.com/au/en/home/life-science/lab-equipment/orion-aquasensors-water-analysis-portfolio.html . To calibrate the meter synthetic seawater will be used.

Risk assessment of chemical use and disposal

Mitigation	Extent	Intensity	Duration			Consequence	Probability	Significance	Confidence
Without	Wider catchment	Medium	Medium term			Moderate	Possible	Low	Medium

[42] GHD, 2017(a)

Mitigation measures: • Proper handling practices e.g. lifting chemicals on ladders or temporary platforms is not permissible. • Proper chemical labelling; • Safe storage practices e.g. in lockable sealed building; • Signs showing correct procedures; • Staff handling training; • Store chemical wastewater in sump; and • Slowly discharge neutralized solution into the brine so that discharge complies with environmental requirements. • Chemicals will be handled, stored and disposed in accordance to their SDS/MDS.									
With	Wider catchment	Low	Medium-term			Moderate	Improbable	Low	High

Noise Impacts

Noise associated with the high-pressure pump in the desalination plant will be a nuisance to nearby hospital and residences if noise is not contained within the plant. Noise reduction or acoustic packages are recommended and should be installed to reduce noise emitted from the plant.

The noise limits at the boundary have been specified as follows. A noise limit of 55 dBA measured as the equivalent continuous sound pressure for one hour for the hours of 7:00 am to 10:00 pm (same noise level as a refrigerator) and 45 dBA for the balance (same noise as a background suburban area) as measured at the desal site boundary has been specified.

Workers will be required to wear proper hearing protection.

The desalination plant location in Betio will be in the same compound with the future hospital, which means that the noise levels will have to be kept low during the operation of the plants. The area will in fact become quieter than it used to be during the previous user of the site, the causeway contractor.

Risk assessment of noise impacts

Mitigation	**Extent**	**Intensity**	**Duration**	**Consequence**	**Probability**	**Significance**	**Confidence**
Without	Local	Medium	Long-term	Moderate	Highly probable	Medium	High
Mitigation measures: • Install noise reduction or acoustic packages; and • Workers required to wear hearing protection.							
With	Local	Low	Long-term	Moderate	Possible	Low	High

Odour Impacts

There is no major odour expected from the desalination plants. There will be some odour from the groundwater pumped from the bores, as noticed during the drilling study, but is minimal and not noticeable beyond a few metres. This was assessed during the trial bores.

In the sewage pumping area in Betio where the brine effluent pipe for Betio desalination plant will be connected, there is already some sewage smell within a few meters from the pumps. This project will not make the situation any worse.

Impact of Increased Greywater

Increased greywater production and disposal is an impact that has been considered outside the scope of the STWSP. It is a major issue though and needs to be focused in the forthcoming Sanitation Roadmap Addendum study (due 2020) and sanitation projects following from the study.

c) Summary

In summary, the significance of the impacts from the operation of the desalination plant and the PV solar plant are assessed to be low or very low, provided that the mitigations outlined in this section and Section 7 – Environmental and social management are followed. The exception are the risks to the quality of the fresh groundwater reserves from waste disposal practices, which remains high even with mitigations because the consequences of the impact remain major. The risks for the operation of the plants are summarized in Table 15.

Table 15 - Impact Assessment Ratings for the Operation Stage

Impact - Operation	Consequence	Probability	Significance	Confidence
Risk of increase of greenhouse gas emissions from operation of desalination plant	Major	Probable	High	Medium
With mitigation	Moderate	Improbable	Low	Medium
Risk associated with the failure of the Solar plant	Moderate	Possible	Low	High
With mitigation	Minor	Improbable	Very low	High
Risks from generated wastes	Moderate	Probable	Medium	High
With mitigation	Minor	Possible	Very low	High
Risks to marine water quality from brine outfall	Major	Highly probable	High	Medium
With mitigation	Minor	Possible	Very low	High
Risks of brine disposal to the marine ecosystem	Moderate	Highly probable	Medium	High
With mitigation	Minor	Possible	Very low	High
Risks associated with the failure of the desalination plant	Moderate	Possible	Low	High
With mitigation	Minor	Improbable	Very low	High
Impacts associated with the water quality supplied by the plant	Moderate	Possible	Low	High
With mitigation	Moderate	Improbable	Low	High
Risk associated with local solid/waste disposal practices on fresh groundwater resources	Major	Highly probable	High	High
With mitigation	Major	Probable	High	Medium

Impact - Operation	Consequence	Probability	Significance	Confidence
Impact of additional water supply on existing wastewater systems	Moderate	Possible	Low	Medium
With mitigation	Moderate	Improbable	Low	Medium
Risks associated with chemical use and disposal	Moderate	Possible	Low	Medium
With mitigation	Moderate	Improbable	Low	High
Noise impacts	Moderate	Highly probable	Medium	High
With mitigation	Moderate	Possible	Low	High

5.4 Potential Impact of Climate Change and Climate Variability on the Project

As discussed in various chapters earlier – 4.1, 5.1 c), 5.2 f) and 5.3 a) - the climate risk classification of this project is high, and this project is tremendously helping in climate risk adaptation. At the same time, during design, construction and operation, the project needs to take into account the climate variability in site, material and structure selection. There will also be an education and service center established by the project, which will improve the level of climate change and water resources understanding on Kiribati and is therefore entirely a climate adaptation activity.

5.5 Cumulative Impacts

Together with other water and sanitation sector interventions that are taking place in South Tarawa, the positive impacts of the project on public health, socio-economy and environment of South Tarawa can be magnified. Similarly, due to various development activities that are simultaneously going on, the continuous coordination between different projects and organisations is important to avoid negative cumulative impacts due and overexertion of the sensitive environment of Kiribati.

5.6 Analysis of Alternatives

a) Alternative to the Desalination Plant

The alternative supplementary sources of water were assessed in the Tarawa Water Master Plan 2010-2030 report and were also addressed in the environmental assessment that accompanied the South Tarawa Water Supply Options Assessment Desalination Feasibility Study.[43] The water sources included: bulk importation by ship, constructed rainwater catchment, recycling, the construction of island for groundwater collection and pumping, and construction of a SWRO water plant (desalination plant). The Master Plan assessment concluded the following:

- Bulk importation is extremely expensive and might only be suitable to emergency only,
- Rainwater catchment is constrained by vulnerability to prolonged drought, shortage of space, high costs, and difficulties with keeping the water free of contamination.

[43] GOK & ADB. 2012.

- The scope of water recycling is limited as extensive recycling of water sourced from household wells already occurs throughout Tarawa.
- The construction of an island for ground water collection is capital intensive and would pose several environmental problems associated with the substantial amount of aggregates needed to create such an island
- The saltwater reverse osmosis option was adopted as the most economical means to augment water supply on South Tarawa, provided it can be effectively maintained throughout 10 years and more. The system can be containerized and hence tested for workability according to design preference and performance before shipment, located in area of highest demand and direct connection to the existing water supply network, limited land area requirement, producing high quality of water, and that the system can incorporate an energy recovery system that reduces the amount of energy used by the plant.

b) Alternative Location of Desalination Plant and Brine Disposal

During the preparatory phase (PPTA) of the project in 2017, twelve different site were proposed and considered for the location of the desalination plant for Betio (for exact sites, see table 2, chapter 3.3).

The lands with private ownership were eliminated due to complications with land procurement. Identification of landowners involves court proceeding that can last for more than a year. Two of the sites were zoned as open space and therefore were eliminated based on social sensitivity of the area. A transmission tower is located on one of the sites and would create limitations on land area with significant impact on site layout. Furthermore, that site is not ideal for sourcing feed water from the bores. One site was at Bonriki and is not ideal as a major portion of the land is swampy and is not good for construction. Also, in that one the bores would be remote from desalination plant and require their own electrical power system. A new water transmission pipeline from Bonriki would also be required possibly connecting to the existing pipeline around Ambo. It was assumed in 2017 that strategically, it is preferable to have two water supply systems located at either end of South Tarawa with the SWRO plant located at Betio where population density is highest and located furthest from the Bonriki groundwater reserve. A site at Bairiki was considered as it is also close to Betio. However, the site was too sandy and there would have been a need to improve soil bearing capacity. It is located in close proximity to residential area and the church, so the noise level was also considered. Additionally, the area is prone to destructive waves during extreme westerly bad weather event thus a coastal protection structure would be needed bearing additional cost. Five of the sites assessed in 2017 were located at Betio and those were found mostly suitable for the desalination plant. One site was eliminated as PUB will be relocated to the site. Even if the site is available the total length of pipeline required for brine discharge would have been around 2.8 km running through the residential area. Others were also good locations, but extra distance is needed to run the brine discharge to the ocean to miss the cemetery and residential buildings. The preferred location selected was the current Betio site. It was preferred because it is located more than 100 meters from the shoreline and therefore will not be exposed to coastal wave events which might cause local inundation. The ocean outfall pump station that can provide a means of brine disposal is located across the road, saving approximately more than US$2 million from building an independent outfall system for the plant. Furthermore, the site is already significantly disturbed so additional construction activities will not significantly impact flora or fauna.

During the PDA phase in 2019, it was decided to have an additional site in McKenzie. The main reason for having two desalination plants instead of the one in Betio only, was that the

updating of the hydraulic models showed that it is very difficult to transfer the water from Betio to as far down as Bikenibeu as the transmission pipeline was designed to flow in the other direction. As a better alternative, it was decided to split the desalination plant across two sites placing one component (3.5 MLD) at Betio and a second component (2.5 MLD) at McKenzie, where an available area was identified at the proposed OTEC system site. This has been referred to as the decentralised option and the following graph shows the cumulative power consumption over time for the two options. The decentralised option will result in a saving of 6,312 MWh over 20 years, worth $4.1 million on today's electricity tariffs.

c) Alternative to Desalination Design

Seawater desalination can be achieved through reverse osmosis and distillation. Distillation is a phase separation method whereby saline water is heated to produce water vapor, which is then condensed to produce freshwater. The various distillation processes used to produce potable water, including MultiStage-Flash, Multiple Effect, Vapor Compression, and Waste-Heat Evaporators, all generally operate on the principle of reducing the vapor pressure of water within the unit to permit boiling to occur at lower temperatures, without the use of additional heat. Distillation units routinely use designs that conserve as much thermal energy as possible by interchanging the heat of condensation and heat of vaporization within the units. The major energy requirement in the distillation process thus becomes providing the heat for vaporization to the feed water. However, the methods require high levels of technical input for operation and maintenance.

Reverse osmosis, a preferred design, does not require the need to vaporize the water, but only the use of membranes with controlled pore size, separating water from the saline solution.

d) Alternative to Feed-Water Sources

The alternative feed water sources are the underground blackish water and the coastal seawater. Although the underground blackish water has lower salinity and therefore reduced energy requirements for desalination, it is polluted with variable concentration of solutes that can lead to operational difficulties. The coastal seawater on the other hand tends to contain variable solutes and it is a highly turbid environment requiring more effort to filter. The feed water obtained from bore holes below the aquifer are naturally filtered and has more constant solute and impurity levels.

e) Alternative to Brine Delivery Pipeline

Apart from the preferred alternative, where a simple excavation across the road is done to provide sufficient workspace to lay the transfer pipeline for brine discharge from the desalination plant to sump at the ocean outfall pump station, construction using horizontal directional drilling (HDD) is another option.

The HDD is used to bore through the ground and involves a GPS-guided drill head creating a bore hole from the surface at the outlet of the desalination, to a few meters below the surface under the road to the desire location at the pump station. The technique can manoeuvre the drill head horizontally and vertically to maintain the required angle and route. The technique will enable the placement of the borehole through the ground and feeding the brine transfer pipe through the borehole, avoiding the need to dig trenches which would damage the newly completed tar sealed road surface at which the pipe can be laid.

Horizontal directional drilling is done with the help of a viscous fluid known as drilling fluid. It is a mixture of water and, usually, bentonite or polymer continuously pumped to the cutting head or drill bit to facilitate the removal of cuttings, stabilize the bore hole, cool the cutting head, and lubricate the passage of the product pipe. The drilling fluid is sent into a machine called a reclaimer which removes the drill cuttings and maintains the proper viscosity of the fluid. Drilling fluid holds the cuttings in suspension to prevent them from clogging the bore. A clogged bore creates back pressure on the cutting head, slowing production. For environmental compliance, the viscous fluid must be recovered for proper disposal.

The method is constrained by the availability of freshwater, a scarce resource on the island. The use of HDD is further constrained by the fact that it works best with solid rock. Most of the ground materials on the atoll island a few meters below surface is sand. The existing underground utilities are also vulnerable to damage and repair may require trenching.

Excavating across the road (in Betio) is preferred as only compacting and resurfacing of the small excavated road surface area is required. In McKenzie this is not relevant, as the plant is located by the sea, no road needs to be crossed.

f) The 'No Project' Alternative

The no-project scenario is a continuation of the status quo, with continued reliance on contaminated harvested rainwater and on the limited groundwater resource in Bonriki/Buota, supplemented by continued use of contaminated shallow groundwater supplies in inhabited areas elsewhere. Without the project, the per capita water supply becomes increasingly restricted due to population growth and the effects of climate change, while contamination risks increase and public health outcomes worsen. The main implications of the no project alternative are that the current water shortage problem will worsen in the immediate future. Additional demand on the existing water reserves will increase to the level that it will no longer be able to sustainably supply potable water, if the current extraction rate continues from the freshwater lens source. The health risks that are related to insufficient and poor quality of water will increase. Additional climate change associated increases in sea level rise and the frequency of inundation events may catastrophically impact the present system of infiltration galleries, where groundwater is extracted for the current water system, as seawater inundation would render the shallow groundwater non-potable.

5.7 Project Benefits

The project uses a mix of approaches to increase the quantity, quality and availability of safe water in South Tarawa. A mix of approaches, including physical infrastructure and "soft" approaches such as behavioural change programs, is appropriate due to the complexity of the water issues faced in South Tarawa. The overall benefits of the Project will be increased access to potable safe water, and improved health and sanitation practices for the residents of South Tarawa.

a) Public Health Benefits

The project will provide new infrastructure to increase the supply of safe water to consumers on South Tarawa by 6,000 m3 per day. The project will provide a continuous 24 hours a day and 7 days a week potable water supply to all consumers at acceptable pressure and will ensure that residents have access to at least 57 lcd (litres per capita per day) of safe water, through 2040.

The additional clean water from the desalination plan and rehabilitated water infrastructure proposed in this project will ensure that the wider community have access to safer water and that the recommended 50 liters per person benchmark for ensuring low levels of health concern is achieved, limiting negative health issues that are related to poor water quality and insufficient quantity. The public health outcomes will be substantial as morbidity and fatalities from water borne disease in South Tarawa will be reduced. Continuous 24 hours a day and 7 days a week access to piped water will ensure residents do not have to resort to using contaminated groundwater supplies, and households have sufficient water available to meet needs for consumption, personal and food hygiene, laundry and bathing. This will in turn result in a reduction of waterborne disease, reducing the burden on the health system. The primary beneficiaries are communities in South Tarawa, particularly women and children.

The Project through a water, sanitation and hygiene (WASH) awareness program (WAP) will implement long-term coordinated and continuing behavioural change programs. It will work with the communities to improve sanitation practices and protection of the water reserve. It will increase community understanding of responsible water use, conservation and protection of water sources. Better health and education will result. It will also upgrade current sanitation services and provide an acceptable alternative to a costly expansion of sewerage systems across all of South Tarawa. The proposed WAP will also work with the Government in developing the required policies and legislation to facilitate an enabling environment for behavioural change programs.

Public awareness activities targeted at the wider community with special focus on women are likely to improve children's health and behavior, such as encouraging the use of hand-washing. The WAP will address household water treatment and safe storage as well as access to appropriate hygiene facilities for women and girls (such as hand washing facilities with soap and water and private menstrual hygiene management facilities) at home, at school and in clinics. Proper hygiene facilities will play an important role in enabling improved attendance for girls and female teachers in schools.

b) Socio-economic Benefits

For small islands, the major challenges with reverse osmosis are the production costs and the difficulty of finding and maintaining trained personnel. The issues faced in managing water in South Tarawa are complex, wide-ranging and diverse, but there are very few adequately trained people to deal with them. More vocational training and professional development opportunities will build capacity on the island and will reduce the financial risks of installing new infrastructure. Jobs will also be generated during project implementation and preference for employment in the project will be given to affected people or members of their families.

Improvement in health of individuals will also result in improved economic situation through people being more productive and reducing absenteeism. Furthermore, the project will reduce economic and social exclusion of poor and vulnerable groups by improving access to safe and reliable water supply in South Tarawa, where around 24% of the population is below the basic needs' poverty line. The primary beneficiaries are communities in South Tarawa, particularly women and children. Women will benefit from improved water supply via (i) reduced burden of collecting water from other sources and treating it through boiling; (ii) improved productivity with reduced incidence of sickness and disease among household members.

Additional socio-economic benefits include, improved planning, management, and sustainability of future water supply, improved development planning, and could result in increased tourism potential.

c) Environmental Benefits

The project will increase the resilience of the services to climate change by installing a system to provide freshwater to local residents, even if the freshwater aquifer becomes contaminated due to salt water inundation and by locating the new infrastructure at a suitable elevation above the current high tide level. Thus, the environmental benefits of the project are extensive, including also the reduction of leakages of pipes and the behavioural changes of people through increased awareness in environmental health and conservation and climate change resilience issues.

The project will incorporate a renewable energy component with the installation of the new Solar PV plant which will offset the energy requirements of RO and avoid additional greenhouse gas emissions as most energy in South Tarawa is produced from diesel. The project will also lead to increases in water conservation, both through reduced water losses and also through increased water conservation measures.

6 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

The mitigation and monitoring activities recommended in this ESIA are summarized in this Section. A draft environmental and social management plan (ESMP) has been prepared which includes the proposed mitigation measures to avoid, minimise, rehabilitate or compensate for negative impacts, and the monitoring and reporting requirements.

The ESMP contains the components crucial to effective environmental management of the project including: i) organizational responsibilities; ii) consultation and information disclosure; iii) GRM; iv) plan for mitigation of impacts; and, v) monitoring and reporting.

An ESMP is developed to achieve the following objectives:

- To reflect the environmental and social issues and impacts identified during project preparation;
- To implement and monitor mitigation measures within the construction areas; and
- To comply with the laws and regulations of the country and with international standards and best practice guidelines.

6.1 Institutional Arrangements

Implementation of environmental safeguards including environmental management provisions and requirements is a joint responsibility between the MISE and PUB and DBO contractor. The MFED will be the executing agency and will have the overall responsibility for ensuring that the project activities comply with the project agreements and covenants. The MISE and PUB, on behalf of MFED, will implement the project, including managing consultants and the contractor, according to the requirements. The supervision consultant will include an environmental specialist to support the PMU.

The MISE and PUB will be the implementing agencies and will have responsibility for subproject related activities including inter-ministry coordination. MISE retains responsibly for the environmental management and monitoring tasks of the project. MISE will exercise its functions through the PMU and is responsible for the project delivery and day-to-day project management activities. It is expected that the supervision consultant will be appointed for project implementation, to undertake environmental monitoring. MISE will be responsible for ensuring that the contractor does not start construction activities until requisite approvals have been received from MELAD-ECD, as required by the contract and by law.

After the completion of construction, PUB will be responsible for operations and ongoing maintenance of all assets.

a) Project Management Unit

The PMU will undertake environmental management and oversee monitoring tasks during the development and delivery of the project. The PMU specialists with the assistance of PIA consultant will assist in all aspects of implementation of the environmental assessment and permits as required:

- Ensure the updated ESIA including ESMP and any conditions of the environmental license are integrated into the project's bid and contract documents;
- Participate and facilitate, as per the project's stakeholder engagement and management plan (SEMP), consultations to advise affected communities of the scope and scheduling of the work;

- Depending on the environmental management experience of the contractor, prior to the preparation and submission of the construction ESMP (CESMP), provide induction whereby the details of the CESMP are confirmed, and the contractor informs the community of the schedule of works;
- Review the CESMP prepared by the contractor and provide recommendations for revision or strengthening as required. Upon receipt of the CESMP that can be approved, advise the Supervision/Resident Engineer that approval for commencement of works can be issued;
- Undertake regular site visits to independently inspect and audit the contractor's compliance with the approved CESMP and the supervision consultant's monitoring;
- Should non-compliant work or activities be identified, this will be raised to the Supervision/Resident Engineer who will issue a defect notice or corrective action request. All notices and requests will be recorded and reported; and
- Prepare and submit i) inputs to quarterly progress reports and ii) semi-annual safeguards monitoring reports.

Table 16 – Requirements and Tasks of ES

Environmental Specialist (ES) of PIA Consultant
Qualifications and experience. The specialist with a degree in environmental science, planning or engineering with at least 10 years' experience on project implementation. Experience in the Pacific and/or water sector projects will be an advantage. The consultant will demonstrate sufficient experience in: (i) preparing and reviewing/commenting on ESMP; and (ii) providing guidance and support to contractors on environmental management broadly and preparation and implementation of CESMP in particular.
Detailed tasks. (i) Provide guidance for the contractor's environmental, health and safety officer (EHSO) to deliver induction and training on the environmental management aspects of the project to the contractor; (ii) Guide the preparation of the CEMP, based on the EMP included in the environmental assessment report. The CEMP will include risk assessment based on the contractor's approach to the works and construction methodology, monitoring checklists, record sheets for written instructions and/or corrective actions requests; (iii) Ensure that the CEMP addresses the construction stage requirements of the project's stakeholder engagement and management plan (SEMP or CCP) with respect to notices and information to the public regarding advance notice for noisy or other activities (earthworks, equipment haulage, road closures etc); (iv) Ensure that the CEMP addresses the construction stage requirements of the project's grievance redress mechanism; and (v) Prepare guidance for monitoring and reporting on the compliance of the contractor with the CEMP. (vi) Assist in implementation of the project's stakeholder engagement and management plan (SEMP or CCP) and grievance redress mechanism (GRM); (vii) Provide assistance in resolving grievances (viii) Undertake inspections and audits of contractor's implementation of the approved CEMP. Advise the Engineer of any corrective action requests. (ix) Prepare inputs covering safeguards (including capacity building and consultations) to quarterly progress reports (x) Prepare and submit to MISE and ADB semi-annual safeguards monitoring reports

b) The Contractor

The Contractor will be responsible for translating the ESMP in the bid documents into their CESMP that reflects the methodology they will use to deliver the works. The CESMP will include all site specific and sub-plans as required. The contractor will engage an environmental specialist (ES) and a full-time environment, health and safety officer (EHSO) who will be responsible for implementing, and reporting implementation of, the approved CESMP.

The environmental management responsibilities of the contractor include:

- Recruiting a suitably qualified and full-time EHSO;
- Preparing and submitting for review and approval the CESMP. Coordinating with PMU and supervision consultant for updating the CESMP as/when required;
- Implementing the approved CESMP including addressing and resolving corrective action requests issued by the Supervision/Resident Engineer;
- Undertake noise measurements and establish the noise baseline for subsequent monitoring;
- Recruiting an approved service provider to deliver the STI/HIV/AIDS briefings and awareness and prevention program;
- Coordinating with PMU and supervision consultant in respect of continued community consultation, implementation of the GRM and information disclosure;
- Applying for permits/licenses as required for new materials sources and preparing and submitting extraction and management plans;
- Ensuring that all imported material and equipment is subject to quarantine clearance and receives appropriate phyto-sanitary certificates;
- Participating in joint inspections with PMU and supervision consultant as required;
- The ES/EHSO will maintain a site diary and GRM register (including actions taken to resolve the issue and close-out dates); and
- Including status of CESMP (including issue and response to corrective action requests), consultation activities and GRM implementation in the monthly reports.

The requirements and tasks for the **environment, health and safety officer (EHSO)** are given in the following tables.

Table 17 – Requirements and Tasks of Contractor's EHSO

Environment, health and safety offices (EHSO)
Qualifications and experience. The EHSO will have experience in environmental management including during project implementation. Experience in the Pacific and/or on water sector projects and a degree in environmental science, planning or engineering will be an advantage. The EHSO should have experience in: (i) establishing environmental management systems (database, checklists, corrective actions and close-out recording, and general reporting); (ii) inspecting compliance with the approved CEMP and environmental provisions of the contract including issuing notices of non-conformance and the like; and (iii) preparing the required reports.
Detailed tasks. (i) provide induction and/or training on the environmental management aspects of the project to workers; (ii) prepare checklists to assist in monitoring compliance with the approved CEMP; (iii) monitor and report on the compliance with the approved CEMP and complete monitoring checklists that will be compiled into the monthly reports prepared by the contractor; (iv) record (on checklist or other) the written instructions and/or corrective actions requests issued by the supervision consultant. Record all such notices, effectiveness of the rectification and date of close-outs; (v) coordinate and work with the PMU and supervision consultant to implement the project's communications and consultation plan with respect to notices and information to the public regarding advance notice for noisy activities and blasting (noise, road closures etc); (vi) coordinate and work with the PMU and supervision consultant to implement the project's grievance redress mechanism during the land clearing activities; and (vii) prepare and submit reports as agreed with the contractor and supervision consultant.

c) Environment and Conservation Department

The ECD is required to review the ESIA and environment license application and assist in monitoring construction activities against environment license conditions.

The ECD has been provided with capacity building and technical assistance programs, which have provided extensive policy and legislative improvements, practical training, mentoring and capacity building in all aspects of environmental assessment, monitoring and compliance. This has resulted in improved staff capacity to manage the roles and responsibilities and implement the CSS. Nevertheless, insufficient staff numbers (in the EIA section) and resources hamper capacity for enforcement and monitoring. It is therefore recommended that the supervision consultant provide mentoring and capacity building to the ECD as opportunities arise.

d) Summary of responsibilities in environmental management

A summary of various parties' responsibilities for environmental management in the project is provided in **Table 18**.

Table 18 – Environmental Management Responsibilities

Project stage	Responsible agency	Responsibilities
Feasibility studies, detailed design & review and project approval	PMU	Review designs prepared as part of ongoing project and complete detailed design. Update feasibility study including safeguards due diligence as required. Update ESIA and ESMP based on detailed design. Format ESIA as per CSS and submit environmental license, include updated ESMP and environmental license conditions in bid and contract documentation.
	ADB, WB	Prepare documents package for Board review (incl. TORs and project conditions, covenants in project agreement). Board approval of project. Assist government to recruit supervision consultant.
Pre-construction	PMU, PIA Consultant	Include environmental safeguards specialist as part of PIA consultant team. Assist PMU to implement the project's CCP. Ensure updated ESMP and any conditions of environmental license are included in the bid and contract documents. Include TOR for DBO contractor's ESHO. Prior to works commencing ensure the baseline conditions are benchmarked and recorded—including noise—as required by the ESMP for subsequent monitoring. Provide inputs to the bid evaluation in respect of contractor's response to the ESMP requirements including the suitability of the EHSO proposed as part of the contractor's team.

Project stage	Responsible agency	Responsibilities
		Provide induction training to the contractor prior to the preparation and submission of the contractor's CESMP and as required work with the contractor's EHSO to identify appropriate construction methodologies and detailed site-specific mitigations.
		with the contractor's EHSO to identify appropriate construction methodologies and detailed site-specific mitigations. Review and approve the contractor's CESMP and advise supervision PIA consultant Engineer of approval to trigger "no objection" to commencement of activities/works.
	ADB, WB	Provide comments on the CESMP and proposed monitoring checklists.
	Contractor	Recruit suitably qualified full-time EHSO. Prior to any works commencing, prepare CESMP including the site-specific plans, work method statements and construction methodologies and GRM.
	Contractor (continues)	Submit CESMP to PMU and supervision consultant for review and approval/clearance (revising as necessary if required). The CESMP has to be submitted clearance at least 30 days prior to commencement of construction activities (including any site clearance); The CESMP has to include: • detailed management measures and monitoring plan required for the pre-construction, construction and O&M stages of the works; • respond to all conditions included in the environmental license; • detailed organizational set-up and communication/reporting channels, budget and resourcing, general approach to the works, work statements/methods, site-specific EMPs for sites and activities, and sub-plans. Identify materials and equipment sources and apply for BMP for new sources and clearance consents and compliance certificates for imported materials and equipment. Provide pre-mobilization induction on CESMP (incl. OHS) to employees. Recruit approved service provider to provide STI/HIV/AIDS awareness and prevention training for workers and community.
Construction	Contractor	Inclusion of EHSO as part of core team. Provide ongoing training, awareness and "tool box" sessions for workers. Implementation of CESMP. Implementation of CCP and GRM as pertains to construction. Reporting of CESMP and GRM implementation in monthly reports. Implementation of corrective actions as requested by Engineer.

Project stage	Responsible agency	Responsibilities
	PMU, PIA Consultant	Supervise, monitor and report on contractor's implementation of CESMP and all other contractual obligations. Enforce contractual requirements. Audit construction phase through environmental inspections and review monitoring reports and data. Submission of quarterly progress reports and semi-annual monitoring reports. Work with contractor EHSO for provision of awareness/training to workers and information transfer to contractor as required.
	ADB, WB	Undertake regular review missions. Review monitoring reports. Disclose project information as required.
	ECD	Ensure compliance with government requirements. Review complicated issues, if any, arising from the project. Participate in monitoring.
Operation	PUB	Provide budget to undertake maintenance activities and operation stage environmental monitoring as required by ESMP.
	Maintenance contractor	Undertake environmental monitoring and prepare bi-annual reports. Prepare maintenance reports to adaptively manage environmental risks related to operations (per ESMP).

6.2 Environmental and Social Management Framework and Management Plan (ESMP)

This chapter describes the issues and mitigation measures for potential negative environmental impacts, and mitigation responsibilities. The applicant is committed to the measures and if unexpected adverse impacts occur, contact will be made immediately with the Principal Environmental Officer (MELAD).

a) Mitigation

The recommended mitigation measures are defined in the environmental management plan tables (ESMP matrix, **Table 19**, **Table 20** and **Table 21**), starting with the actions required during the design or pre-construction period, followed by the construction period and finally the operating period of the desalination plants.

The pre-construction period measures relate to planning items to prevent impacts to the community, longevity of infrastructure, and cultural and heritage important sites. During pre-construction, measures to facilitate compliance with environmental regulations and provide environmental and social protection and monitor the same will be implemented. During the construction period, mitigation actions should be undertaken, all related to the construction and instalment of the SWRO desalination plant and solar PV system, trench for the main pipelines and large storage tank and waste management. The safety of workers and the public is also addressed. In the operation stage, the environmental management obligations become the responsibility of the proponent, MISE, and the operator, PUB.

b) Monitoring

The ESMP tables (ESMP matrix on the following pages), also list the actions to be undertaken to monitor effectiveness of the proposed mitigation measures and to record compliance by the contractor. The monitoring actions are aligned with the mitigations. The process is important to ensure safeguards are implemented and any unexpected impacts are responded to swiftly and appropriately. The monitoring cost is summarized in Table 22.

Monitoring during construction will focus on inspecting work sites to confirm construction, waste and fuel management is according to specifications and acceptable standards specified in the contractor's country of origin (if Kiribati standards do not exist), and that the safety of the workers and the public is upheld. Both compliance and effects monitoring actions should take place as part of day to day construction supervision, and will be the primary responsibility of the contractor, supervised by the Supervising Engineer. A site inspection checklist shall be taken into use, looking at housekeeping, waste management, chemical storage, worker safety etc and will cover project close-out ensuring that all waste and plant has been removed, disturbed land revegetated. The checklist will cover the items listed in the ESMP.

During the operation phase, monitoring is the responsibility of PUB, the operator of the newly installed and upgraded infrastructure. The objectives of monitoring are to (i) quantify that sufficient dilution of the disposed waste brine is attained through a well maintained and functioning diffuser after construction and over time, (ii) maintain the performance of the infrastructures at prime level to reduce potential environments impacts and safeguard issues that could arise from the failing systems, (iii) ensure workers adhere to correct and safety operation procedures (iv) ensure wastes generated during the operation are disposed safety (v) water generated from the desalination plant and pumped from the water reservoirs is safe

for consumption and (vi) understand the contribution of the improved water quality to waterborne diseases, and trends in relations to reduce use of unsafe water.

The salinity level should be monitored monthly for six months after the plant is running at 80% capacity to take account of variation in season, tides, currents and any other factors that affect the performance of the outfall. The salinity level should be taken at seabed level and mid depth, at point of discharge, 10m, 20m and 50m on either side of the point of discharge parallel to the reef edge and identified as offshore sites; at 5m from the reef edge at mid- depth perpendicular to the offshore sites; and two locations mid-way between the shore and the reef edge along the outfall pipeline route. Obtaining feedback from local communities on fishing catch from and adjacent to the outfall site will form the baseline data on fishing effort and catch of the area. The Fisheries Department has done a lot of work on social economic surveys related to arsenal fisheries, their involvement will be paramount in the success of data collection and analysis. If the water quality data for six months confirms the modelling studies, no further sampling is recommended, as the sampling will require a dive team and boat which is onerous and impracticable on the long run.

c) Reporting

The reporting will be undertaken at all levels. The contractor will prepare monthly reports and these will include status of implementation of the approved CESMP and be submitted to the PMU. These reports will contain a summary of corrective action requests issued by the Supervising Engineer. The PMU will prepare quarterly progress reports (QPR) which will include a section on safeguards implementation. The PMU will also prepare and submit to MFED and ADB/WB the semi-annual safeguards monitoring reports which will summarize results of inspections, contractor monthly reports and the QPR. The semi-annual safeguards monitoring reports will be disclosed.

d) ESMP Matrix

The following tables provide the ESMP matrix for the project.

Table 19 – ESMP – Design and Pre-construction

Project activity or environmental issues	Mitigation and Management – Pre-construction		Monitoring			
	Mitigation Measures	Implementation Responsibility	Verification	Timing/ Frequency	Responsibility	
					Implementation	Oversight
Environmentally responsible procurement (5.1 a)	Land acquisition and lease issues resolved, and agreements reached. Provisions for land access and compensation mechanisms for clearing of fruit bearing trees, vegetables and if permanent structures are damaged or removed should be addressed adequately; All subprojects will pass through the CSS/SEMP. The ESIA report is prepared on behalf of the executing agency and reviewed by the ECD within MELAD and the development partners. ECD issues environmental license for the project; The project ESMP is integrated into the bidding documents. Obtaining plans from the PUB showing the locations of utilities and infrastructure (power, telecom, other) and consultation with residents and/or landowners on the relocation of utilities prior to commencing excavation operations. Ensure ESIA and updated ESMP incorporated into bid and contract documents. Require Project ESMP as basis for CESMP to be prepared by contractor and reviewed and cleared by PMU; Contractor to recruit environmental health and safety officer (EHSO) and prepare CESMP for	PMU/GOK (compensation /lease payment and ECD); PDA Consultant / ECD PDA Consultant Contractor PIA Consultant/ Contractor	Land DDR cleared; Environmental license; Bid & contract documents; Contractor's staff contracts – fulltime works' supervisors and EHSO (and deputy) recruited;	Prior to works commencing - once	PMU	MISE, (PIA) ADB/WB

Project activity or environmental issues	Mitigation and Management – Pre-construction		Monitoring			
	Mitigation Measures	Implementation Responsibility	Verification	Timing/ Frequency	Responsibility	
					Implementation	Oversight
	PMU clearance prior to commencement of works; Contractor will appoint an experienced site supervisor at each works site; If required, PMU to provide support to contractor during CESMP preparation.		Approved CESMP			
UXO survey and clearance/disposal (5.1 b)	Survey for UXO will be undertaken. The TOR for the survey (and disposal) will be prepared by the supervision consultant supporting the PMU;	PMU + UXO specialist team as required	Survey; TOR; Results of UXO monitoring;	Note: UXO survey has been carried out for Betio drilling sites during the PDA in 2019. No UXO detected.		
	Should UXO be identified, these will be disposed of following established government and police protocols and procedure;					
Use of land (temporary) outside lease area – working and laydown areas (5.1 c)	Laydown sites to store containerized building materials may be required outside the project sites - use of GOK leased land or state land should be arranged, or negotiated with land owners if private land to be utilized; The project RF and draft RP includes provisions for this temporary use and will need to be complied with by contractors; Separate approval may be required by the ECD and needs to be sorted and cleared prior usage of any land.	PMU/GOK (compensation / lease payment and ECD); Supervising engineer; Contractor	Land DDR cleared; Environmental license; Signed lease/agreements	Prior to works commencing – as required	PMU; Contractor	MISE, ADB/WB

Project activity or environmental issues	Mitigation and Management – Pre-construction		Monitoring			
	Mitigation Measures	Implementation Responsibility	Verification	Timing/ Frequency	Responsibility	
					Implementation	Oversight
Climate change and natural hazards risks (5.1 d)	Planning new infrastructure at a suitable elevation above the current high tide level (utilizing accurate topographic survey); Ensuring new infrastructure is designed to withstand extreme weather events, such as sea water inundation; Selection of renewable system (solar PV) in the design of power supply to support desalination facility; and Design system to provide treated, safe water to reduce the requirement for consumers to boil water for treatment using green-house gas emitting sources.	PMU	Surveys; Design reports	During detail design period	PMU (specialists as required)	MISE, ADB/WB

Table 20 – ESMP – Construction

Project activity or environmental risk	Mitigation and Management - Construction		Monitoring			
	Mitigation Measures	Responsibility	Verification	Timing/ Frequency	Responsibility	
					Implement ation	Oversight
Well construction (5.2 a)	Planning for well-depths below the freshwater lens; Proper procedures for well-casing installation; Monitoring of freshwater lens salinity levels; and Develop erosion and sedimentation control plans.	Contractor; Supervising Engineer	Well logs	As required throughout works period	PMU/PIA consultant	MISE, ADB/WB
Obtaining construction materials and need for aggregates – risk of introduced alien species (5.2 b)	Local aggregates if required can be sourced from Te Atinimarawa Company Limited; Quarantine clearance to be obtained from the concerned authority for any imported aggregates and plant; Pipes that are associated with the desalination plant will be prefabricated and purchased by the project and will be either stainless steel or plastic; No additional mining for aggregate or other materials will be conducted by the project. Inspect the local gravel take to ensure that it is in line with ADB/WB policies and local legislation.	Contractor; Supervising Engineer	Contract for local materials; Phytosanitary clearances for imported materials and plant	As required throughout works period	PMU/PIA consultant –	MISE, ADB/WB
Earthworks and vegetation clearance (5.2 e)	Erosion and sediment control plan will be completed prior to the commencement of civil works and mitigation measures implemented accordingly. Ensure survey of proposed locations of desalination plant, solar PV system and water supply infrastructure identifies and avoids	PMU/PIA consultant; Contractor	Approved report; Marked survey plan and trees to be retained clearly marked on site	Prior to works commencing – as required	PMU/PIA consultant	MISE, ADB/WB

Project activity or environmental risk	Mitigation and Management - Construction		Monitoring			
	Mitigation Measures	Responsibility	Verification	Timing/ Frequency	Responsibility	
					Implement ation	Oversight
- impact on terrestrial ecosystems	important sites and minimizes footprint to reduce requirement for vegetation clearing (vegetation to be retained/protected clearly marked). Ensure the trees that are to be cut (in McKenzie) will be compensated to the owner as per the local regulations.					
Installation of brine disposal pipe, permeate delivery, and upgrading of the reticulated system causing damage to property and plant and disturbing residents (5.2 d)	Contractor will appoint an experienced site supervisor at each works site; Undertaking condition survey prior to any works and planning to avoid damage to property and plant; ensure that no mangroves will be removed. At the start of the works the contractor will file a checklist confirming that necessary pre-planning was completed; Site rehabilitation upon completion - refurbishing of road and disturbed ground to original status. Apart from the road, disturbed grounds resulting from earth works will be refilled, vegetation and trees removed along the trenching route will be replaced where appropriate.	Contractor; Supervising Engineer	Works supervisors appointed; Condition survey; Completed inspection checklists; Sites rehabilitated to agreed standard	During installation	PMU/PIA consultant	MISE, ADB/WB
Use of outfall for brine disposal - overflow and spillage of raw sewage from sump at the outfall pump	Installing a by-pass pipe to allow continuous outflow of the sewage while desalination waste pipeline is connected to the sewage outfall; Accounting for the likely overflow and spillage problems in the CESMP;	PMU; Contractor	Design report and technical specifications for pipe upgrading; CESMP	Prior to and during works	PMU/PIA consultant	MISE, ADB/WB

Project activity or environmental risk	Mitigation and Management - Construction		Monitoring			
	Mitigation Measures	Responsibility	Verification	Timing/ Frequency	Responsibility	
					Implement ation	Oversight
(Betio) (5.2 c)	Having qualified personnel on site to oversee the upgrading work. Contractor to engage an experienced marine ecologist, to guide (i) a survey of coral formations in the path of the outfall and (ii) removal and relocation of live coral Contractor to ensure that the Contractor's Environmental Management Plan (CEMP), prepared as part of the design for the facility includes (i) engaging an experienced marine ecologist to guide the survey of coral formations in the path of the outfall and process of removal and relocation to thrive at a nearby site, (ii) marking the work area with buoys (iii) use of a light weight, rubber tracked excavator for trench formation, (iv) particulars for removal of construction waste including provision for hazardous materials and prohibition of sea dumping and (v) a site safety plan, to include, in additional to general requirements, specific measures that reflect the hazard posed by the high energy environment at the intertidal platform edge, such as specification of an appropriate vessel with adequate anchor or spud for such environments. Adoption of the construction methodology specified in the bid documents.					

Project activity or environmental risk	Mitigation and Management - Construction		Monitoring			
	Mitigation Measures	Responsibility	Verification	Timing/ Frequency	Responsibility	
					Implementation	Oversight
Impacts to marine ecosystem of outfall pipe construction (McKenzie) (5.2 d)	Finding environmentally friendly way of pipeline layout Having qualified personnel on site to oversee the upgrading work.	PMU; Contractor	Design report and technical specifications for pipe upgrading; CESMP	Prior to and during works	PMU/PIA consultant	MISE, ADB/WB
Impacts from water infrastructure improvements	Erosion and sedimentation control plans should be developed; Use of stormwater best management practices (BMPs).	PMU; Contractor; Supervising Engineer	Design report; CESMP	During detail design period – prior to installation	PMU/supervision consultants	MISE, ADB/WB
Encroachment on private property or permanent use of site. (5.1 e)	Consultation with and written approval from land owners for access when intrusion on to private properties is inevitable; Formulation of lease agreements in cases where the sites are not leased by GOK.	Contractor	Signed agreements and/or leases as required	Throughout construction as required	PMU/Supervising Engineer	MISE, ADB/WB
General risks associated with all construction activities						
Climate Change impacts e.g. greenhouse gas emissions from vehicles (5.2 f)	Construction vehicles, equipment, and generators will be serviced regularly to reduce emissions. Locating construction plant and equipment inland away from the shoreline is required to minimise risk of loss or damage from ocean inundation	Contractor; Supervising Engineer	Maintenance records; Site inspections / completed site inspection checklists	Throughout construction as required	PMU/Supervising Engineer	MISE, ADB/WB

Project activity or environmental risk	Mitigation and Management - Construction		Monitoring			
	Mitigation Measures	Responsibility	Verification	Timing/ Frequency	Responsibility	
					Implement ation	Oversight
Noise nuisance from construction (5.2 f)	Restricting the working hours to between 0800 hrs. and 1700 hrs. from Monday to Friday, or Saturday if there is a need to work on the weekend, this is important, especially in areas where residential dwellings are located adjacent to the construction area, as in the desalination construction area and the upgraded water supply infrastructure. Use of vehicles, plant and equipment, that comply with international standards for construction equipment noise emission, such as Part 204 of US Federal Regulations Noise Emission Standards for Construction Equipment (40 CFR 204)). Verification of such compliance from the country of origin is required. The CESMP will include measures to meet the requirements of the WB's Environmental Health and Safety Guidelines (EHSG). Maintenance repair should also be routinely performed during the construction phase and making the record available whenever needed to the concerned authority.	Contractor	Workers allocated and wearing PPE; Complaints register; Vehicle and plant maintenance records	Throughout construction	PMU/Supervising Engineer	MISE, ADB/WB

Project activity or environmental risk	Mitigation and Management - Construction		Monitoring			
	Mitigation Measures	Responsibility	Verification	Timing/ Frequency	Responsibility	
					Implementation	Oversight
Dust generation and nuisance (5.2 f)	Daily spraying/wetting of the access roads, sites (including excavated trenches for water supply network upgrades) material and stockpiles; Locations for stockpiles of materials or waste materials will be approved by the PMU/supervision consultant and by the ECD if required; Loose materials hauled to/from sites will be secured with a tarpaulin to prevent debris; Ensure emissions are minimal through standardized site management such as dust watering or stockpile covers. Removal of spoil to stockpile sites or use as refill material; Contractor will provide equipment that conforms to international emission standards, verified by emission test certificates and maintenance records, as in the case of control of black smoke emissions.	Contractor	Designated stockpile areas approved; Workers allocated and wearing PPE; Dust plumes; Complaints register; Vehicle and plant maintenance records; completed site inspection checklists	Throughout construction	PMU/Supervising Engineer	MISE, ADB
Localized impacts on terrestrial ecology -	Identify trees and vegetation to be removed on survey plan, plan will be approved by Supervising Engineer;	Contractor Supervising Engineer	Phytosanitary clearances for	Prior to and during clearance	PMU/Supervising Engineer	MISE, ADB/WB

Project activity or environmental risk	Mitigation and Management - Construction		Monitoring			
	Mitigation Measures	Responsibility	Verification	Timing/ Frequency	Responsibility	
					Implement ation	Oversight
vegetation cleared and/or affected during construction (5.2 f)	Mark trees and vegetation to be removed (with fluorescent paint or tags) as per plan; Only trees and vegetation marked on plan to be removed. All trees and vegetation removed, and any others affected during the installation of the solar PV system and excavation work will be compensated in accordance with GOK schedules; Prohibition of burning vegetation and residual bushes and grasses when clearing planting sites; Only cutting flora which are a direct obstacle to project infrastructure works; All vessels carrying equipment and materials for the project will be subject to inspection by agriculture quarantine inspectors.		imported materials and plant; Survey plan and protected trees marked on-site; Compensation paid for productive trees removed	works and earthworks		
Ecological impacts associated with spillage of hazards material during construction (5.2 f)	Regular checks for leaking oil or fuel from machinery, ensuring that any leaks are promptly repaired and/or parts replaced within two days as part of maintenance of vehicles and equipment to international standards; and Contractor will implement the measures identified to mitigate the impacts from storage and spillage of hazardous substances and other chemicals and materials.	Contractor	CESMP; Secured storage area (concerted and bunded); Spill kit and worker training records; completed site inspection checklists	Throughout construction	PMU/Supervising Engineer	MISE, ADB/WB

Project activity or environmental risk	Mitigation and Management - Construction		Monitoring			
	Mitigation Measures	Responsibility	Verification	Timing/ Frequency	Responsibility	
					Implement ation	Oversight
Generation of wastes and waste management (5.2 f)	Prepare a solid waste management plan as part of the CESMP; Separate and store wastes with respect for health and environment. Identify any waste that can be reused or recycled; Contain all stored wastes in secure receptacles within construction sites and the compound, avoiding littering and runoff; No waste is to be burned; Workers will be advised that littering will not be permitted. Waste generated construction activities at sites will be cleared and disposed of as per the above; Use recycled or renewable building materials (e.g. timber) where possible; Optimize and reduce waste production. Avoid mix of different waste and minimize waste disposal into the approved dumping area or landfill.	Contractor	Solid waste management plan as part of CESMP; completed site inspection checklists	Throughout works	PMU/Supervising Engineer	MISE, ADB/WB

Project activity or environmental risk	Mitigation and Management - Construction		Monitoring			
	Mitigation Measures	Responsibility	Verification	Timing/ Frequency	Responsibility	
					Implement ation	Oversight
Transport, storage and use of hazardous materials (5.2 f)	Contractor prepare plan as part of CESMP; All fuels or other potentially hazardous materials will be stored at secure and managed sites (bunded and concreted floor and walls), identified by the contractor and approved by the PMU/supervision consultant. Fuel and oil to be stored in bunded and concreted areas with 110% capacity; All chemicals will be clearly labelled. Spill kit, appropriate to the hazardous materials being used, to be kept on-site and workers to be trained in its deployment; Regular checks for leaking oil or fuel from machinery, Ensuring that any leaks are promptly repaired and/or parts replaced within two days as part of maintenance of vehicles and equipment to international standards; Any surplus hazardous materials shall be removed from the island when the contractor demobilizes. The contractor's workshop will have clearly marked waste disposal bins to store filters, rags and waste oil, for disposal at the landfills; All asbestos concrete pipe disposal will be supervised by a competent person, trained in asbestos abatement. Pipe sections will be wrapped and marked with the cautionary statement "Danger Asbestos-Containing Material". The pipe sections will be buried at an authorized location.	Contractor, Supervising Engineer	CESMP; Secured storage area (concerted and bunded); Spill kit and worker training records; Records of safety briefings; Completed site inspection checklists	Throughout works period	PMU/PIA consultants	MISE, ADB/WB

Project activity or environmental risk	Mitigation and Management - Construction		Monitoring			
	Mitigation Measures	Responsibility	Verification	Timing/ Frequency	Responsibility	
					Implementation	Oversight
Materials and plant haulage - traffic disruption and pedestrian safety risk (5.2 f)	Contractor to prepare a traffic management plan as part of the CESMP; Advance notification (through radio and newspaper) to advise road closures, detours and the like to facilitate work activities.		Traffic management plan as part of approved CESMP; Traffic control measures implemented; Signage and barriers installed as required	Throughout construction	PMU/Supervising Engineer	MISE, ADB/WB
Occupational and community health and safety impacts (5.2 f)	Contractor to prepare health and safety plan, complying with the EHSG, as part of CESMP; including: • personnel being appropriately qualified on OHS; • training of workers; • first aid and evacuation / hospitalization procedures; • identification of hazards and measures to avoid them at individuals worksites • regular safety checks of vehicles and plants; • hazard warning signs; • proper transport of materials	Contractor	Health and safety plan as part of approved CESMP;	Throughout construction	PMU/PIA consultant	MISE, ADB

Project activity or environmental risk	Mitigation and Management - Construction		Monitoring			
	Mitigation Measures	Responsibility	Verification	Timing/ Frequency	Responsibility	
					Implement ation	Oversight
Foreign and non-Tarawa workers - social conflict (5.2 f)	Contractor to provide information on Kiribati culture (obtained from PMU) to the expatriate workers; Contractor Code of Conduct to be agreed and implemented at all times. A satisfactory code of conduct will contain obligations on all project staff (including sub-contractors and day workers) that are suitable to address the following issues: • Compliance with applicable laws, rules, and regulations of Kiribati • Compliance with applicable health and safety requirements (including wearing prescribed personal protective equipment, preventing avoidable accidents and a duty to report conditions or practices that pose a safety hazard or threaten the environment) • The use of illegal substances • Non-Discrimination (for example on the basis of family status, ethnicity, race, gender and religion) • Interactions with community members (for example to convey an attitude of respect and non-discrimination) • Sexual harassment (for example to prohibit use of language or behavior that is inappropriate, harassing, abusive, sexually provocative, demeaning or culturally inappropriate)	Contractor	Agreed code of conduct; GRM register; Meetings and information brochures to community; Records of workers – hours and wages paid (by aged and sex); Records of delivery of STI/HIV/AIDS awareness and prevention training; Completed site inspection checklists	Throughout construction	PMU/PIA consultant	MISE, ADB

Project activity or environmental risk	Mitigation and Management - Construction		Monitoring			
	Mitigation Measures	Responsibility	Verification	Timing/ Frequency	Responsibility	
					Implement ation	Oversight
	• Violence or exploitation (for example the prohibition of the exchange of money, employment, goods, or services for sex) • Protection of children (including prohibitions against abuse, defilement, or otherwise unacceptable behavior with children) • Sanitation requirements (for example, to ensure workers use specified sanitary facilities provided) • Avoidance of conflicts of interest (such that benefits, contracts, or employment, or any sort of preferential treatment or favors, are not provided to any person with whom there is a financial, family, or personal connection) • Respecting reasonable work instructions (including regarding environmental and social norms) • Protection and proper use of property (for example, to prohibit theft, carelessness or waste) • Non retaliation against workers who report violations of the Code, if that report is made in good faith.					

Table 21 – ESMP – Operation

Project activity or environmental risk	Mitigation and Management – Operation Stage		Monitoring			
	Mitigation Measures/Parameter	Responsibility	Verification/ Timing	Frequency	Responsibility	
					Implement	Oversight
Use of fossil fuel and greenhouse gas emission (5.3 a)	Installation of solar PV system to compensate for the energy used by the desalination system; Provision of safe, treated water to customers that reduces requirement for boiling water and associated greenhouse gas emissions.	PUB/MISE	Records of performance levels, e-coli and chlorine residuals	During operations	ECD (MELAD)	GOK
Impacts associated with the failure of the solar plant	Fences with lockable gates. Regular maintenance (preventive and corrective) The building contractor should be obligated to provide a relevant training program to the operators. The training will ensure that the infrastructure is operated according to the intended safe procedure, and that preventive and corrective maintenances are undertaken appropriately. Diesel generators as backup power supplies proposed for the following locations. • Betio desalination plant • McKenzie desalination plant • Betio maintenance depot • Each of the four customer service centres	PUB/MISE	Lack of failure and complaint from the public	During operations	PUB/MISE	GOK
Generated waste (5.3 a)	Minimize wastes, where possible. Spent filter cartridge and other solid wastes from the desalination plant will be disposed at the Betio landfill through routine collection by the Betio Town Council or by PUB whenever needed. On site waste bins will be provided.	PUB	Record of disposal date and volume per waste category	During operations	PUB/MISE	
Impact of brine disposal on marine water quality and	Dispose of brine at the Betio plant via the existing sewerage outfall, which is at 30m depth.	PUB/MISE	Ambient salinity level is attained near the reef	During operations	PUB/MISE	GOK

Project activity or environmental risk	Mitigation and Management – Operation Stage		Monitoring			
	Mitigation Measures/Parameter	Responsibility	Verification/ Timing	Frequency	Responsibility	
					Implement	Oversight
marine ecosystem (5.3 b)	Upgrade sewage outfall including 14 diffuser ports allow more rapid mixing in Betio;. Require design and build contractor to install a diffuser that causes rapid mixing of the brine, returning to ambient levels within 10m from the point of discharge, as substantiated by dispersion modelling.		and on the reef flat			
Impacts associated with the failure of the desalination plant (5.3 b)	Fences with lockable gates, lockable manhole for underground water valves and visible signs indicating danger and restricted areas are displayed visibly to the public; Regular maintenance (preventive and corrective) The building contractor should be obligated to provide a relevant training program to the operators. The training will ensure that the infrastructure is operated according to the intended safe procedure, and that preventive and corrective maintenances are undertaken appropriately. Use of full SCADA controls and associated alarms. Having tankers for emergency use (water from Bonriki).	PUB/MISE	Lack of failure and complaint from the public	During operations	PUB/MISE	GOK
Quality of drinking water produced through desalination & brine dilution (5.3 b)	Regular inspection and maintenance Water testing for salinity and harmful pathogens; Inform the public to boil water when chlorination system fails or presence of harmful level of pathogens is detected in the system	PUB/MISE	Reduce trend in disease related to unsafe water	Monthly for drinking water; and after 80% operation monthly in first 3-6 months for testing of brine dilution at outfall	PUB/MISE	GOK

Project activity or environmental risk	Mitigation and Management – Operation Stage		Monitoring			
	Mitigation Measures/Parameter	Responsibility	Verification/ Timing	Frequency	Responsibility	
					Implement	Oversight
				monitoring sites; after that annually		
Impact of solid/waste disposal (5.3 b)	Minimize waste. Regular disposal of waste (eg. used filter cartridges) at Betio landfill. Securely store on-site waste in bins provided.	PUB	Completed site inspection checklists	During operations	MISE/MELAD/OB / Min. of Health and Medical Services	GOK
Impact of additional water supply on existing wastewater systems / Increase of greywater production and disposal (5.3 b)	Encourage that wastewater plumbing in all households are connected to the sewerage system where available; Increase of greywater is an impact that has been considered being outside the scope of the STWSP. It is a major issue though and needs to be focused in the forthcoming Sanitation Roadmap Addendum study and sanitation projects following from that. It shall be ensured that all households in the non-sewered area have proper drainage system for the bathroom, laundry, kitchen and toilet to the septic tank or designated disposal location; and Ensure that septic tanks are emptied by vacuum truck and disposed at a nearby sewage outfall at appropriate intervals.	PUB/MISE	Records.	During operations Timing of the sanitation study: 2020	PUB/MISE	GOK

Project activity or environmental risk	Mitigation and Management – Operation Stage		Monitoring			
	Mitigation Measures/Parameter	Responsibility	Verification/ Timing	Frequency	Responsibility	
					Implement	Oversight
Chemical use and disposal (5.3 b)	Proper handling practices e.g. lifting chemicals on ladders or temporary platforms is not permissible. Develop a manual for the storage and handling of chemical cleaning products. Proper chemical labelling; Safe storage practices e.g. in lockable sealed building; Signs showing correct procedures; Staff handling training; Store chemical wastewater in sump; and Slowly discharge neutralized solution into the brine so that discharge complies with environmental requirements. Chemicals will be handled, stored and disposed in accordance to their SDS/MDS.	PUB/MISE	Number of accidents	During operations	PUB/MISE	GOK
Nuisance & noise (5.3 b)	Desalination warehouse is installed with acoustic packages (noise reducing materials); observe IFC guidelines for noise	PUB/MISE	Record of public complaints	During operations	PUB/MISE	GOK
Odour (5.3 b)	There will be some odour from the groundwater pumped from the bores, as noticed during the drilling study, but is minimal and not noticeable beyond a few metres. This was assessed during the trial bores.	PUB/MISE	Record of public complaints	During operations	PUB/MISE	GOK
Occupational health and safety	Develop an OHS manual for the operation of the desalination plant and chemical cleaning process. Contractor must complete their own health and safety plans	PUB/MISE	Number of accidents	During operations	PUB/MISE	GOK

e) Capacity of Proponent and Operator - Monitoring

PUB and MISE are obligated to ensure all monitoring needs are undertaken as expected in accordance with the assigned schedule. Establishing a safeguard post within PUB to implement all safeguard measures or assigning the duty to an existing staff member that will implement the measures after the construction phase and beyond is essential. Training should be incorporated as part of the project.

The proposed monitoring activities are within the capacity of PUB except for the visual inspection and sampling of the outfall and diffuser ports which requires SCUBA diving for inspection. There are several certified SCUBA divers on the island who can carry out the inspection work with a cost ranging from $6,000 - $8,000 per year (according to PPTA 2018). The cost includes boat hire, fuel cost, hire of SCUBA gears, and inspection fee. The indicative cost of water quality monitoring by PUB and MHMS is provided in the following table.

Table 22 – Summary of Water Quality Monitoring Costs (covering desal and network)

Impact to be monitored	Means of Monitoring	Operation		
		Frequency	Responsible Agency	Indicative annual cost (USD)
Water Quality	Laboratory testing of water quality in the distribution network	24 tests annually from each zone	PUB/Contractor but testing to be undertaken by MHMS	26,000
	Salinity test for brine dilution and drinking water. Cost of testing machine and probe	Regular for drinking water and monthly for testing of brine dilution at outfall monitoring sites	PUB	5,000
	Socio-economic survey on arsenal fisheries impacts	Annual	PUB in collaboration with Fisheries Department	2,000
Implementation of safeguards	Recruitment of new staff and training		PUB	10,000

Water quality will be monitored based on WHO guidelines.

Whilst a capacity needs assessment for ECD/MELAD has not been conducted as part of this ESIA, as ECD is responsible for monitoring the work progress to ensure compliance with the license conditions it is recommended that any monitoring capacity development activities for monitoring for the PUB are also extended to include ECD and ensure collaboration between the ECD and PUB. Capacity building during implementation

The capacity building during implementation shall include the following:

- Provide orientation for the contractor, PMU, MISE and MELAD personnel on safeguard measures, including implementation of the Environmental Management Plans (EMP), Safety Management Plan and Resettlement Plans;
- Provide training for PUB, MISE staff responsible for designing and implementing safeguard measures to ensure these are well understood and implemented effectively;

Comprehensive training plan shall be prepared in the beginning of the project implementation. PIA consultant will arrange the training together with PMU.

6.3 Grievance Redress Mechanism

The STWSP under the PDA has established a grievance redress mechanism (GRM) for any matters related to project design, construction and operation. From a safeguard's perspective, members of the public may perceive risks to themselves or their property or have concerns about the environmental performance of the project. These issues may relate to construction and operation and therefore they will have rights to file complaints for the contractor, PUB and the MISE to address promptly and sensitively, and for complaints to be made without retribution.

The GRM process established is not only compliant with safeguards requirements from donors, but also with national legislation. The implementation of social safeguards following ADB and WB policies calls for the implementation of best practices, one of them being the need for an internal feedback and grievance redress mechanism to be effectively available. The GRM process was prepared by FCG during the PDA and in close consultation with the STWSP Community Engagement Team and the STWSP' PMU. A separate document has been prepared (and attached to RP) describing and guiding the GRM. The MISE Public Relations officer was nominated in September as the GRM Officer in charge of receiving and facilitating the grievances. At the time of completion of this report no grievances had been lodged.

The GRM was established during the PDA stage as minor site works required for the detail design have taken place. As part of the detail design test bore holes were drilled at the two desalination plant sites, Betio and Mackenzie. Prior to the commencement of these works the GRM process was finalised and put in place. Sign boards were erected on these sites and contact details of the STWSP Project Management Unit (PMU) provided. It was recommended by the PDA team for the GRM to be positioned within the PMU as this is the organisation mandated with the power to coordinate all project related activities, structures and systems.

During construction, the contractor will be required to comply with the Project ESMP and the approved CESMP, including any issues relating to noise, dust nuisance, accidental damage to property/utilities and exhaust emissions. The contractor will appoint one staff member as a GRM officer for each worksite to receive complaints and initiate corrective action as appropriate. This name will be made available to the Supervising Engineer. Further, the name and contact details of the contact person for each site will be presented on a notice board at work sites and at the MISE. The notice board will also state (i) that members of the public with a grievance or concern have the right to register complaints (verbally or in written form) and for appropriate and reasonable action to be taken to address any valid complaint and (ii) that complaints can be made to the individuals concerned either verbally, in person, or in written form and that (iii) a written response will be provided within 48 hours.

The contractor will maintain a complaints book on site, containing grievance lodgement forms that are filled out in duplicate, with one copy provided to the complainant. The forms will be also available for claimants to fill on their own and submit anonymously into the

GRM inbox[44]. The forms will record date, time and nature of the complaint and information on the rights of the complainant and process to be followed for assessing and acting on the complaint. The forms will allow space for anonymous complaints to be registered. Registering and resolving a complaint will be at no cost to the complainant. To facilitate the process and have a better understanding of the complaint, the form prompts the complainant to identify a solution to the grievance.

The contractor will then address the complaint and take corrective action agreed to with the complainant. For minor complaints, such as noise or dust nuisance, or disregard of safety procedures, immediate corrective action will be taken. For more serious issues requiring guidance or further discussions, the contractor will raise the issue with the Supervising Engineer. A written response will be prepared, stating either (i) the nature and duration of action that has been taken, (ii) where an issue is not readily addressed by direct action on site, the steps that have been taken for resolution or (iii) complaint is considered invalid, an explanation as to why. In each case, the complainant will be informed as to their rights for the next step. The response will be handed to the complainant or made available for them to collect, within 48 hours of the complaint being received. The steps in the grievance resolution process are shown below.

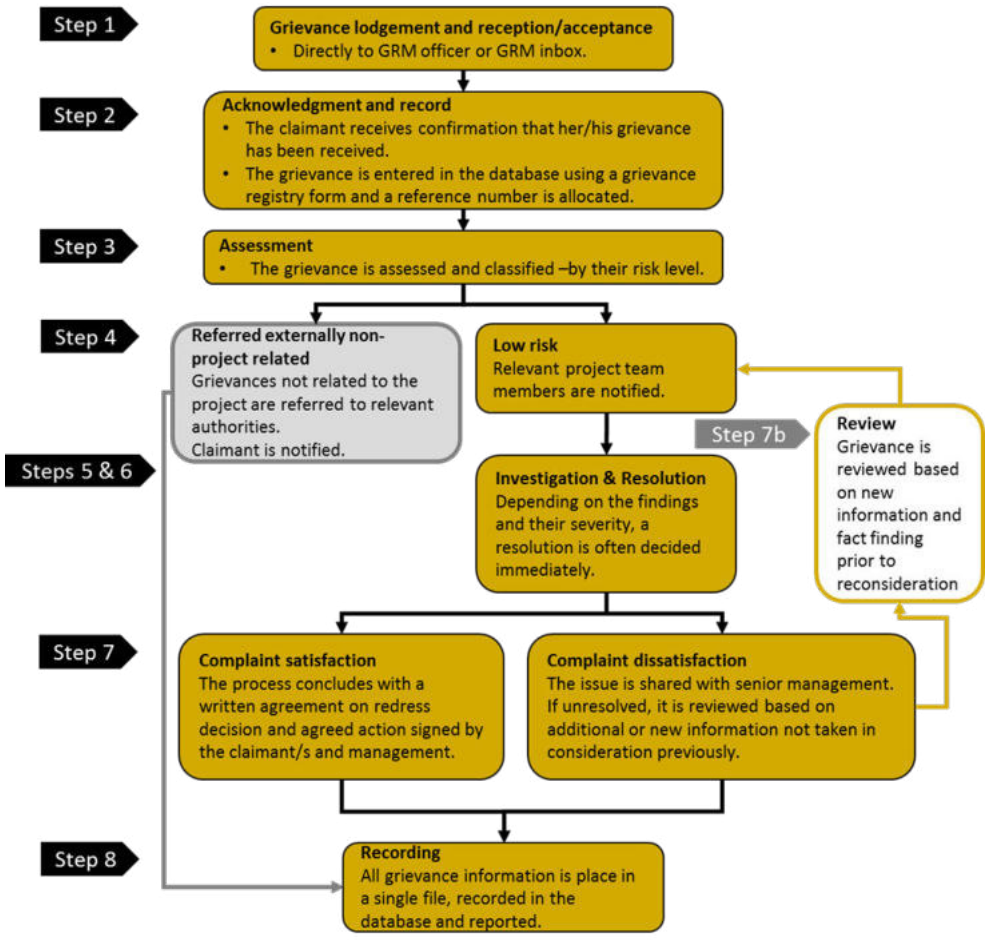


Figure 30 - Steps in the Grievance Resolution Process

[44] The GRM inbox is a secure letter box type located at multiple locations including MISE, PMU office and work-site offices.

Should the complainant remain dissatisfied with the action taken or the explanation received, the matter/complaint file will be forwarded to the Supervising Engineer (see step 7 on **Figure 30** above). The Supervising Engineer will have assigned a member of staff with the role of GRM Officer who may be the same community liaison officer. The name of this individual will be provided on the complaints registration form, with contact details and notice that this individual can be approached for follow up in respect of the complaint and that this may be done in person, by phone or in written form. The Supervising Engineer will consult with MISE and on their behalf review the complaint and the response of the contractor, then make a decision to be referred to the complainant within a maximum of two weeks. If the complainant remains dissatisfied with the Supervising Engineer's decision, the grievance may be filed with the Magistrate's Court, which under normal conditions involves a registration fee. The Magistrate's ruling will be binding on all parties.

Due to the classification of the STWSP and the likely social and environmental impacts, a Grievance Redress Committee (GRC) is not deem required. The occurrence of grievances with significant impacts to those affected may merit the conformation of a GRC. However unlikely, an alternative flowchart diagram for the inclusion of the GRC is also presented. The levels of responsibility for grievance management during construction are shown in **Figure 31.**

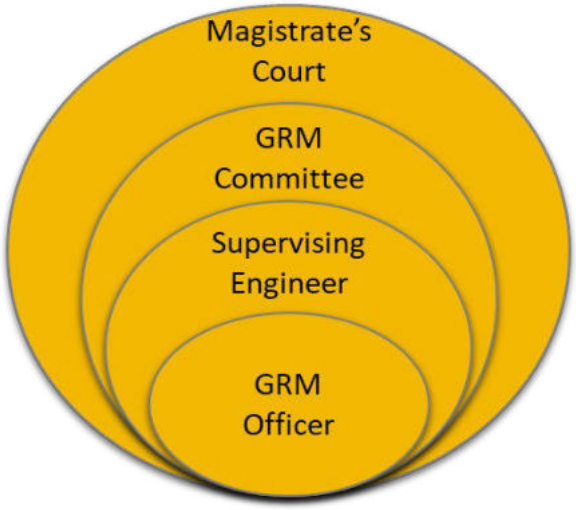


Figure 31 – Levels of Responsibility for GRM during Construction

The Contractor in coordination with the PMU will review and update the GRM established for the PDA.

On completion of the works, and when the contractor's defects liability period has passed, the infrastructure is handed over to MISE and PUB. The PUB, is responsible for infrastructure service delivery, will be required to receive and act on complaints relating to the operation and maintenance of the desalination plant, water supply infrastructure and solar PV system. A complaints register will be maintained.

The contractor will maintain a register of all complaints and grievances received either on site or at the office. The register will include: date of the complaint, the name of the complainant (and their contact details), name/title of person receiving the complaint, nature of complaint, any actions taken to immediately resolve the complaint and any future actions required, and close-out date when the complaint was satisfactorily resolved. The register will be subject to inspections during audits and monitoring.

7 LOCAL COMMUNITY, STAKEHOLDER ENGAGEMENT AND CONSULTATION

7.1 Engagement and Consultations

a) Public Consultations

Open consultations have taken place throughout the preparatory phases leading to the tendering of the STWSP. During the PPTA formal consultations took place with participants from Betio, Bonriki and few other villages on South Tarawa through community workshops. The workshops were held at a range of venues including community and religious maneabas, community meeting areas, houses and clinics, at times considered most convenient for stakeholders. During the PDA phase consultations with members of the community as well as with community-based organizations took place between January and September 2019. Similar to the PPTA, meetings took place at neutral and convenient places in order to allow wide participation from members of the public.

For both, the PPTA and PDA, meetings at each of the community halls began by project members disclosing the latest available information on the project, including descriptions of the project, potential environmental impacts, and to seek feedback relating to the project and any concerns. These workshops and community meetings were held between 3rd and 11th February 2018 for the PPTA and between 20th June and 15th January 2020 for the PDA.

Records of meetings highlighting key questions raised are included in Appendix 7.

Attendance records show a total of 528 people (approx. 1% of the population in South Tarawa) attended ranging from 15 people in Bairiki through to 62 people in Banreaba. The representation of the community of South Tarawa on the consultation was not only significant in terms of absolute numbers, but also in the gender balance. Of those involved in the consultation 53% were women and 47% men, the population of South Tarawa according to the 2015 Census has 52% women and 48% men. More detail is provided in the table below.

Table 23 – Summary of Public Consultations Participants

Village	Date	No. of participants		
		Male	Female	Total
PPTA				
Betio (Temanoku)	3 Feb 2018	8	10	18
Betio (Temakin)	6 Feb 2018	15	30	45
Bairiki	9 Feb 2018	9	6	15
Teaoraereke	7 Feb 2018	13	18	31
Bangantebure	11 Feb 2018	15	35	50
Bonriki	11 Feb 2018	21	10	31
Total		**81**	**109**	**190**
PDA				
Betio Temakin (residents and desal.plant)	20 Jun 2019	-	15	15
Causeway	21 Jun 2019	14	5	19
Ambo East	22 Jun 2019	1	9	10
Eita East	23 Jun 2019	5	7	12
Banraeaba	26 Jun 2019	37	25	62
Temaiku 1	29 Jun 2019	20	11	31
Ngaon Ambo	29 Jun 2019	10	5	15
Te Kawai ae boou	1 Jul 2019	9	8	17
Takoronga Clinic	2 Jul 2019	-	6	6

Village	Date	No. of participants		
		Male	Female	Total
Tabonkabauea	4 Jul 2019	-	15	15
Eita West	6 Jul 2019	8	4	12
Betio Bonnanon te Beero	25 Jul 2019	4	9	13
Betio Ueen te Bitati	23 Jul 2019	3	8	11
KUC Buota	1 Aug 2019	15	5	20
Catholic Church Buota	2 Aug 2019	18	14	32
Bonriki Water Reserve residents	13 & 20 Oct 2019	15	11	26
McKenzie Desalination Plant landowners	4 to 10 Jan 2020	10	11	22
Total		**169**	**168**	**338**
Grand total		**250**	**277**	**528**

Sources: PPTA consultations, 2018 and PDA consultations 2019

b) Key Stakeholder Consultations

Initial consultation during the PPTA was undertaken as part of the socio-economic surveys. In addition to this, individual meetings were held with potentially affected households (AHs) identified during the assessment process as well as institutional partners (i.e. Church of the Latter-Day Saints). Follow up consultation during the PDA was conducted with community members and community representatives as well as institutional partners.

During the consultation periods for the PPTA and PDA the project objectives and processes were explained. The community was advised of the project scope, including the benefits and impacts. During the PPTA the rationale and process for acquiring private land was explained, however this was not necessary during consultations held at the PDA as the detail design didn't identify the need for land acquisition. The project compensation matrix was referenced and compensation entitlements were clarified.

During the PPTA the AHs were informed of the STWSP Grievance Redress Mechanism (GRM) to be put in place should any unforeseen issues arise, or should there be any cause for grievance. During the PDA the GRM was put in place and those consulted made aware of it existence, characteristics and process. At the time of finalizing this review of the ESIA, no grievances were lodged.

Questions raised by the AHs were addressed by the PPTA and PDA teams during the socio-economic survey and community wide consultation, particularly related to the future project stages involving detailed design, at which time land requirements would be formalized. The outcome of the consultation was that households taking part in the socio-economic survey verbally agreed to allow the project to acquire their land subject to the safeguards established by the RF. During the PDA consultation with AHs the STWSP Community Engagement Team provided information answered questions on the detail design. Preliminary agreements were made with AHs where tanks would be located.

7.2 Key Findings from Engagement and Consultation

a) Summary of issues raised

At the consultation meetings, the public were informed of the main components of the project that includes installation and operation of a RO desalination plants and solar PV system, and the upgrading of the water supply system on South Tarawa and Buota. The activities involved and proposed locations for each component were presented including the reasons why these locations were chosen.

Information on the production capacity of the desalination plant, source of feed water, how the brine will be disposed, potential environmental impacts of brine on the marine and terrestrial ecosystem were disclosed. While participants were not concern over the construction of the desalination plant in Betio, as this is land that hasn't been used by the community but for the processing plant for the new tar-sealed road, they were interested in details on the household connections characteristics and the tariff for the water supply and it potential affordability concerns.

Issues raised at these meetings, related to the existing situation caused by the poor state of the water supply system, to impacts of construction. Issues relating to the state of water supply system were (i) some areas in Betio are not connected to the reticulated water supply system, (ii) freshwater extraction from Betio has increased the salinity level in the water lens and could worsen if the existing extraction rate continues and the perceived potential cumulative impacts from the desalination plant in Betio, (iii) the cost of the water service, and (iv) job opportunities that may arise from the construction and operation of the system.

Participants were also interested on environmental and social issues that could arise during the construction phase and particularly the desalination plant. Specific issues related to (i) land access, (ii) excavation works and related impacts on trees and permanent structures removals, noise, dust, increased traffic that would cause nuisance during construction, destruction of the newly completed tar-sealed road and impacts on traffic. Mitigation measures for each impact, and the benefits associated with the implementation of the project, formed parts of the discussion during the consultation meeting.

b) Means of addressing issues raised

The issues of main concern, namely the effects of the current state of the infrastructure, will be addressed by the proposed infrastructure improvements. The water reticulation system will be installed at Bonriki and other areas not connected to the system. Salinity level of wells in Bonriki is anticipated to improve as water extraction will remain unchanged overtime. Concern over the removal of vegetation and structures during construction will be limited to sites where individual items of equipment or damaged sections of pipe need to be replaced. However, the need to avoid the removal of or damage to trees during excavation, and replanting as required, is included in the ESMP. Likewise, a resettlement plan[45] is in place to address issues on removal of structures.

The effect of feed water extraction on ground stability and freshwater lens is negligible. Effects on fish populations and coral reef were examined and was also found to be negligible, as dilution of the brine effluent is expected over a short distance from the point of discharge. The ESMP includes a monitoring process that will track changes the salinity level over and adjacent to the point of discharge. Risks of damage to vegetation and salinity level of ground freshwater lens from leaks in the brine disposal system and failure of the desalination plant will remain but will be mitigated by improvements in the management and implementation of improved maintenance that is expected to result from capacity building and maintenance support components of the project. The government is to deal with labor issues and compensation to land owners over disturbed land. The production of salt from the brine is an option, however chemical wastes associated with the brine would render the salt unsafe for consumption.

Table below provides a summary of the consultation outcomes, including the most relevant raised, their proposed mitigation strategies and control safeguard measures together with an indication of the responsible organizations/entities for the implementation of such measures.

[45] The Resettlement Plan has been updated following the completion of the detail design during the PDA.

Table 24 – Summary of Consultation Outcomes

Issues raised	Proposed mitigation	Control or safeguard measures	Responsible for implementation of mitigation
Increased salinity of the water lens due to over extraction of fresh water and how this can be exacerbated by the desalination plant.	The effect of feed water extraction on ground stability and freshwater lens is negligible. A monitoring regime that tracks changes on the salinity level will be put in place.	ESMP includes a monitoring process that will track changes the salinity level over and adjacent to the point of discharge.	Contractor building, commissioning and operating the plant and supervising engineer. Subsequently PUB when taking operational control of the Plants.
Brine disposal and impacts on fish populations and coral reef as well as ground fresh water	Brine disposal impact is considered unlikely as the dilution of the brine effluent is expected over a short distance from the point of discharge. A monitoring regime that tracks changes on the salinity level over and adjacent to the point of discharge will be put in place. Risks of damage to vegetation and salinity level of ground freshwater lens from leaks in the brine disposal system and failure of the desalination plant will remain but will be mitigated by improvements in the management and implementation of improved maintenance that is expected to result from capacity building and maintenance support components of the project.	ESMP includes a monitoring process that will track changes the salinity level over and adjacent to the point of discharge.	Contractor building, commissioning and operating the plant and supervising engineer. Subsequently PUB when taking operational control of the Plants.
Equal and fair job opportunities for local residents.	Work with local community groups that represent the different villages. Construction contractor to work in collaboration with the Community Engagement Team to identify the community groups at each village that have wider community representation to establish a criteria to identify workers.	Stakeholder engagement and management plan to include measures to ensure equal and fair employment opportunities.	Contractor building, commissioning and operating the plant and supervising engineer.
Construction impacts, particularly in regard to amenity.	Put in place measures to minimize emissions and provide regular information local residents on construction activities and their impacts.	ESMP includes measures to minimize impacts on amenity to neighboring dwellings.	Contractor building, commissioning and operating the plant and supervising engineer.

Issues raised	Proposed mitigation	Control or safeguard measures	Responsible for implementation of mitigation
Potential eviction at the completion of the Project.	The Government has issue a letter to the World Bank providing decision and reassurance that illegal settlers would not be evited during the life of the Project.		
Impacts to livelihood of residents who use land to support their subsistence	Work with impacted families at the Mackenzie Desalination Site that use the land for gardening, collecting of coconuts and breading of pigs to identify alternative means to support and compliment their subsistence.	The Resettlement Plan and the ESMP provide guidelines to minimize impacts on local communities and households.	Contractor building, commissioning and operating the water supply network and supervising engineer.
Impacts to livelihood of residents whose incomes depend on from agricultural activities	The detail design has identified that households in the site for the PV plant could retain contained cropping areas around their dwellings and access tracks	The Resettlement Plan and the ESMP provide guidelines to minimize impacts on local communities and households.	Contractor building, commissioning and operating the water supply network and supervising engineer.
Access to jobs for construction and operation of the Project	Work with local community groups that represent the different villages. Construction contractor to work in collaboration with the Community Engagement Team to identify the community groups at each village that have wider community representation to establish a criteria to identify workers.	Stakeholder engagement and management plan to include measures to ensure equal and fair employment opportunities.	Contractor building, commissioning and operating the plant and supervising engineer.

7.3 Future engagement and consultation activities

The preparatory and detail design phases of the Project have engaged extensively with communities through organizations at the community level.

The Project will establish continuous and ongoing consultation with all stakeholders, beneficiaries and directly affected people. Ongoing consultation will be guided by the project's Stakeholder Engagement and Management Plan. During the construction phase the contractor will disclose information on the location and duration of construction operations, as well as the GRM. The contractor will assign a Project GRM officer and a liaison officer at each site, they will be responsible for receiving, and acting on complaints.

The Project's Stakeholder Engagement and Management Plan created during the PDA will be updated by the PMU/supervision consultant during the design and pre-construction stage, this plan will guide the process (means, methods, frequency, documentation etc.) for all communications about the project.

7.4 Information disclosure

Project information will be disclosed to stakeholders as per the project's Stakeholder Engagement and Management Plan. Disclosure will follow the requirements of the ADB Public Communications Policy 2011, the World Bank safeguard and communication

requirements, and any laws of the Government. This will include uploading of the environmental assessment and other safeguard due diligence documents on the ADB and WB websites and making these documents available for local disclosure. Draft and final version safeguards documents will be disclosed locally (including summaries in i-Kiribati) and by the ADB and WB on their websites.

8 CONCLUSIONS

The water issues faced in Tarawa atoll are amongst the most complex, vital and varied in the world. The proposed South Tarawa Water Supply project reflects the complexity of the water problem in South Tarawa and uses a mix of approaches to provide additional water, reduce water leakage, provide institutional strengthening and behavioral change programs. Using two main approaches, changes to physical infrastructure and behavioural change programs, the project will generate significant environmental and health benefits that more than outweigh any adverse environmental impacts incurred during construction and operation.

The project will build new and rehabilitate existing water and electrical infrastructure and implement a WASH program in South Tarawa. It is anticipated that the project will provide significant public health benefits such as consistent service of and access to potable public water and reduced public health risks from contamination. This will in turn result in a reduction of waterborne disease, reducing the burden on the health system. The primary beneficiaries are communities in South Tarawa, particularly women and children. The project will also have socio-economic benefits such as from the generation of new jobs, vocational training opportunities and improvement of the economic situation through reduced absenteeism. Environmental benefits associated with the project include water conservation and the use of renewable energy which will reduce the use of fossil fuels. Additional benefits include, improved planning, management, and sustainability of future water supply, improved development planning, and increased tourism potential. The project will also increase the resiliency of the water infrastructure to the impacts of climate change and natural hazards.

The natural habitat of South Tarawa has already been highly modified by the built environment and the densely populated community. Identified environmental risks and impacts of the project include the short-term impacts from noise and nuisance, solid waste, dust, and disruption during construction. The impacts from the operation of the desalination plant include the impacts on marine water quality and ecosystem from the brine disposal and the use and disposal of chemicals. Further risks to the project include the risk of the new infrastructure failing and the impacts of sludge disposal from the proposed sanitation units. Identified social impacts include the impacts of resettlement, land access and encroachment onto private property. All risks were assessed to be very-low, low or medium significance provided that the mitigations outlined in this ESIA are implemented. The exceptions are the significance of the risks to the quality of the fresh groundwater reserves from waste disposal practices which remains high. The proposed WASH campaigns are being implemented in order to address those risks.

The projects key environmental and social management and mitigation measures include the development, implementation and monitoring of an ESMP. The ESMP addresses the impacts and risks associated with construction and operation of the SWRO desalination plant, solar PV system, and water supply infrastructure and will be updated and further developed as a CESMP by the contractor. To mitigate the social impacts the project will be located on government land whenever possible. A Resettlement Plan (RP) was prepared to address potential impacts on land and/or assets due to the desalination plant, water storage/booster pumps and the installation of the PV. This outlines the proposed consultation and compensation of APs. Where possible, government owned or leased land has been identified for siting of project infrastructure.

In conclusion, the ESIA has found that no major short-term or cumulative environmental or social impacts are likely to occur from the Project, provided that the ESMP is updated, implemented and monitored and the RP is implemented. The overall environmental, health and socio-economic benefits of the project more than outweigh the adverse environmental and social impacts that will occur.