



Guidelines for the design and implementation of community-managed water storage in Tuvalu



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EXECUTIVE SUMMARY

In Tuvalu, the Pacific Adaptation to Climate Change (PACC) project is building resilience to drought by improving the country's water resources management. These guidelines, developed as part of the PACC demonstration project, detail the process undertaken to design and build a community-managed water cistern in Lofeagai community, in the north of Funafuti Atoll.

Funafuti has about half of the country's population, and the resulting high demand for water makes the island particularly vulnerable to drought. Lofeagai was selected for the PACC pilot demonstration project through a vulnerability and adaptation (V&A) assessment and a stakeholder consultation process. This process identified Lofeagai as the most vulnerable community on Funafuti, followed by Tekavatoetoe.

The only source of freshwater in Lofeagai is rainwater and desalinated water purchased from the government. Before the PACC project, there was no communal cistern and rainwater was stored privately only.

The project design stage included a socio-economic assessment (SEA) in the Lofeagai community, community consultations, and a cost-benefit analysis (CBA). These helped to clarify the decision to build a cistern with capacity of 700,000 L. It was also decided this would be linked to and managed by the Lofeagai EKT church (Ekalesia Kelisiano Tuvalu, or Congregational Christian Church of Tuvalu), of which 75% of the community are members. Construction began in early 2012 and the cistern was completed in late 2012.

As a community-based adaptation project, the involvement of the Lofeagai community in all stages of the project was crucial. Because the cistern was built within the EKT church area, one important objective was to ensure that the 25% of the community who do not belong to the EKT church did not feel excluded from the project.

Tuvalu's demonstration project is a good example of how comprehensive planning and proactive management can successfully deliver outcomes. The project successfully identified one of the most vulnerable communities, selected a sustainable and efficient solution within the PACC budget, and used informal community leadership to implement and manage the adaptation measure. The project has also attempted to mainstream gender issues, and the Tuvalu National Council of Women has been actively involved in the project.

Following successful implementation of the project in Lofeagai, Tuvalu was given additional funding in the next phase of PACC (called PACC+) to replicate the project in Tekavatoetoe. The new cistern is smaller than the one built in Lofeagai (288,000 L) but will follow the same arrangement with the EKT church in Tekavatoetoe. Handover to the Tekavatoetoe community is expected in mid-November 2014.

As well as carrying out the demonstration project, the Tuvalu PACC team has been central to the development of *Te Kaniva*, the Climate Change Policy Framework, and the National Strategic Action Plan (NSAP) for climate change and disaster management. PACC and the Integrated Water Resources Management (IWRM) projects have also coordinated the development of the Water and Sanitation Policy.

ABBREVIATIONS

CBA	Cost–benefit analysis
EDF10	Tenth European Development Fund [project]
EKT	Ekalesia Kelisiano Tuvalu (Congregational Christian Church of Tuvalu)
ENSO	El Niño Southern Oscillation
GDP	Gross domestic product
IWRM	Integrated Water Resources Management
L	Litre
M&E	Monitoring and evaluation
NGO	Non-governmental organisation
NSAP	National Strategic Action Plan
NWSSC	National Water and Sanitation Steering Committee
PACC	Pacific Adaptation to Climate Change [programme]
PSCCP	Pacific Climate Change Science Program
PWD	Public Works Department
SEA	Socio-economic assessment
SPREP	Secretariat of the Pacific Regional Environment Programme
TANGO	Tuvalu Association of Non-Government Organisations
V&A	Vulnerability and adaptation [assessment]

1. INTRODUCTION

The Pacific Adaptation to Climate Change (PACC) programme is the largest climate change adaptation initiative in the Pacific region, with projects in 14 countries and territories. PACC has three main areas of activity: practical demonstrations of adaptation measures; driving the mainstreaming of climate risks into national development planning and activities; and sharing knowledge in order to build adaptive capacity. The goal of the programme is to reduce vulnerability and to increase adaptive capacity to the adverse effects of climate change in three key climate-sensitive development sectors: coastal zone management, food security and food production, and water resources management. The programme began in 2009 and is scheduled to end in December 2014.

Drought has been identified in Tuvalu's National Strategic Action Plan (NSAP) for climate change and disaster risk management as one of six significant risks that could result from climate change. In order to improve the country's resilience to drought, the PACC project is focusing on improving Tuvalu's water resources management, at both community and national level.

The PACC project addressed two priorities identified by the Te Kaniva (climate change policy framework) under its first goal, 'Strengthening adaptation actions to address current and future vulnerabilities':

- Assess water availability and feasibility of water security options including rainwater harvesting, underground water and desalination on all islands.
- Implement improved rainwater harvesting, access to underground water and install energy efficient desalination on all islands.

These guidelines for the design and implementation of community-managed water storage in Tuvalu have been developed as part of the PACC demonstration project. The guidelines are mainly directed at government agencies, local non-governmental organisations (NGOs), regional organisations and donor agencies interested in developing similar projects in other parts of Tuvalu, in order to improve the availability of drinking water, especially during drought periods. They detail the process undertaken by the PACC team to design and build a community-managed water cistern in Lofeagai community, in the north of Funafuti Atoll. Before the PACC project, Lofeagai community did not have any communal water reserve. During water shortages, community members had to travel to their 'home island' community tanks, located up to 15 km south, and carry the water back to their homes.

An important objective of the PACC project is to support effective planning. In detailing the steps to design and implement the demonstration project, this document aims to provide the reader with the following information:

- An understanding of the challenges during drought events in Tuvalu, and the added stress due to climate change;
- The relevance of community-managed water cisterns as a sustainable way to increase Tuvalu's resilience to drought;
- The steps to design and implement a community-managed water supply project, within the Tuvalu context; and
- Experiences of the Tuvalu PACC team, in particular the critical factors that have made the project successful.

1.1. The PACC project in Tuvalu

1.1.1. Project rationale and objectives

The Government of Tuvalu recognises the strong linkage between climate change and rainfall patterns. In a country with no surface water and inadequate groundwater resources, reduction in rainfall can have a disastrous effect on the islands' water supply.

The objective of the PACC project in Tuvalu is 'to enhance the capacity of Tuvalu to adapt to the impacts of climate change, including variability, in the water sector'.

In order to reach this objective, three outcomes have been identified:

Outcome 1: Integrate gender and climate change including variability considerations into targeted national and sectoral frameworks;

Outcome 2: Increase the resilience of the Lofeagai community to climate change and extreme event risks in the water sector;

Outcome 3: Increase understanding and awareness of how to reduce vulnerability to climate variability and change through the PACC pilot project and mainstreaming processes, and apply lessons learned and good practices to future water sector projects in Tuvalu.

This document details the design process and implementation of the demonstration measures (Outcome 2).

1.1.2. Institutional framework for PACC project

The PACC project is implemented within the Public Works Department (PWD) of the Ministry of Public Utilities and Infrastructure. The PACC Tuvalu team (PACC coordinator and assistant) is supported by PACC regional implementing agency the Secretariat of the Pacific Regional Environment Programme (SPREP), regional and local consultants, and a technical working group of advisory staff members from other government departments connected with the water and/or climate change sectors (Figure 1).

In order to improve the institutional capacity for the water and sanitation sector, a National Water and Sanitation Steering Committee (NWSSC) has been set up under the PACC project, with the support of the Pacific Integrated Water Resources Management (IWRM) project. The committee comprises representatives from various government ministries, agencies, non-governmental organisations, and civil society organisations and institutions. The Tuvalu National Council for Women is represented on the Committee and provides a gender perspective to the project. The NWSSC oversees the implementation and management of the PACC project and thus is the authority in charge for the demonstration project (Outcome 2). The governance component of the PACC project (Outcome 1) follows the policy development process under the Development Coordinating Committee and the responsible Minister.

Other climate change programmes and activities are implemented under the Department of Environment (DoE), which is the focal point for all climate change related issues.

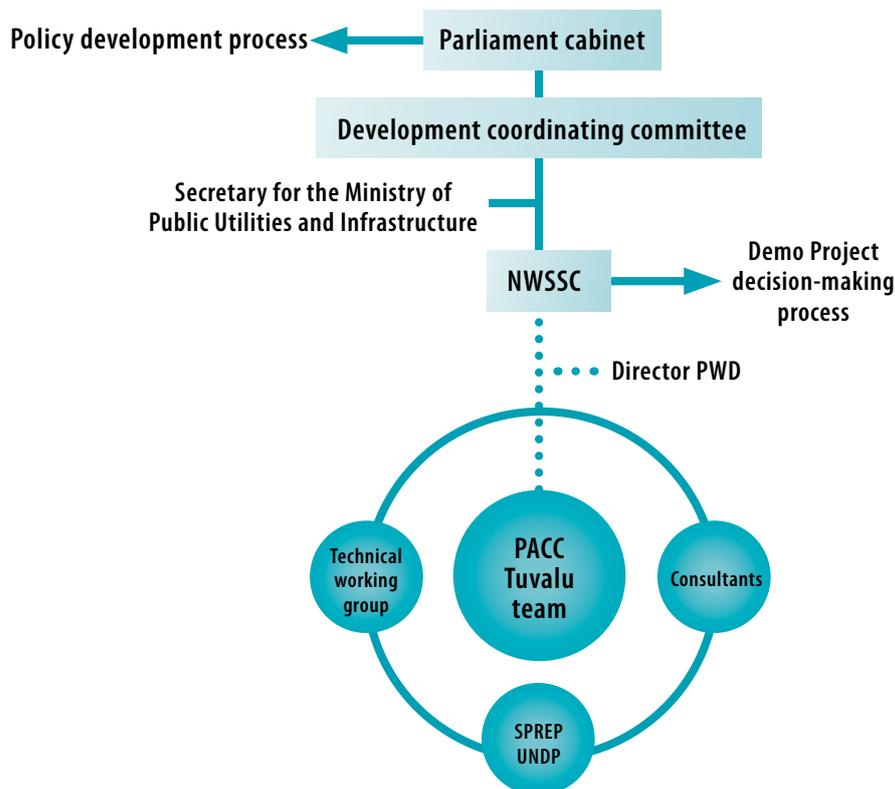


Figure 1. The institutional framework for PACC in Tuvalu.

2. COUNTRY INFORMATION AND CONTEXT

2.1. Background

2.1.1. Geography and demographics

Tuvalu is an independent state located in the southwest Pacific Ocean, northwest of Fiji. Tuvalu consists of nine low-lying islands (three reef islands and six atolls) scattered over 500,000 km² and having a total land area of 27 km² (Figure 2).

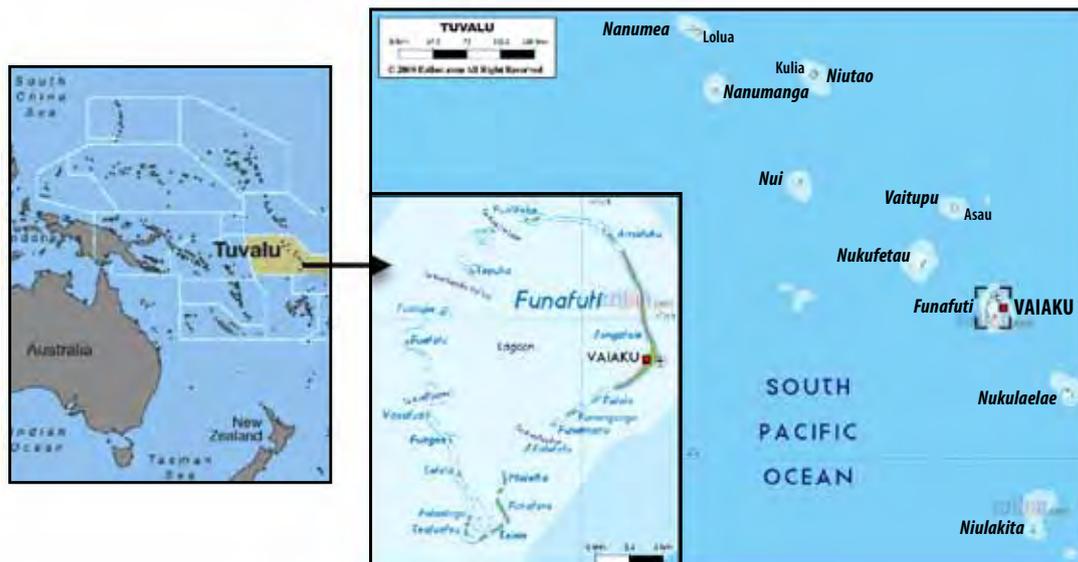


Figure 2. Map of Tuvalu (source: Ezilon, 2009).

The maximum elevation in the country is 5 m above sea level. The six atolls, namely Nukulaelae, Funafuti, Nukufetau, Vaitupu, Nui and Nanumea, are each composed of islets around a lagoon. Nanumaga, Niutao and Niulakita are raised limestone reef islands. Tuvalu's islands generally have poor soil condition supporting a limited variety of flora (GoT, 2011b).

Tuvalu's population is estimated at 11,206 (SPC, 2011). Data from the last census in 2002 gave a population of 9,561. In 2002, nearly half of the population lived in Funafuti. The population in Funafuti continues to grow (by 17% between 1991 and 2002) as Tuvaluans migrate from outer islands in search of better opportunities. At the same time, outer island populations are decreasing (on average -2.6% between 1991 and 2002) (SPC, 2005).

2.1.2. Socio-cultural and economic background

Tuvalu is a constitutional monarchy and part of the British Commonwealth. The traditional leadership comprises a hereditary chief or king for each island. Each island has its own council (Kaupule) led by its traditional leader. Local government (Falekaupule) is a fusion between the traditional leadership and the introduced governing system. This system, endorsed in 1997 to promote decentralisation and reduce migration from outer islands, confers local governance power to the Falekaupule.

Attachment to one community ('home island') plays an important part in a Tuvaluan's social life. The attachment is based on marriage – a wife adopts her husband's home island community.

Tuvalu's economy is small and government revenue mainly comes from fishing licence fees, the assets of the 'tv' internet domain and income from the capital of the Tuvalu Trust Fund. External economic influence is strong and the government also relies on international development assistance (GoT, 2011b).

Private incomes are supplemented by remittances from seafarers employed on foreign vessels, transfers of cash and goods from the growing population of Tuvaluans living in New Zealand and Australia, and repatriated earnings of seasonal workers employed in New Zealand's Recognised Seasonal Employer Scheme (GoT, 2011b).

2.2. Climate

2.2.1. Observed trends

Tuvalu's climate is hot and humid with very little variation in temperature. The minimum air temperature is 25–26°C and the maximum temperature is 31–32°C all year round. The average annual rainfall ranges from 2,900 mm in the northern islands to 3,400 mm for the southern part of Tuvalu, including Funafuti. Rainfall patterns are characterised by a dry season from May to October and a wet season from November to April (Figure 3).

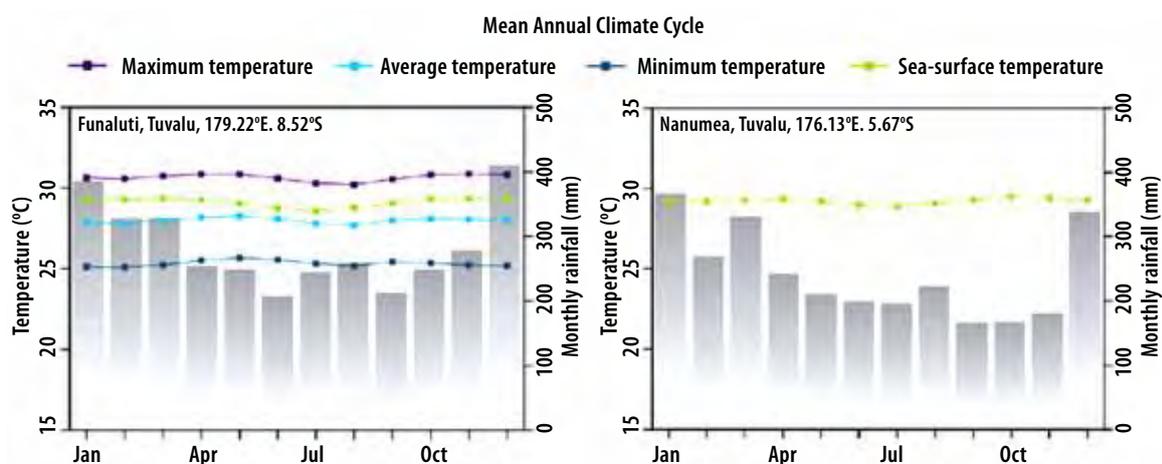


Figure 3. Monthly temperatures and rainfall for Tuvalu (source: PCCSP, 2011).

Similar to other Pacific Islands, inter-annual rainfall variability is high in Tuvalu and influenced by El Niño Southern Oscillation (ENSO) events. The El Niño phase generally brings wetter conditions and La Niña dryer conditions.

The northern islands such as Nanumea are more affected by the El Niño cycle. During an El Niño phase, rainfall can be five times the average (twice as much for Funafuti). La Niña years, in contrast, can bring severe droughts.

During the last 50 years, an increase in temperature has been observed in Tuvalu (PSCCP, 2011). Sea level, measured since 1993 by satellite altimeters, has risen by about 5 mm per year since 1993. Ocean acidification has also increased since the 18th century and will continue to increase over the next decades.

Tuvalu is vulnerable to three main extreme events:

1. Tropical cyclones;
2. Spring tides;
3. Drought.

Tropical cyclones generally occur between November and April. An average of eight cyclones hit Tuvalu per decade. Cyclones seem to be more prevalent during El Niño years (12 per decade) whilst La Niña years generally see a reduction in cyclones (four per decade).

Spring tides are a threat for Tuvalu as they can cause major flooding on the islands. According to the Pacific Climate Change Science Program (PSCCP), the top 10 king tides recorded all occurred between February and April (PSCCP, 2011).

Drought is also a threat for the country as it relies primarily on rainwater for its water supply. The northern islands tend to be more affected by severe droughts, however the population density in Funafuti and high demand for water make the island particularly vulnerable to drought (PSCCP, 2011).

2.2.2. Projected trends

The PCCSP has recently published new trends for Tuvalu (Table 1). According to the Program, future climate in region will be characterised by:

1. An increase in sea surface and air temperature;
2. More extreme events (heat and rainfall);
3. An increase in rainfall;
4. Less frequent tropical cyclones but they may be more intense;
5. Sea level rise and ocean acidification will continue.

Table 1. Trends in future climate for Tuvalu (PSCCP, 2011).

Projected trend	Confidence
Increase in sea surface and air temperature: by 2030, increase in temperature could reach up to 1°C	Very high
Increase in frequency of extreme heat days: this is a result of global increase in temperatures	Very high
Mean sea level will continue to rise: by 2030, sea level could have risen by 5 to 15 cm	Very high
Ocean acidification will continue to increase	Very high
Annual and seasonal mean rainfall is expected to rise: all global climate models show an increase in average rainfall. However, there are some uncertainties on the values	High
Increase in frequency of extreme rainfall days: this is a result of global increase in rainfall	High
Drought events are expected to decrease	Moderate
Number of tropical cyclones are expected to decrease	Moderate

3. THE WATER SECTOR IN TUVALU

3.1. Water resources and management

3.1.1. Water resources

Rainwater is the primary source of freshwater in Tuvalu. There is no surface water and groundwater resources do not hold a large volume of freshwater.

According to Falkland (1999), groundwater may exist on the western side of the airport in the wider section of Fongafale (Funafuti) and in the small islets of Tepuka and Fualefeke in the northwestern part of the Funafuti atoll.

According to White (2005), and based on a compilation of assessments done over the past 20 years on the outer islands, a total of 1 million cubic metres of groundwater could be abstracted for water supply in the outer islands (Table 2). However, a more comprehensive assessment is required to understand the full extent of the fresh groundwater and its sustainable yield.

Table 2. Estimated groundwater resources.

Island	Islet	Estimated groundwater area (km ²)
Nanumea	Main village	0.73
	Lakena	0.53
Nunumaga		0.90
Niutao		0.81
Nui	Fenua Tapu	0.08
	Meang	0.15
Vaitupu		1.24
Nukufetau		0.21
Nukulaelae		0.03
	Fenualago	0.02
	Tefakai	0.02
Niulakita		0.15
Total		4.90

Most of the water supply is harvested at the domestic level with rainwater catchments attached to dwellings. Quality and quantity of water varies greatly depending on tank capacity, the quality and extent of the roofing and guttering, and the location (northern islands have less rainfall on average than southern ones). A survey undertaken in 1997 revealed that more than 91% of households in Tuvalu own a water tank. It is likely that with recent donor projects more than 95% of the households are equipped with a water tank at present (GoT, 2011a). The total volume of domestic water storage in Funafuti is estimated at 23,391,736 L.

Communal water cisterns are also common, attached to public buildings (e.g. schools and community halls) or private community buildings (e.g. churches). Data are available on the community rainwater storage for the outer islands, for example, SOPAC (2011). In Funafuti, one major community cistern can hold 1,390,000 L of water. Prior to the PACC project the total volume of communal water storage for Funafuti was 2,626,564 L. With the water cistern recently built by the PACC project in Lofeagai, the total volume is now around 3,426,000 L. The government storage (i.e. hospital, PWD, and government buildings) can also hold a total volume of water of around 3,018,020 L (Table 3).

Table 3. Days of water supply for Funafuti Atoll [adapted from Wolff, 2009].

Source	Total storage at full capacity (L)	L/person	Days at 50 L/person/day	Days at 80 L/person/day	Days at 100 L/person/day
Government reserves	3,018,020 (2,768,020 ¹)	615	12	8	6
Community reserves	3,426,000	761	15	10	8
Household rainwater tanks	23,291,736	5176	104	65	52
Total	29,386,320	6,375	131	83	66

Note: The table is based on a population of 4,500 and provides an indication of the days of supply that could be provided by the current infrastructure.

¹ Water available after supply to vessels

Desalinated water is also produced by PWD on Funafuti. The maximum production capacity is currently 190,000 L per day from three functional units (1 x 100,000 L, 1 x 50,000 L and 1 x 40,000 L). There is one other unit, currently non-functional.

Groundwater is not widely used in Tuvalu and less than 2% of households are reported to own a well (Burke, 1998). In Funafuti, groundwater use is limited to feeding pigs, washing pigpens and flushing toilets. Its use can be extended to washing clothes and bathing during drought periods (SOPAC, 2007).

3.1.2. Water management

At the domestic level, the maintenance of water infrastructure is at the expense of each household. However, the government has been providing rainwater harvesting equipment (tanks, gutters and downpipes) to households in need, mostly through donor projects. Recently, under the Tenth European Development Fund (EDF10; a €7.3 million aid project focusing on water and sanitation, including waste and energy), 1,233 households in the outer islands were provided with rainwater infrastructure.

Communal water storage infrastructure is managed at a community level. Generally, cisterns are attached to community halls. Householders get their water from their community cistern in times of need, even if their community hall is far from where they live (i.e. their 'home island' community). When there is a declared drought, the government takes control of all the communal storages and, depending on the situation, limits water to 40 L per household per day.

Desalinated water, although vital as an emergency supply, is very expensive to produce for the government who cannot pass the full cost of production and delivery to the community (i.e. the community would not be able to afford it). Desalinated water is supplied to households at Aus\$13.50 per 500 gallons (1,900 litres). During droughts, desalinated water is pumped to communal storages to supply the community with a minimum amount of water per day.

Donor programmes introduced latrine construction in the early 1980s to improve hygiene, however with little consideration of the porous soil and shallow water table. The majority of toilets are flush with septic tanks or pour flush. Most of the septic tanks are in reality cesspits and it is reported by SOPAC (2007) that the few concrete septic tanks that have been installed are poorly designed (i.e. do not have any buffering or sand filtration).

3.2. Institutional framework and policy context

The principal actors in the water sector in Tuvalu are the Environment Department, the Ministry of Public Utilities and Infrastructure, the Ministry of Health, the Kaupule (local councils) and the Tuvalu Association of Non-Government Organisations (TANGO) (Figure 4).

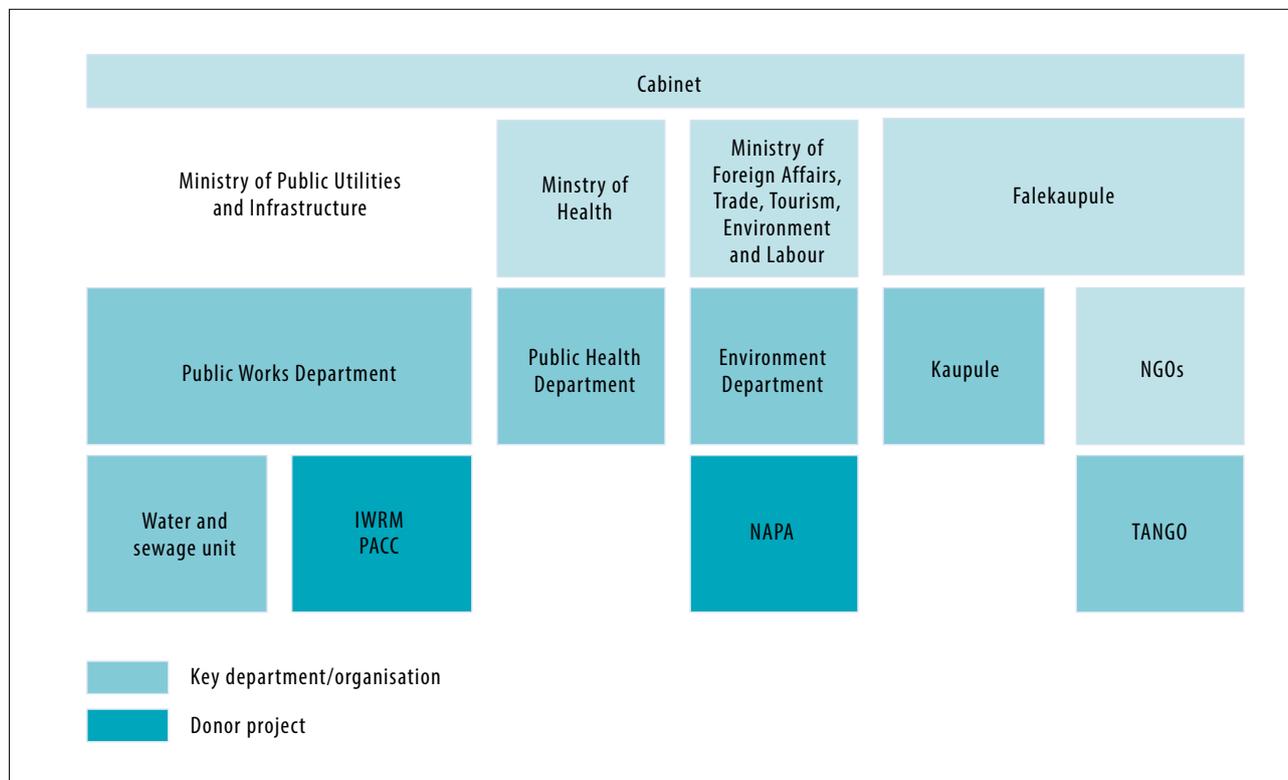


Figure 4. Institutional framework for the water sector in Tuvalu.

Mandates and responsibilities of each agency (regarding the water sector) are as follows:

- Environment Department: environmental policy (including climate change policy);
- Ministry of Public Utilities and Infrastructure: water and sanitation policy, water asset maintenance and development (i.e. construction), water production and distribution;
- The Ministry of Health: water safety planning (including water quality monitoring and awareness);
- Kaupule: land and water bill, grassroots projects;
- TANGO: water, sanitation and public health awareness.

PACC and IWRM projects have worked together to support the development of the Sustainable and Integrated Water and Sanitation Policy 2012–2021, which was endorsed by the Government in 2012 and published in 2013. The policy is based on five guiding principles:

1. Access to safe drinking water and sanitation is a fundamental human right;
2. Water is everyone’s business, and all Tuvaluans have a role in the management of water and sanitation;
3. Water and sanitation services in Tuvalu should, over the long term, operate on a sustainable basis;
4. Managing risk is more effective than responding to consequences;
5. Effective water management is an important national response to the impact of climate change.

Under the guiding principles, seven goals have been defined. The policy document provides guidance through strategies and risk factors to reach each goal. The IWRM plan, which will serve as the implementation plan for the policy, is to be finalised by 2015.

3.3. Climate risks, vulnerabilities and impacts

Current climate variability and climate change are likely to exacerbate the current threats to the water sector. The following risks have been prioritised because of their observed and expected impacts on the water sector:

- **Sea level rise:** The steady rise in mean sea level poses a serious threat to this low-lying country. In the long term, the territorial integrity of the island could be threatened. Medium term risks include the exacerbation of threats such as coastal erosion, inundation, storm surge and reducing freshwater resources through saltwater intrusion.
- **Tropical cyclones:** Tropical cyclones could decrease in the next century (predicted with moderate confidence). However, risk from cyclones will remain high, with potential damage to infrastructure, livelihoods and biodiversity as well as coastal erosion and inundation.
- **Extreme events:** Recent climate change scenarios are projecting a possible reduction of drought events for Tuvalu, however, an increase in drought intensity (duration and reduction in average rainfall) will seriously threaten Tuvalu. Heavy rainfall events, although an opportunity to harvest more water, bring the risk of floods, with related socio-economic issues (GoT, 2011b; PSCCP, 2011).

3.4. Non-climate drivers of risk

Non-climate drivers that also present risk to the water sector include:

- **Population:** Population growth in Funafuti is increasing the demand for water, putting more pressure on the water supply. Population growth and increased population density also has negative impact on natural resources and associated biodiversity.
- **Pollution:** Contamination of the groundwater with sewage effluent is a recurrent issue in low-lying atoll islands. In Tuvalu studies have shown that both groundwater and water from burrow pits is polluted with faecal bacteria. The typical low maintenance of domestic rainwater harvesting facilities means there is also a risk of contamination in these systems.
- **Institutional capacity/GDP:** Low institutional capacity, lack of skilled people and small economy/low GDP are not enabling factors for the development and maintenance of the water infrastructure, at government and domestic level.

4. THE DEMONSTRATION PROJECT

4.1. Site selection

At the start of the project, an inception meeting was organised with the NWSSC, and Lofeagai was identified as a particularly vulnerable community. The Tuvalu PACC team and the Government of Tuvalu then carried out a vulnerability and adaptation (V&A) assessment in Funafuti's communities. The V&A used community workshops to gather information and feedback from members of each community. Results from the V&A showed that Lofeagai was the most vulnerable community to drought, followed by Tekavatoetoe, as both communities did not have sufficient community water storage.

Lofeagai community was therefore selected for the PACC pilot demonstration project. Following successful implementation of the project in Lofeagai, Tuvalu was given additional funding in the next phase of PACC (called PACC+) to replicate the project in Tekavatoetoe (see Section 4.11).

4.2. Selection of adaptation interventions

4.2.1. Socio-economic assessment

The Tuvalu PACC team carried out a socio-economic assessment (SEA) to collect in-depth information on the community demographic and socio-economic situation, and to identify what climate change risks are likely to impact the most on the community.

All key sectors, and especially those addressed by PACC – food security, water security and coastal infrastructure – were found to be vulnerable to climate variability and change. The SEA findings led to the conclusion that the water sector was the most vulnerable for Lofeagai given that the community did not have any communal water cistern.

SEA findings were that government assistance has been effective in the past few years in supplying households with rainwater catchment infrastructure. However, it was found that tank sizes were not sufficient to cater for everyone in a household even during normal rainfall conditions.

Other key findings were:

1. Groundwater is not recommended for consumption but can be used as a secondary source of water during drought;
2. Water quality (bacterial contamination) is a concern in most households;
3. Three-quarters of the community were members of the EKT church (Ekalesia Kelisiano Tuvalu, or Congregational Christian Church of Tuvalu);
4. During drought, the only mean of accessing water is from other communities' cisterns.

More results from the SEA are given in Section 4.6.

Using the findings of the SEA, a set of recommendations to improve water security in Lofeagai was produced (Table 4).

Table 4. Recommendations for improving water security in Lofeagai.

Area for action	Recommendations
Adaptation measure	Supply of facilities such as water tanks to address water shortage problems at the individual household level
	Improve water catchment/harvesting systems
	Supply of a community water cistern to cater for the community
Water management	Sustainable water management practices, initiatives and technologies for households
	Environmental impact assessment as a precondition for approval of projects in the various sectors
Awareness/ education	Encourage awareness on climate change and its adverse effects
	Encourage awareness on water conservation
	Mainstreaming of climate change at the national, local government and community levels

4.2.2. Cost–benefit analysis

A cost–benefit analysis (CBA) was carried out, which looked at the community cistern option relative to the business as usual scenario (which included desalination during drought periods) (PACC, 2013).

The CBA methodology included:

- Assessing the costs related to set-up (capital) and operation of the community cistern;
- Assessing three main benefit streams: direct benefits of water supplied from the cistern, reduced incidence of sickness and disease, and avoided travel costs to collect water during drought;
- Calculating the net benefit in terms of net present value and benefit:cost ratio;
- Carrying out a sensitivity analysis on some of the key variables and assumptions, and whether they might affect the outcome and recommendation.

The results of the CBA confirmed that the community cistern at Lofeagi represented a worthwhile option to be implemented (Table 5). The sensitivity analysis confirmed this assessment holds true if future rainfall patterns are in fact lower than historical levels.

Table 5. CBA results (source: PACC, 2013).

(1) Present value of costs at 8% discount rate	148,978
(2) Present value of benefits at 8% discount rate	
<i>Additional water supply</i>	197,485
<i>Improved health</i>	<i>Not valued</i>
<i>Avoided travel costs</i>	2,094

	199,579
(3) NPV = (2) – (1)	50,601
(4) BCR = (2) / (1)	1.34

Additional recommendations from the CBA were:

- A cistern management plan should be developed, which should include suggested extraction schedules based on different rainfall scenarios and simple, user-friendly triggers for community members to manage this appropriately. It should also include a maintenance schedule.
- Given the benefits of reducing dependency on desalinated water over the longer term, a study of water demands and the water pricing structure for desalination water in Tuvalu was recommended in order to strengthen the incentives for water conservation whilst ensuring that basic needs are met.
- Monitoring of the pilot project should include collection of rainfall data, water harvest/storage by cistern, and water use (detailing quantity, timing, and who uses the water). This actual/observed data can then be used to repeat this CBA exercise. This 'ex-post' CBA should be a key part of pilot evaluation, which can then be used to reliably inform decisions about up-scaling and replication.

4.3. Objectives and outcomes

The PACC demonstration project objective was to build resilience to drought at the community level through the provision of an additional water supply.

Expected outcomes from installing the 700,000 L cistern in Lofeagai are:

- An additional source of water for all Lofeagai residents;
- An additional 40 L of drinking water per household per day for the Lofeagai community, for up to 6 months during drought periods;
- Total capacity of the government water storage extended.

4.4. The planning process

The Tuvalu PACC team used a comprehensive planning process for its demonstration project. The four-phase process included: an inception phase, to review existing data and identify the recipient community; a design phase, to gather extensive knowledge of the recipient community and design the best adaptation option; an implementation phase where the solution is being delivered to the community; and a monitoring and evaluation phase to assess the impact of the adaptation project and ensure that it is delivering the expected benefits (Figure 5).

Community engagement has been an ongoing part of the planning process, and is described in Section 4.5.

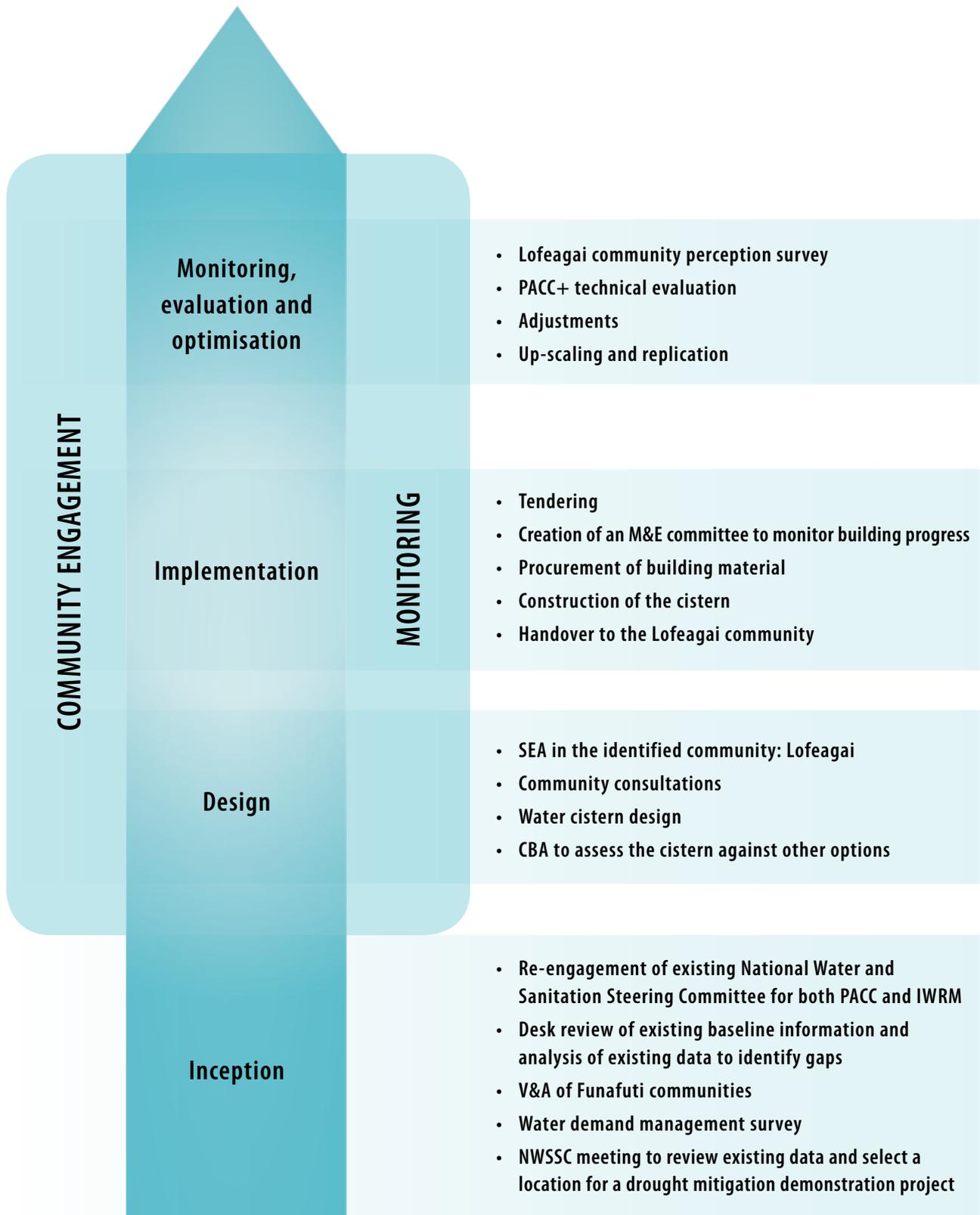


Figure 5. The planning process for the PACC demonstration project.

4.5. Community engagement

Community awareness, engagement and ownership are vital to the sustainability of the demonstration project. The main community engagement activities carried out by the PACC project were:

- National inception meeting;
- Lofeagai community meetings and workshops;
- V&A in all communities;
- Regular meetings with EKT church leaders in Lofeagai;
- Door to door socio-economic survey in Lofeagai;
- Door to door community perception survey in Lofeagai;
- Quarterly newsletter;
- Weekly radio broadcasting;
- Participation in national events;
- Co-organisation of World Water Day activities with Pacific IWRM project.

The PACC Project held its inception workshop on 11 January 2010, inviting government officials, community leaders, youth leaders, women leaders and nongovernment officials. Later in 2010, all communities in Tuvalu were invited to participate in the V&A process, through workshop sessions.

After identification of Lofeagai as the most vulnerable community to drought, a series of training activities and workshops were held to gather community knowledge on water and climate change and explain the PACC adaptation project. From the beginning of the project, the team decided that all communication training and materials would be delivered in Tuvaluan. A local consultant was hired to prepare a communication strategy. A newsletter was part of the strategy and was produced every quarter to inform both local and regional stakeholders on the progress of the project.

As a community-based adaptation project, the involvement of the Lofeagai community in the design, implementation and evaluation phases of the project was considered crucial. Because the cistern was being built within the EKT church area, one important objective was to ensure that the 25% of the community who do not belong to the EKT church did not feel excluded from the project. Door to door surveys were helpful to ensure that all the community was represented in the decision-making process.

Celebration of World Water Day has also been an important platform for PACC and the IWRM project, to showcase their work and develop community awareness on water management, sanitation and climate change issues. In 2010, 2011, 2012, 2013 and 2014, both projects jointly organised the event, spread over a week, with school arts competition and quizzes, on themes around water and climate change. In 2011, PACC developed educational pamphlets to be distributed to schools as part of the World Water Day celebration week. PACC also participated in other national events such as World Environment Day and World Biodiversity Day.

A radio programme was also created by the PACC team and has been on air every Monday at 7.30pm and followed up with a public debate.

PACC has also been actively involved in two national public awareness campaigns, namely 'Global Hand-washing Day' and 'World Cleaning Up Day'.

4.6. The demonstration site: Lofeagai

4.6.1. Geography and environment

Lofeagai community is located along a narrow, 6 km strip of land, from the 'BP depot' to the northernmost end of Fogafale in Funafuti Atoll (Figure 6). The maximum height above sea level in Lofeagai is 3 m. As for all the country, the community is extremely vulnerable to sea level rise, flooding, cyclones and drought events.



Figure 6. Location of the Lofeagai community.

Vegetation in the Lofeagai area includes *Pisonia* (pukavai), *Cordia* (kanava), *Calophyllum* (fetau), *Guettarda* (pua), *Scaevola* (gasu), *Pemphis* (gie), *Messerschmidia* (tausunu), coconuts, bananas and several types of pandanus trees.

The land around Lofeagai has been progressively degraded, first during the war when the USA military dug a burrow pit to build the airstrip. There has been further degradation by landowners taking soil for development purposes. Some of the resulting pits now form ponds of water between the shore and the road, further reducing land available for the community. Some of the pits have been used as public dumps creating a dangerous environment, especially for the poorest community members who live near to the dumps.

4.6.2. Demographics

The SEA completed for the PACC project in 2011 revealed that Lofeagai has a total population of 637 in 97 households, with an average of 5–8 people per household. The male:female ratio is 112:100, and Tuvaluans represent 95% of the community. Most of the Lofeagai community (74%) is composed of non-Funafuti islanders, as the area has been providing space for outer island migrants coming to Funafuti in search of better opportunities (Table 6). Added to migration from other densely populated areas on Funafuti, the population in the community has nearly doubled since 2002.

Table 6. Home island of Lofeagai community.

Nanumea	Nanumaga	Niutao	Nui	Vaitupu	Nukufetau	Funafuti	Nukulaelae	Others
9%	10%	6%	5%	12%	23%	22%	8%	4%

4.6.3. Socio-economic situation

ADB (2011) estimates that 26% of the population of Tuvalu lives under the poverty line. The SEA reveals similar results for Lofeagai, with 21% of the community considering themselves poor and facing hardship conditions and 57% believing they belong to the middle class.

Sources of household income are mostly wages and salaries (55% of households). Most households have only one individual engaged in formal employment (21% of Lofeagai population). Seventy-nine percent of the population do not have a formal job and are unemployed, catering for the household or engaged in village life activities.

Sex-disaggregated data for Lofeagai show that for the 11% of the community who have completed tertiary education, the male:female ratio is 100:77. Roles and chores within households are quite traditional, with men in charge of food supply and income and women in charge of food preparation and household chores.

With regard to water management, men are actively involved in collecting water (from the household tank or from the closest public cistern when the tank is empty) and maintaining water infrastructure. Women are the main users, for food preparation, general cleaning and bathing of children (Table 7).

Table 7. Roles of women and men in the Lofeagai community.

Tasks	Female (no.)	Male (no.)	Tasks	Female (no.)	Male (no.)
Ocean fishing	2	84	Working at Pulaka pits	11	58
Lagoon fishing	26	87	Collecting waters	34	69
Sea-bed fishing	23	83	Taking kids to school	64	42
Preparing salt fish	72	30	Cleaning the house	88	43
Selling fish for profit	70	24	Building the house	12	86
Preparing food	89	25	Cleaning rain gutters	7	87
Cooking food	89	28	Cleaning the toilets	76	54
Gardening	50	45	Seeking income	73	90
Planting edible trees	37	64	Looking for food	75	90

Religion is central in the Tuvaluan community. The main religion in Tuvalu is EKT. In Lofeagai, 75% of the population is affiliated with the EKT church. Other religions include Jehovah's Witnesses, Catholics, Bahaii, Seventh Day Adventists, Brethren, Latter Day Saints, and others (Figure 7).

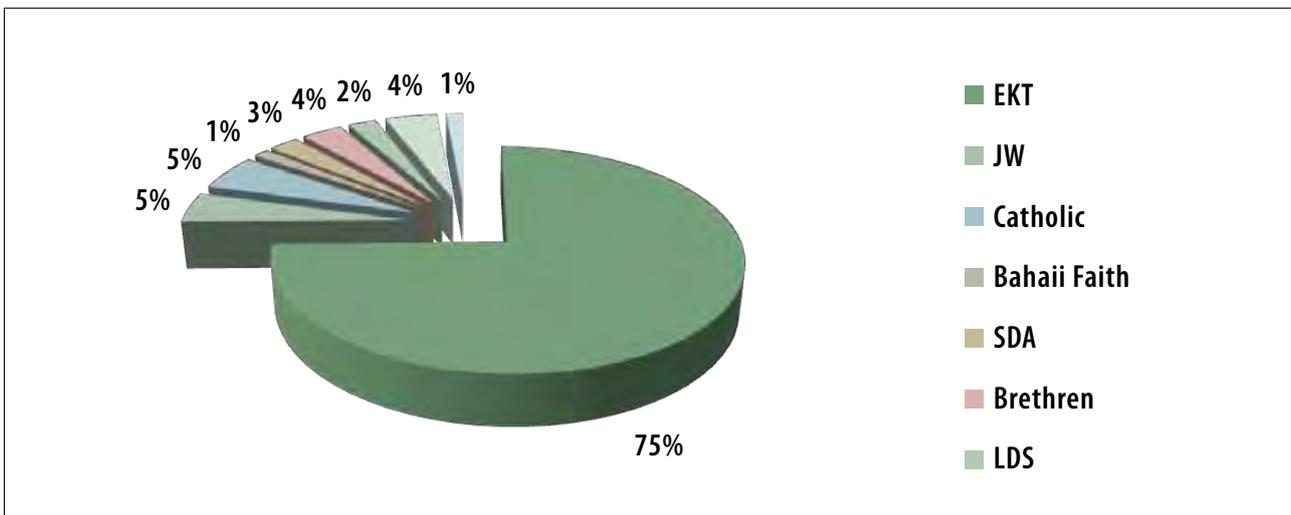


Figure 7. Lofeagai population religion affiliations.

4.6.4. Water supply and sanitation

The only source of freshwater in Lofeagai is rainwater and desalinated water purchased from the government at Aus\$13.50 per 500 gallons (1,900 litres). Before the PACC project, there was no communal cistern and rainwater was stored privately only. The total volume of storage before the PACC project was 7,692 kL. With the cistern the total storage is now 8,392 kL.

Most households are equipped with 10,000 L locally manufactured polyethylene tanks which, for an average household of seven people and a restricted water demand of 40 L per person per day, offer 35 days of supply during drought. Households in Lofeagai generally have a poorly maintained water catchment.

Forty-eight percent of the community use flush toilets with septic tanks or (more often) cesspits; 35% use pour flush toilets; and 13% do not have any toilet. One percent have a compost toilet. Compost toilets are one of the best solutions to avoid sewage contamination of the groundwater and the coastal area on the lagoon side. However, community acceptance of this technology is very low in Lofeagai.

4.6.5. Local stakeholders, institutions, and coordination structures

There are national laws and policies restricting access to vulnerable resources (e.g. coral aggregate and sand) and conservation areas, as well as regulations on fishing methods. However there are currently no laws or national regulations covering water resources.

Lofeagai falls under the authority of the Funafuti Kaupule (i.e. town council). Lofeagai residents pay head tax and other business taxes to the Funafuti Kaupule.

Socially, home island communities gather together regularly. These communities have a hereditary leader (king or chief) and a board (secretary, treasurer). The EKT church, to which 75% of the community belongs, is led by a chief deacon, a board and a pastor.

The SEA identified that except for the EKT community, there is no formal leadership or decision-making body for the Lofeagai community. The capacity for the EKT church to operate and maintain the cistern as a communal water body was an important factor for the PACC project.

4.7. Project design

4.7.1. Process

Following the identification of Lofeagai as the site for the pilot project, and a desk review of existing data and gaps in knowledge, two assessments – the V&A and the SEA – were carried out to identify the most relevant demonstration option to increase Tuvalu’s resilience to drought within the PACC budget. A water demand management survey was also undertaken in order to gather an accurate picture of households’ water consumption and needs.

In late 2011, with the adaptation option identified, a local consultant was contracted to design the cistern. A pilot site design report was produced to identify the best location and features of the cistern, which included a three-dimensional picture of the end product (Figure 8).

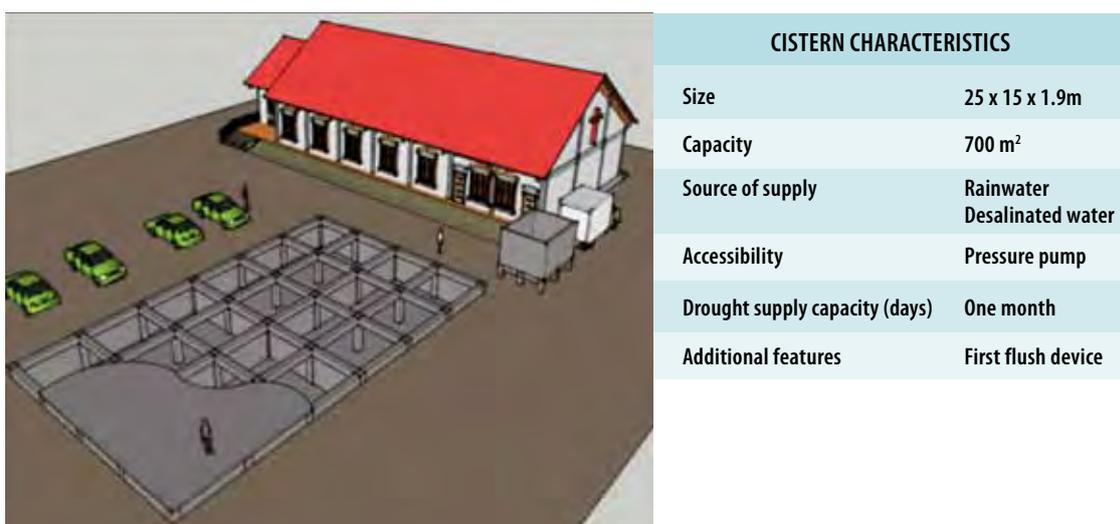


Figure 8. Illustration and characteristics of the planned cistern.

4.7.2. Calculating optimum size of the cistern

In order to decide on the most suitable size for the cistern, the pilot site design report used rainfall averages for Lofeagai and forecasted water demand. Considering the roof size of 546 m², the proposed 700,000 L cistern would take around 5.5 months to recharge in an average year (Table 8). Using two scenarios of 40 L and 100 L per household per day, in a severe drought event (no rainfall), the cistern would provide respectively 6 months of water (40 L per household per day) and 2.5 months of water (100 L per household per day) (Table 8).

Although 5.5 months is a long recharge time, this time will be reduced during the wet season and during heavy rainfall events. Also, adding an extra roof catchment on top of the cistern in the future would reduce the recharge time.

Table 8. Calculation for the design of the water cistern.

Data		Calculations
Roof surface	546 m ²	Estimated average of water harvested monthly (average rainfall x roof surface area x runoff coefficient): $546 \text{ m}^2 \times 0.292 \text{ mm} \times 0.8 = 127.55 \text{ m}^3 = 127,550 \text{ L}$
Average rainfall (monthly)	292 mm	
Total storage area	700 m ³	Estimated time needed to fill up the cistern (assuming no water is being abstracted): $700/127.550 = 5.5 \text{ months}$
Domestic water demand per household per day – without drought restrictions	100 L	Monthly water demand per household (average daily water demand per household x 30 days): $100 \times 30 = 3,000 \text{ L}$ Number of months of supply for Lofeagai community starting with a full cistern in a severe drought event (no rainfall): $750,000/3000/97 = 2.4 \text{ months}$
Domestic water demand per household per day – drought restrictions in place	40 L	Monthly water demand per household (average daily water demand per household x 30 days): $40 \times 30 = 1,200 \text{ L}$ Number of months of supply for Lofeagai community starting with a full cistern in a drought event (no rainfall): $700,000/1200/637 = 6 \text{ months}$

Within the given PACC budget and the above criteria, it was agreed that a cistern with capacity of 700 kL was the most suitable. A bigger cistern would be more costly and might not be justified, as it would rarely recharge fully. A smaller cistern would provide less than 6 months' supply to Lofeagai during drought, which would be too low to justify the cost involved.

The cistern plans were then developed, and are provided in Appendix 1.

4.8. Project implementation

In September 2011, with the cistern design completed, PACC started to work on the procurement of building materials and a bid for tender was advertised using Tuvalu government procedures. The implementation of the demonstration project was planned to start in October 2011 with completion scheduled for July 2012, allowing time for variations/issues.

The planned schedule was as follows:

- September 2011: design of engineering plans completed and bid for tender advertised;
- October 2011: contractor identified;
- October 2011 to July 2012:
 - Installation of gutters to the Lofeagai chapel for rainwater collection;
 - Construction of the 25 x 15 x 1.9 m water cistern;
 - Construction of a small overhead tank;
 - Installation of water pump;
 - Installation of first flush system;
- August 2012: Handover to the Lofeagai community.

The project implementation did not go entirely as planned and there were some delays. Excavation work on site began in early 2012. According to the March 2012 PACC newsletter, machinery breakdowns coupled with heavy rainfall and high tides delayed the project. In order to overcome this issue and keep working, the building team decided to build the cistern by compartment instead of waiting to have everything ready to build it in one go.

On 30 March, PACC organised a small gathering with the Lofeagai community to celebrate the first cement poured in the foundation (a normal custom in Tuvalu). The Tuvalu media department was there to cover this event.

The cistern construction was successfully completed in late 2012, 4 months behind schedule (Figure 9). The official handover to the Lofeagai community was held on 23 January 2013, in the presence of the Deputy Prime Minister and Minister for Public Utilities Hon. Kausea Natano. Figure 10 shows the completed cistern.

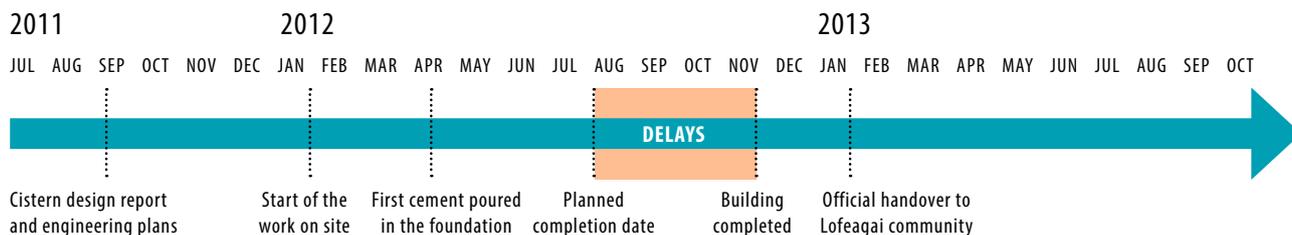


Figure 9. Project implementation process.



Figure 10. The completed water cistern at Lofeagai, and the EKT church.

Although the time of work on the site was only 2.5 months, it took a total of 11 months to be finished. Miscalculations on material ordered and lack of communication from the building supervisor were identified as the main issues causing the delay. A shortfall of funds also meant that PACC had stop the work for a few months until a solution was found. The main issues and PACC actions to overcome them are summarised in Table 9.

Following completion, management and maintenance of the cistern and associated infrastructure (pipes, guttering, etc.) is under the responsibility of the Lofeagai EKT church. A simple, 2-page plan to inform the church leaders and the Lofeagai community on basic rules for the use of the cistern has been developed and is on display next to the cistern. The plan recognises the needs of women and vulnerable groups to have equal access to and share of the cistern benefits.

Table 9. Project implementation issues and responses.

Issue	PACC team response
Heavy rainfall and high tides	Build the cistern by compartment allowing dewatering of small areas
Lack of equipment – only one truck available to attend all of contractor’s projects	A meeting was held at CEO level to raise issue. It was agreed that the director for PWD would now personally supervise the work and replace previous supervisor. Material was quickly ordered and priority was given to the PACC project to access PWD machinery.
Building supervisor does not communicate efficiently and has not provided any report on issues arising and reason for delay	
Shortfall of construction materials not available on island (has to be shipped from Fiji)	
Shortfall of funds – PACC Tuvalu spent all of the allocated funds for quarter 3 which were not sufficient to cover agreed costs of works	The issue was raised with SPREP and agreement was reach for SPREP to advance funds while waiting for the 4th quarter payment to be transferred by UNDP

4.9. Linkages with strategic plans and processes

The overarching document for all sectors in Tuvalu is the *Te Kakeega* (Sustainable Development Strategy). The document details goals for key strategic development sectors. One priority (11.4) concerns the environment and the need to develop resilience to climate change.

The PACC project has been central to the development of *Te Kaniva*, the Climate Change Policy Framework, and the National Strategic Action Plan (NSAP) for climate change and disaster management, which serves as the implementation plan for the policy.

PACC and IWRM projects have also coordinated the development of the Water and Sanitation Policy. The Policy is gender-sensitive, for example, it recognises the need for women to be involved in the decision-making process for the water sector, and to target women in awareness activities. An IWRM plan is currently being developed by the IWRM project and will serve as the implementation plan for the Water and Sanitation Policy.

The demonstration project is in line with existing strategies and plans for the climate change and water sector as it improves resilience to climate vulnerability and change at a community level. It especially addresses the first goal of the NSAP, ‘Strengthening adaptation actions to address current and future vulnerabilities’, and the two priorities:

1. Assess water availability and feasibility of water security options including rainwater harvesting, underground water and desalination on all islands.
2. Implement improved rainwater harvesting, access to underground water and install energy efficient desalination on all islands.

4.10. Monitoring and evaluation

The monitoring and evaluation (M&E) process is vital to ensure that the project is sustainable and is delivering expected outcomes. The M&E process of the PACC project has been continuous with quarterly reports on progress, issues and lesson learned. Quarterly reports cover all outcomes of the PACC project, including the demonstration project.

In order to monitor progress on set objectives and expected outcomes, the PACC project uses a logical framework (logframe) assessment methodology. Each of the expected outcomes is subdivided into short-, medium- and long-term objectives detailing various outputs to achieve in order to reach the objectives. As much as possible, quantitative indicators are use to monitor progress (Table 10).

Table 10. Objectives and indicators for the PACC demonstration project as stated in the project logframe.

Objectives	Target and benchmarks
Long Term Outcome 2: Increased resilience of Lofeagai communities to climate risks in the water sector during drought	<ul style="list-style-type: none"> • At least 90% of the Lofeagai population has access to the minimum water supply of 40 L per day per household during extreme dry period. • By 2013, at least 70% of households in Lofeagai community meet the drinking water quality according to the H2S methodology
Medium Term Outcome 2: Target community benefitted from adaptation measures Secured water supply with improved access for the community	100% of households perceive reduction in their vulnerability to shortage of water and build their resilience
Short Term Outcome 2: Demonstration measures to reduce vulnerability in water sector implemented	Provision of additional 700,000 L for the people of Lofeagai community as a backup to support the community during extended dry periods
Output 2.1: Guidelines developed to integrate climate risk into the water sector	Guidelines developed by the end of 2013
Output 2.2: Community water cistern built	A major community reserve built and ready for the people of Lofeagai community to use by the end of 2013
Output 2.3: Water pump at the community reserve installed	By the end of 2012, a community water reserve constructed with a water pump installed reducing the workload for women when collecting water
Output 2.4: Lofeagai water village management plan with gender consideration developed	By the end of the 2013, a management plan endorsed by the NWSSC

The PACC team has been collecting sex-disaggregated data during the construction of the cistern. This has enabled the team to identify and correct several issues as detailed in Section 4.8. In order to assess long- and medium-term outcomes identified in the logframe, a community perception survey was undertaken in 2013 (see Section 5.3).

4.11. Upscaling and replication (PACC+)

In 2013, six of the 14 PACC countries were selected to benefit from additional funding from the multi-country component of PACC+ (US\$2.6m). PACC+ aims to support the upscaling and/or replication of pilot adaptation projects that have demonstrated their efficiency in addressing targeted climate change issues.

PACC Tuvalu was one of the beneficiaries of PACC+. A technical evaluation of the demonstration project was carried out in order to assess the relevance of a replication project in another community and/or an upscaling of the project.

It was decided that the PACC+ funds would be allocated to:

1. Replication of the current project: a water cistern in Tekavatoetoe;
2. An upscaling in Lofeagai with the construction of a roof over the cistern.

Tekavatoetoe was identified during the V&A stage of the project as the second most vulnerable community after Lofeagai. The community was thus prioritised to benefit from the PACC+ funding. The new cistern is smaller than the one built in Lofeagai (288,000 L) but will follow the same arrangement with the EKT church in Tekavatoeote, that is, the church will be responsible for management and maintenance of the cistern and associated infrastructure. The cistern is to serve as a foundation for the new EKT church to be built in Tekavatoetoe (Figure 11). Handover to the Tekavatoetoe community is expected in mid-November 2014.



Figure 11. Construction of a water cistern in Tekavatoetoe as part of the PACC+ replication project.

In Lofeagai, the construction of a roof over the cistern will allow harvesting of more water and will provide a community hall. The EKT church will also contribute financially to the project.

5. SUSTAINABILITY, RELEVANCE, EFFECTIVENESS AND EFFICIENCY

5.1. Sustainability

Sustainability of development projects is arguably the most important and yet often overlooked aspect of project design. Examples of projects that failed to deliver expected outcomes once implemented are numerous.

PACC Tuvalu has successfully reached its short- and medium-term outcomes. Although the project is still very recent, there are reassuring elements indicating that the project will sustainably enhance resilience to drought to the Lofeagai community (Table 11):

- The cistern has been built using thicker than usual cement walls to withstand harsh local conditions;
- The community perception survey revealed that more than 80% of the community is satisfied with the project;
- The cistern will be operated and maintained by an already existing and widely respected community organisation (Lofeagai EKT church);
- The cistern will provide substantial savings to the government during drought events.

Table 11. Sustainability parameters for the PACC demonstration project.

Domain	Parameter	Sustainability indicator
Socio-cultural	Water demand	The cistern is providing an additional 700,000 L of water, which represents 6 months' supply (at 40 L/household/day) for the whole community
	Cultural compatibility	The cistern does not modify status quo of water delivery or infrastructure asset (communal cisterns are a common feature within Tuvalu)
Infrastructure	Life span	Life span of the cistern is 30 to 50 years
	Required maintenance	Required maintenance is low for the cistern and will mostly consist of connected pipes, water gauge, tap, water pump and overhead tank
Political	Political support/in line with public policy/political agenda	The project is in line with Tuvalu's water policy and climate change policy. Water issues are taken very seriously, especially after the critical drought in 2011
Economic	Energy consumption	The project is expected to decrease energy consumption by providing 700,000 L of water that would otherwise have had to be produced by reverse osmosis (RO) in time of drought
	Net benefit/return on investment	This is a community project and no benefit or return on investment is expected. However, as detailed previously, the saving for the government (to produce RO water) and the community (to purchase RO water) will be significant
Environmental	Impact on groundwater resource	Although groundwater is not widely used in Funafuti, increasing rainwater storage has the potential to reduce groundwater abstraction
	Adverse effect on environment	None identified at this stage
	Climate resilience	The cistern is building resilience to drought. The infrastructure should not be vulnerable to cyclones; however, in the long term sea level rise could threaten the cistern. Currently and in the future flooding is the main risk for the infrastructure as saltwater and runoff could contaminate the water

5.2. Relevance and effectiveness

Concrete water cisterns are a proven and efficient way to store water. They are expensive to build but offer one of the best lifespans among storage technologies.

Concrete water cisterns are already widely used in Tuvalu and the Pacific region and therefore do not offer much in terms of learning about the technology. However, there are some important lessons to be learned from the planning approach used by the PACC project, in order to identify and empower existing informal coordination structures within the community to support the project.

There are numerous examples of projects that have failed in the region due to negligence and lack of maintenance. Similarly, land issues have proven to be particularly hard to tackle in the region and have led to the failure of several community projects. In identifying the church as the best body to operate and maintain the cistern, PACC Tuvalu has successfully overcome land issues (i.e. the cistern has been built on land leased by the church) and maintenance and operation responsibilities (i.e. all maintenance will be covered by the church which is likely to fulfil its obligation to the community).

One risk in this approach is that not all the community in Lofeagai is affiliated to EKT and some community members (15–20%) were concerned about the cistern being attached to the church. The challenge is to ensure fairness over access to the service. In order to overcome this issue, PACC Tuvalu developed an MoU between the Government and the Lofeagai EKT Church that details entitlements and rights over the use of the water.

5.3. Efficiency

The expected benefits that the project will bring to the community have been stated in the logframe as short-, medium- and long-term outcomes. The main goal is to improve resilience to climate variability and change by reducing vulnerability of the community to drought and water shortage. One immediate outcome of the project is an improvement in access to water supply within the community.

In order to evaluate whether or not the project has been efficient in delivering expected outcomes to the community, a door-to-door survey was carried out in Lofeagai by the PACC Tuvalu team in February 2014. The survey revealed that the majority of the community is satisfied with the outcomes brought by the project and confident that it will address water shortage issues that the community will face in the future (Table 12).

Table 12. Community perception survey results.

Expected benefit	Community satisfaction
Is the solution improving water security in the community?	78%
Proximity of water supply	100%
Reduced financial stress on community members	88%
Fully address water shortage issues for the future in Lofeagai	84%

Note: This is an interpretation of the results from the PACC survey. The questions were not exactly formulated as presented in the table above.

The survey did not capture the reason for non-satisfaction in the project (i.e. the 22% of the community who did not believe that water security was improved). However, it is likely to be due to:

1. The location of the cistern and attachment to the EKT church (i.e. non-EKT community members might feel that the project will not benefit them directly);
2. The technology involved: some community members could have preferred a desalination technology that will offer 'endless' water supply during drought.

6. ADJUSTMENTS

Throughout the implementation and M&E phase, a series of adjustments have been necessary to overcome unexpected issues or to change features of the demonstration project that did not suit the recipient community. Necessary adjustments made during the building phase were detailed in Section 4.8. Further adjustments made to the project are detailed below.

Overhead tank: A land issue arose at the end of the building phase as the landowner next to the church was not happy to have a concrete overhead tank overlapping on his land. To overcome this issue, the PACC team decided to install a PVC overhead tank on top of the cistern.

Pump: Originally, an electric pump was chosen to pump the water from the cistern. However, the church leader was concerned about the cost of running the pump that would be fall to the church. Instead the church leader asked for a manual pump to be installed. However, this was raised as a concern during the evaluation of the project by a water expert in 2013, as it may limit access as some community members may not be able to operate a manual pump. It was recommended instead to install a solar pump, in order to guarantee access to the water by everyone. However, it was recommended to have a manual pump as a backup device and also in case of over-use of the water by the community, in order to conserve water.

Flow meters: Flow meters were not originally planned to be installed in the cistern. However it was raised during the review of the project in 2013 that flow meters could help with the management of the cistern in order to set daily limits. Flow meters have therefore been installed.

Management plan: A management plan for the cistern was planned from the early stages of the project. However, its format and objectives have varied as the mid-term review of the project recommended to have a comprehensive integrated water management plan for Lofeagai that will include the cistern. This was also raised during the PACC+ evaluation. However, the PACC+ evaluation recommended to develop a very simple, 2-page plan to directly inform the church leaders and the Lofeagai community on basic rules for the use of the cistern. This plan has been developed and is now on display next to the cistern.

7. LESSONS LEARNED

7.1. Overall

1. Comprehensive planning can deliver great outcomes. It can be argued that the construction of a cistern is a relatively easy task compared to other PACC water projects, however the Tuvalu PACC project has been very successful in identifying gaps in knowledge and necessary steps to implement its demonstration project. The project successfully identified one of the most vulnerable communities, selected a sustainable and efficient solution within the PACC budget, and used informal community leadership to implement and manage the adaptation measure. Tuvalu's demonstration project is a good example of how comprehensive planning and proactive management can successfully deliver outcomes.
2. A better prepared M&E could have avoided some minor issues. During a field visit by a water expert in June 2013, the expert observed that three of the cistern manholes were open. Looking inside, two of them had been filled with rubbish (metal tin and a few other scrap metals), probably by children. This was signalled to the PACC coordinator who informed the pastor and the rubbish was removed and the manholes shut. This could have been avoided by a more regular monitoring of the cistern use.

7.2. Step by step lessons learned by the project team

As part of the M&E process, quarterly reports required the project team to report on progress and share issues they were facing and lessons learned in overcoming the issues. Table 13 gathers the main lessons learned by the PACC team in this way.

Table 13. Lessons learned by the PACC team during the course of the project.

	Lesson learned/recommendation
Community engagement, training and awareness	<ul style="list-style-type: none"> • When conducting an awareness/training/workshop whereby you engage your core team, ensure to hold a debriefing session after a day's hard work to work out gaps for improving the next day's agenda • All training material to be available in local language • Always try questionnaires with staff in office before heading to the field to ensure they flow correctly and are easy to understand • Do not presume that everyone uses new communication technologies. Always integrate this with more traditional communication systems • Not everyone is comfortable with participating in a workshop or speaking up in a meeting. The use of questionnaires is often a relevant means of gathering people's opinions
Implementation	<ul style="list-style-type: none"> • Ensure that the budget is carefully planned • Ensure that the project manager for the construction work is a good communicator and provides regular updates on the progress and issues faced • Ensure that the contractor has sufficient machinery available for the project • Monitor the procurement process and ensure that sufficient material is available on site
Monitoring and evaluation	<ul style="list-style-type: none"> • Have regular monitoring in place even after completion of the project (included in the budget) to ensure that it is used accordingly and deliver expected benefits
Coordination	<ul style="list-style-type: none"> • Coordination is very important between different projects that share similar goals. This helps to share resources, knowledge and costs, as well as deliver joint outcomes such as the Tuvalu Water Policy developed with the IWRM project.

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APPENDIX 1. LOFEAGAI WATER CISTERN PLANS

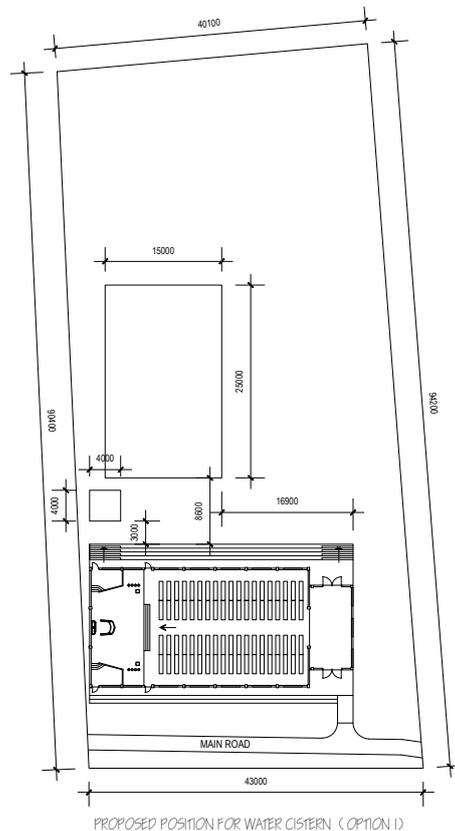
LOFEAGAI COMMUNITY WATER CISTERN PROJECT

PROJECT NO:1111

- A00 - SITE PLAN
- A01 - FLOOR PLAN
- A02 - FOUNDATION PLAN

- S01 - SECTIONAL

- D01 - TYPICAL DETAILS 1
- D01 - TYPICAL DETAILS 2
- D01 - TYPICAL DETAILS 3



PROPOSED POSITION FOR WATER CISTERN (OPTION 1)

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REF.	DATE	REVISION

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CLIENT:
PACC

PROJECT:
PROPOSE WATER CISTERN FOR LOAFEGAI AREA

DRAWING TITLE:
PROPOSED SITE PLAN

DESIGNED: C LEEPO DRAWN: C LEEPO

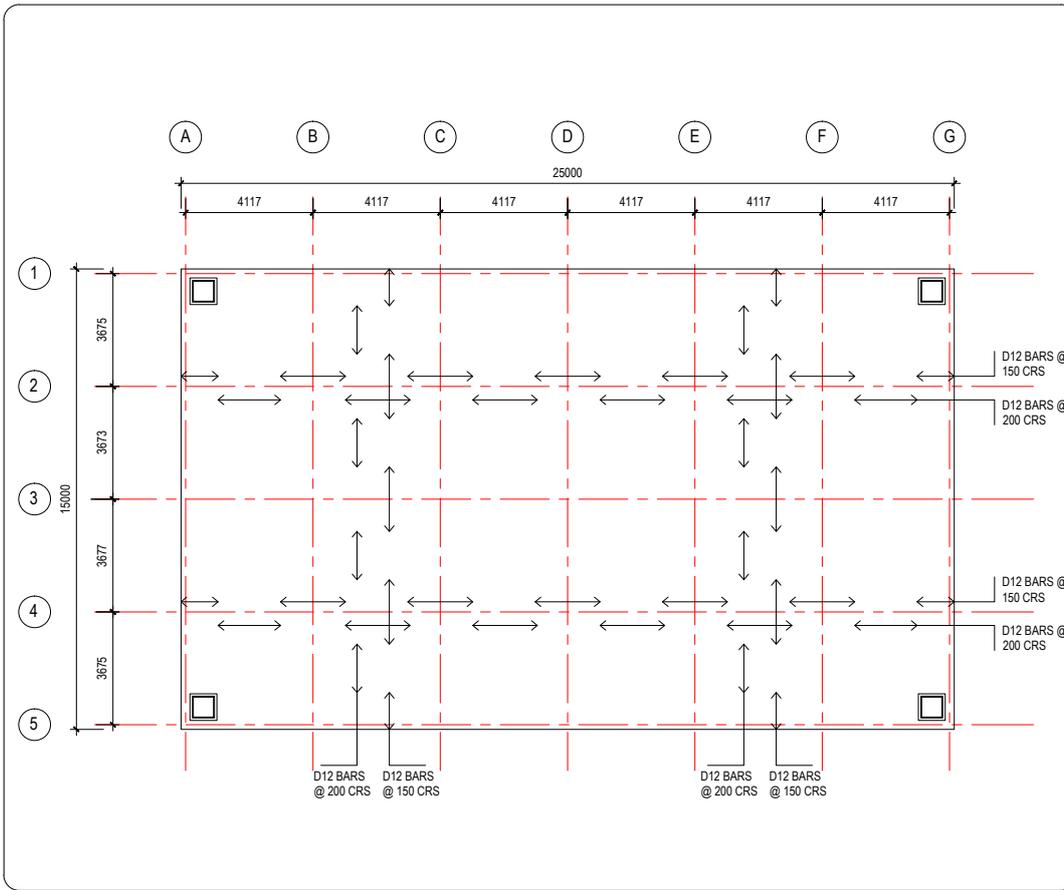
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DATE: 28/04/2011 DIVISION: DSU

PROJECT NO:

SHEET NO	REVISION	SHEET NO

A00



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PH: 20 302
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CLIENT:
PACC

PROJECT:
PROPOSE WATER CISTERN FOR LOAFEGAI AREA

DRAWING TITLE:
FLOOR PLAN LAYOUT

DESIGNED: C LEEPO **DRAWN:** C LEEPO

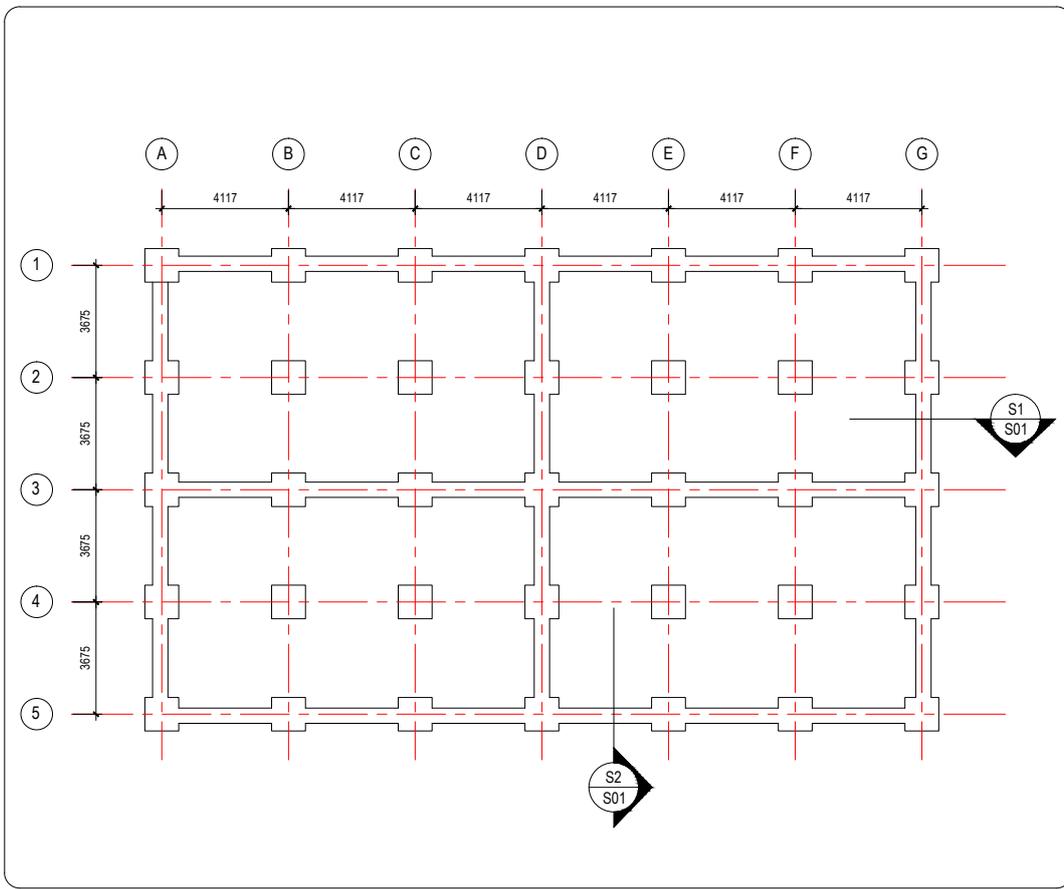
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DATE: 28/04/2011 **DIVISION:** DSU

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CLIENT:
PACC

PROJECT:
PROPOSE WATER CISTERN FOR LOAFEGAI AREA

DRAWING TITLE:
FOUNDATION LAYOUT

DESIGNED: C LEEPO **DRAWN:** C LEEPO

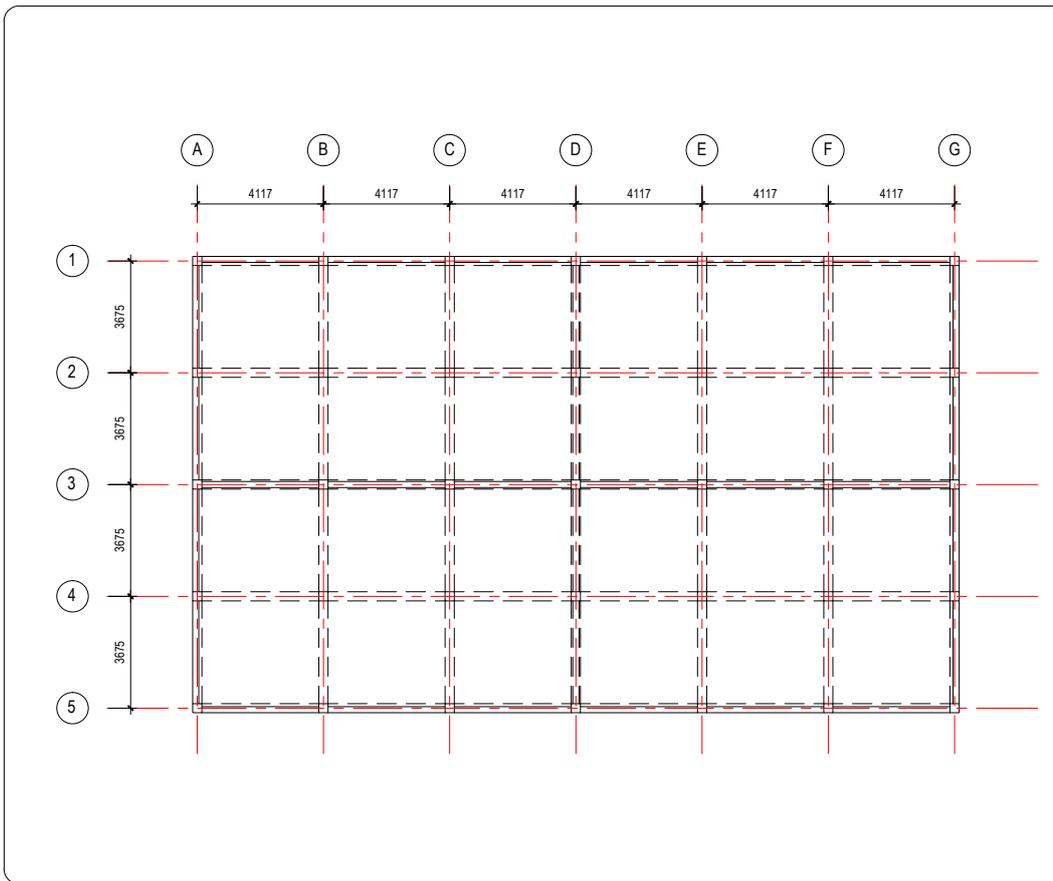
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CLIENT: **PACC**

PROJECT: **PROPOSE WATER CISTERN FOR LOAFEGAI AREA**

DRAWING TITLE: **INTERNAL STRUCTURAL PLAN LAYOUT**

DESIGNED: C LEEPO	DRAWN: C LEEPO
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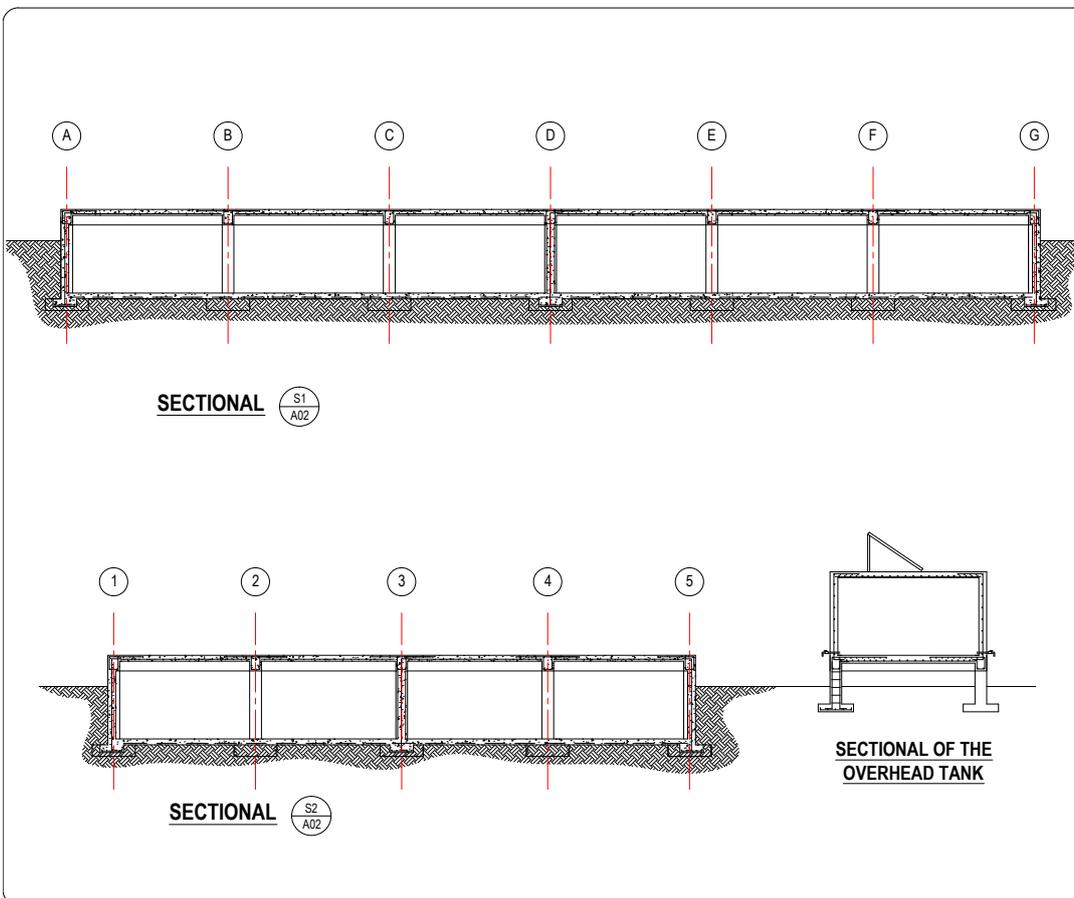
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CLIENT: **PACC**

PROJECT: **PROPOSE WATER CISTERN FOR LOAFEGAI AREA**

DRAWING TITLE: **SECTIONAL DRAWINGS**

DESIGNED: C LEEPO	DRAWN: C LEEPO
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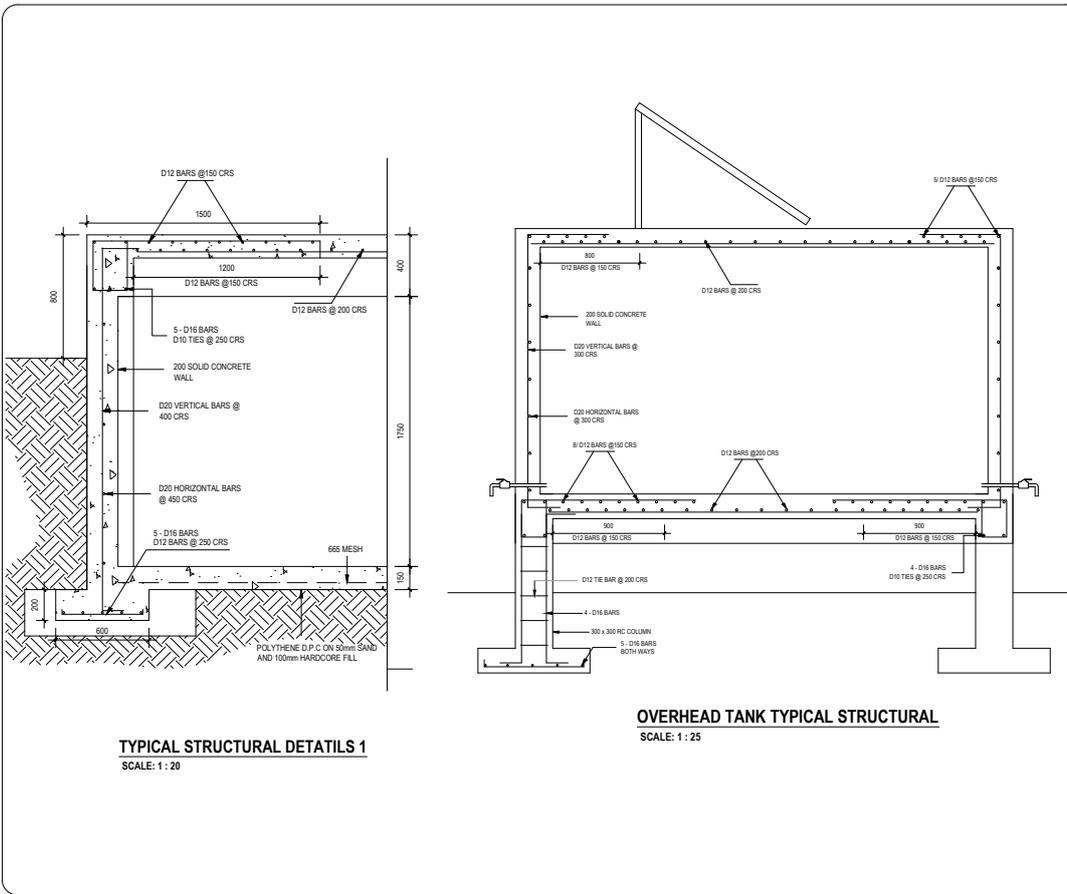
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PROJECT NO:

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CLIENT:
PACC

PROJECT:
PROPOSE WATER CISTERN FOR LOAFEGAI AREA

DRAWING TITLE:
TYPICAL DETAILS

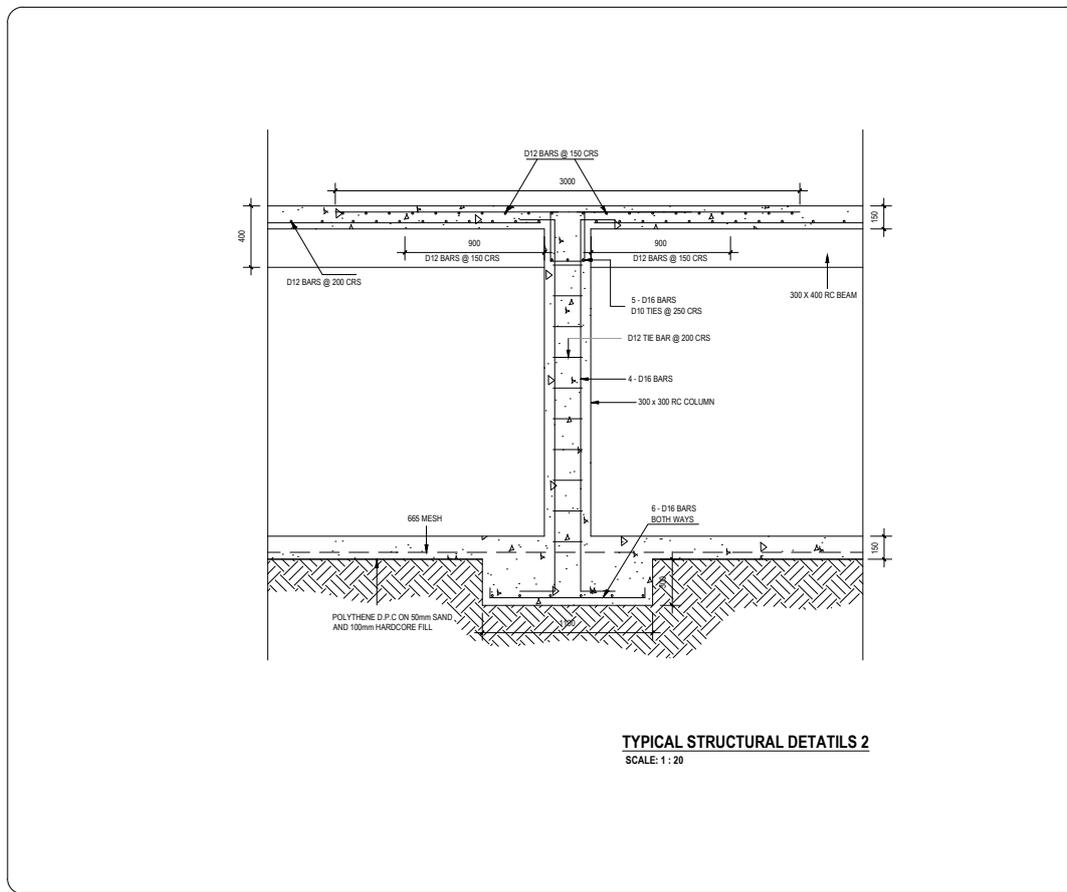
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APPROVED:	SCALE: 1: 100
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DATE: 28/04/2011	DIVISION: DSU
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PROJECT NO:

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CLIENT:
PACC

PROJECT:
PROPOSE WATER CISTERN FOR LOAFEGAI AREA

DRAWING TITLE:
TYPICAL DETAIL DRAWINGS

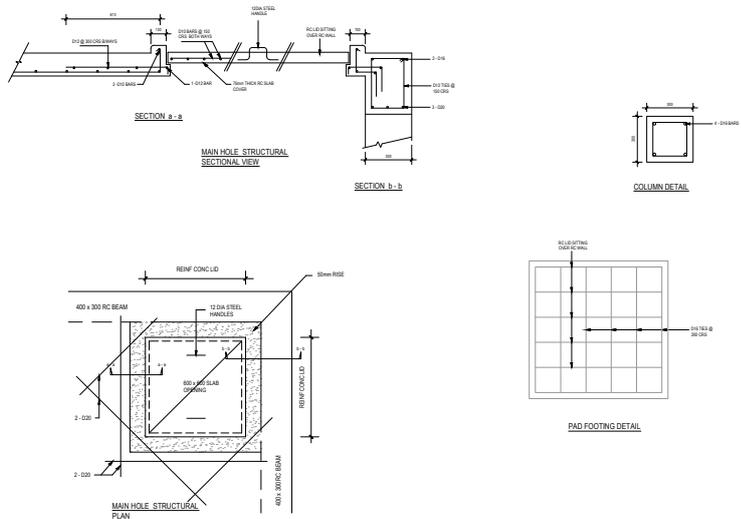
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		D02



TYPICAL STRUCTURAL DETAIL 3
SCALE: 1 : 20

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CLIENT:
PACC

PROJECT:
PROPOSE WATER CISTERN FOR LOAFEGAI AREA

DRAWING TITLE:
TYPICAL DETAIL DRAWINGS

DESIGNED: C LEEPO
DRAWN: C LEEPO

APPROVED: NTS

DATE: 28/04/2011
DIVISION: DSU

PROJECT NO:

SHEET NO.	REVISION	SHEET NO.

D03



PACC – building adaptation capacity in 14 Pacific island countries and territories



PACIFIC ADAPTATION TO CLIMATE CHANGE (PACC) PROGRAMME

The PACC programme is the largest climate change adaptation initiative in the Pacific region, with activities in 14 countries and territories. PACC is building a coordinated and integrated approach to the climate change challenge through three main areas of activity: practical demonstrations of adaptation measures, driving the mainstreaming of climate risks into national development planning and activities, and sharing knowledge in order to build adaptive capacity. The goal of the programme is to reduce vulnerability and to increase adaptive capacity to the adverse effects of climate change in three key climate-sensitive development sectors: coastal zone management, food security and food production, and water resources management. PACC began in 2009 and is scheduled to end in December 2014.

The PACC programme is funded by the Global Environment Facility and the Australian Government with support from the United Nations Institute for Training and Research (UNITAR) Climate Change Capacity Development (C3D+). The Secretariat of the Pacific Regional Environment Programme (SPREP) is the implementing agency, with technical and implementing support from the United Nations Development Programme (UNDP).

www.sprep.org/pacc

PACC TECHNICAL REPORTS

The PACC Technical Report series is a collection of the technical knowledge generated by the various PACC activities at both national and regional level. The reports are aimed at climate change adaptation practitioners in the Pacific region and beyond, with the intention of sharing experiences and lessons learned from the diverse components of the PACC programme. The technical knowledge is also feeding into and informing policy processes within the region.

The Reports are available electronically at the PACC website: www.sprep.org/pacc, and hard copies can be requested from SPREP.

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