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Building Resilience to Climate Change in Pacific Communities

PACC TECHNICAL REPORT 14

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# PACC Demonstration Guide: Improving domestic rainwater harvesting systems in Niue

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# PACC Demonstration Guide: Improving domestic rainwater harvesting systems in Niue

# TABLE OF CONTENTS


| | |
|---|---|
| Acknowledgements | iv |
| Executive summary | v |
| Abbreviations | vi |
| **1. INTRODUCTION** | **1** |
| 1.1. Project rationale and objectives | 1 |
| 1.2. Policy and strategic frameworks | 2 |
| **2. COUNTRY INFORMATION AND CONTEXT** | **3** |
| 2.1. Geography and demographics | 3 |
| 2.2. Socio-cultural and economic background | 3 |
| 2.3. Climate | 4 |
| 2.3.1. Observed trends | 4 |
| 2.3.2. Future trends | 5 |
| **3. THE WATER SECTOR IN NIUE** | **6** |
| 3.1. Water resources | 6 |
| 3.2. Water management | 6 |
| 3.2.1. Public water reticulation | 6 |
| 3.2.2. Rainwater | 8 |
| 3.3. Institutional arrangements and legal framework | 8 |
| 3.4. Climate risks, vulnerabilities and impacts | 9 |
| 3.5. Non-climate-related risks | 9 |
| **4. THE DEMONSTRATION PROJECT** | **10** |
| 4.1. Preparatory phase | 10 |
| 4.1.1. Selection of adaptation sector | 10 |
| 4.1.2. Project planning | 10 |
| 4.1.3. Institutional framework for the PACC project | 11 |
| 4.2. Situational and problem analysis | 12 |
| 4.3. Solution analysis | 12 |
| 4.3.1. Identification and selection of adaptation options | 12 |
| 4.3.2. Technical assessment: rainwater harvesting system design for Niue | 13 |
| 4.3.3. Cost–benefit analysis | 14 |
| 4.3.4. Selected adaptation measure and recipient communities | 15 |
| 4.4. Design phase | 16 |
| 4.4.1. Household survey and database | 16 |
| 4.4.2. Call for expressions of interest, tender process and selected option | 16 |
| 4.4.3. Technical design | 17 |

4.5. Implementation 20
4.5.1. Implementation process 20
4.5.2. Construction of the tank moulding facility 20
4.5.3. Moulding of rainwater tanks 21
4.5.4. Delivery and fitting of rainwater harvesting systems 23
4.6. Monitoring and evaluation 23
4.6.1. M&E process 23
4.6.2. Monitoring delivery, installation and tracking system 25
4.6.3. Project status – November 2014 25
4.7. Adaptive management 25
4.8. Training, knowledge sharing and awareness 26

**5. SUSTAINABILITY, RELEVANCE, EFFECTIVENESS AND EFFICIENCY 28**
5.1. Sustainability 28
5.2. Relevance 29
5.3. Effectiveness 30
5.4. Efficiency 30

**6. LESSONS LEARNED AND BEST PRACTICES RECOMMENDED 31**
6.1. Overall 31
6.2. Step by step 31

REFERENCES 32
APPENDIX 1. HOUSEHOLD SURVEY TEMPLATE 33
APPENDIX 2. MARLEY'S RAINWATER HARVESTING GUIDE AND CATALOGUE ADJUSTED FOR NIUE 35

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# EXECUTIVE SUMMARY


In Niue, the Pacific Adaptation to Climate Change (PACC) project is building resilience to climate variability and climate change by improving the country's water resources management. This technical report was developed as part of the PACC demonstration project, to detail the process undertaken to design and implement a rainwater tank manufacturing plant in Niue and supply eligible households on Niue with rainwater harvesting systems.

The goal of the project is to provide an additional source of water to Niueans, by developing the country's rainwater harvesting capacity at domestic level. Initially aimed at the most vulnerable households on Niue, the project has been extended to all 14 villages on the island under additional funding called PACC+.

Niue's public water supply system provides freshwater, from groundwater, free of charge to all households on Niue. The groundwater lens is 35-40 m thick and thus far, fairly robust to drought periods. However, the current monitoring data is insufficient and precautionary measures have been recommended by the Government of Niue to ensure best use of this resource. The groundwater is deemed safe to drink and is pumped (without prior treatment) into storage tanks on the upper terraces of each village. Most of the villages are gravity fed from the storage tanks, thus do not require any power to pressurise the system. However, a few villages located on the upper terrace rely on power to distribute their water from the storage tanks.

The vulnerability of the water sector to climate variability and climate change was identified by the PACC team through a baseline review of existing literature and additional consultations with the Niue community and government. This revealed that the public water system is vulnerable to cyclones, heavy rainfall and drought periods. Water and power supplies are shut down leading up to, and during, cyclone events and can be down for extended periods in cases where there is damaged infrastructure. Houses that are located on the upper terraces and rely on power-pressured water systems can be left without running water for days. In the case of damage to the power supply infrastructure, the entire island is vulnerable to an interruption in water supply. Long drought periods can also affect the quality of the groundwater with saltwater intrusion. Heavy rainfall events can lead to flooding which carries the risk of contaminants entering the water network through leakages and directly into the freshwater lens from other pathways. Plus rainwater is wasted as it is not collected at the household level.

In order to reduce the vulnerability of the water sector to climate variability and climate change, the project is providing rainwater harvesting systems to eligible households on Niue. This will provide a relief supply of water to most households in case of cyclones, drought periods and heavy rainfall events. In order to reduce shipping costs and develop technical capacity on the island, a rainwater tank-manufacturing plant has been built on Niue and 520 tanks have been produced as at November 2014, with the potential to manufacture more if required, as well as other products. The project team is currently in the process of installing and connecting the tanks to each recipient household.

As of November 2014, 100% of the tanks planned by the project have been manufactured and 40% have been installed. The project will be completed March 2015. It is expected that the Government of Niue, through the Department for Environment in partnership with the Water Division of the Public Works Department, will continue to programme the remaining implementation activities of the project into its planned activities for the year 2015. Activities such as the remaining 60% installation works will therefore be targeted to be completed by end of 2015. Monitoring and evaluation will continue internally as per agreement under the MOU.

# ABBREVIATIONS

| | |
|---|---|
| **CBA** | Cost–benefit analysis |
| **CoC** | Chamber of Commerce |
| **DCA** | Department for Community Affairs |
| **ENSO** | El Niño Southern Oscillation |
| **EOI** | Expression of interest |
| **EU** | European Union |
| **FFD** | First flush diverter |
| **GCCA** | Global Climate Change Alliance |
| GEF | Global Environment Facility |
| **GoN** | Government of Niue |
| HDPE | High density polyethylene |
| **IWRM** | Integrated Water Resources Management [project] |
| **JNAP** | Joint National Action Plan on Climate Change and Disaster Risk Management |
| **M&E** | Monitoring and evaluation |
| **NGO** | Non-governmental organisation |
| **NPV** | Net present value |
| **NWSC** | Niue Water Steering Committee |
| **PACC** | Pacific Adaptation to Climate Change [project/programme] |
| **PACCSAP** | Pacific–Australia Climate Change Science and Adaptation Planning Programme |
| **PMU** | Project Management Unit |
| **PWD** | Public Works Department |
| **SEA** | Socio-economic assessment |
| SNC | Second National Communication |
| **SOPAC** | Applied Geoscience and Technology Division of SPC |
| **SPC** | Secretariat of the Pacific Community |
| **SPREP** | Secretariat of the Pacific Regional Environment Programme |
| **TWG** | Technical Working Group |
| **V&A** | Vulnerability and adaptation assessment |
| **WHO** | World Health Organization |

# 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 water resources management. The programme began in 2009 and is scheduled to end in December 2014.

In Niue, PACC is improving water security to increase resilience against the effects of climate variability and climate change. Cyclones and extreme events such as drought and heavy rainfall events have been identified as threatening to the water sector.

The country has been relying solely on groundwater for its freshwater. The goal of the PACC project is to provide an additional source of water to Niueans, by developing the country's rainwater harvesting capacity at the domestic level.

Initially, only the most vulnerable households were targeted by the project. However, additional funding was brought in to extend the project to other villages. PACC+, an additional funding from the Australian Government created to replicate successful PACC demonstration projects, was integrated into the project in 2012. The following year, the European Union (EU) funded Global Climate Change Alliance (GCCA) project, a climate change adaptation project for Pacific Island Countries, proposed to dedicate its funding to replicate the PACC project. As a result of this additional funding, the PACC project in Niue is now aiming at providing the majority of households on Niue with a rainwater catchment system.

This technical report describes the project process, the results and the lessons learned. It is mainly directed at government agencies, local non-governmental organisations (NGOs), regional organisations and donor agencies working on similar projects in Niue and other Pacific islands. The report aims to provide the reader with the following information:

- An understanding of the challenges to the water sector in Niue, and the added stress due to climate change;
- The current management of water resources in Niue;
- The process undertaken to design and implement the project;
- The experiences of the Niue PACC team, in particular the factors that have made the project successful, and the lessons learned along the way.

## 1.1. Project rationale and objectives

The goal of the PACC project in Niue is "to contribute towards reducing vulnerability and increasing adaptive capacity to adverse effects of climate change in Niue for the water sector".

In order to reach this goal, three outcomes were identified:

- Outcome 1: Policy/plans mainstreamed to build resilience in the context of emerging climate risks in Niue's water sector.
- Outcome 2: Increased water security in Niue through demonstration measures to increase resilience of water supply system against natural disasters and climate variability.
- Outcome 3: Increased understanding of climate change impacts and awareness of how to adapt and build resilience (at community level).

Towards Outcome 1, the project led the development of the Niue Climate Change Policy that has now been endorsed by Cabinet. It was also the lead agency in developing the Joint National Action Plan on Climate Change Adaptation and Disaster Risk management (JNAP). As a result of the PACC Project, Cabinet has also approved the establishment of the Climate Change Division to coordinate climate change initiatives on Niue.

## 1.2. Policy and strategic frameworks

The guiding document for the country is the Niue National Integrated Strategic Plan 2009–2013. The document defines medium-term goals for national development for the financial period 2009/10 to 2013/14.

The Climate Change Policy was endorsed by Cabinet in 2011. The document vision is "A safer, more resilient Niue to impacts of climate change and towards achieving sustainable livelihoods". The JNAP also provides guidance on climate change management.

Table 1 shows how the PACC project is aligned with these key strategic documents.

### Table 1. PACC links to national and sectoral policies.

| Policy or strategy | Sector | PACC project is contributing to: |
|---|---|---|
| Niue National Integrated Strategic Plan 2009–2013 | All | Goal 3: Economic development<br>Sector: Water<br>Key Strategy: Managing water demand by encouraging rainwater harvest to reduce the reliance on groundwater; and exploring the option of introducing tariffs on water usage |
| Climate Change Policy | Climate change | Objective 3: Adaptation<br>Strategy 3.1: Identify vulnerable areas and sectors and develop and implement adaptation options […]<br>Activity: 3.1.1: Develop guidelines for design of water storage systems to enhance resilience to drought events (PACC);<br>3.1.2: Demonstrate water storage systems (PACC). |
| Joint National Adaptation Plan for Climate Change and Disaster Risk Management | Climate change and disaster risk management | Goal 3: Strengthened livelihoods, community resilience, natural resources and assets<br>Action 3.1.1: Strengthen community-based disaster risk management and climate change adaptation programmes |

# 2. COUNTRY INFORMATION AND CONTEXT

## 2.1. Geography and demographics

Niue, the world's largest and highest single raised coral atoll, is located in the central southwest Pacific, 2,400 km north of New Zealand (Figure 1). The total land surface of the atoll is 259 km$^2$ and the island reaches a maximum height of 68 m above sea level. The surrounding ocean reaches depth of up to 4,000 m (SOPAC, 2007).

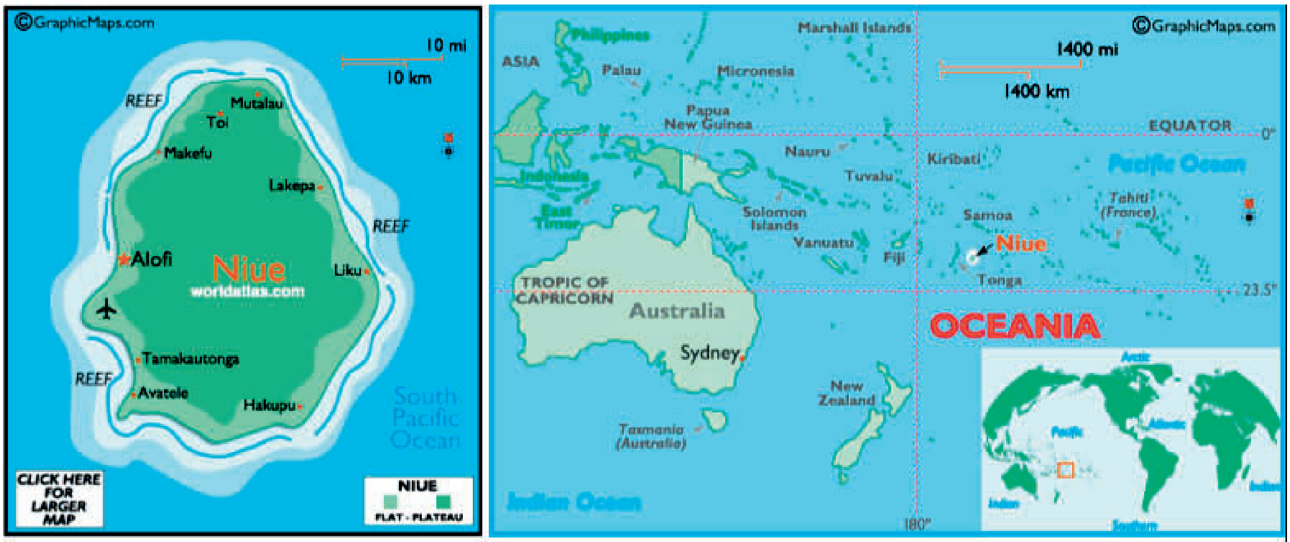


Figure 1. Map of Niue. (Source Graphicmaps 2014: www.land.graphicmaps.com)

The island consists of limestone of approximately 500 m depth. Soil conditions are relatively poor, limiting agriculture, however small-scale agriculture does exist.

Niue's population was 1,460 in 2011 (most recent census figures). The majority of the population is located near the capital Alofi, on the west side of the island. Population growth has been negative for the past decades, from a recorded maximum of 5,194 in 1966. Most of the decline in population is due to residents leaving for New Zealand where economic opportunities are greater. Niueans have had citizenship rights in New Zealand since 1974, when the country entered into a free association with New Zealand (SOPAC, 2007).

## 2.2. Socio-cultural and economic background

Niuean indigenous people are of Polynesian descent. Official languages are Niuean and English and the majority of Niueans are bilingual. Niue has a high level of education, water and sanitation, and public health services. The country has already managed to achieve most of the Millennium Development Goals for 2015 and ranks third in the Pacific region in the Human Development Index, after Palau and the Cook Islands. Life expectancy is high for the region (approximately 67 years) as is adult literacy (99%) (GoN, 2009a).

Niue's economy relies heavily on support from New Zealand and external development partners. New Zealand has a statutory obligation to provide economic and administrative assistance to Niue (GoN, 2009a). Aid accounts for about 70% of Niue's total gross domestic product (Barnett and Ellemor, 2007). Other sources of revenue are taxation, government trading (e.g. fishing licenses) and exports of food products (i.e. fish, noni, vanilla, taro and honey). The public sector is the main employer on the island, accounting for 56% of the total employment (GoN, 2006).

# 2.3. Climate

## 2.3.1. Observed trends

Niue's climate is tropical maritime with an average mean temperature of 24°C. Niue experiences two distinct seasons: a dry season from May to October and a wet season from November to April. The seasonal difference between the warmest months and the coolest is just over 4°C. The average annual rainfall recorded at Hanan Airport is 2052 mm (Figure 2).

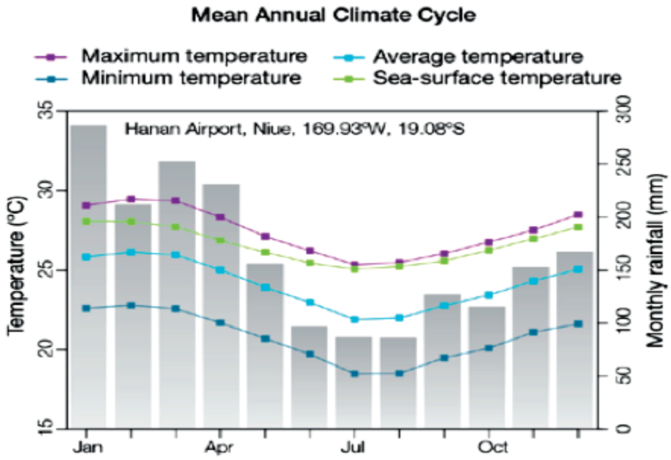


Figure 2. Monthly temperature and rainfall for Niue. (Source: Australian BoM and CSIRO (2011), with permission.)

Similar to other Pacific islands, year to year climate variability is high in Niue and influenced by El Niño Southern Oscillation (ENSO) events. The El Niño phase generally brings drier conditions, especially during the wet season, and lower than average air temperature during the dry season. Conversely, the La Niña phase generally brings wetter conditions.

During the last 60 years, an increase in temperature has been observed in Niue. 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.

Niue is vulnerable to three main extreme events:

1. Tropical cyclones;
2. Drought;
3. Prolonged rainfall periods.

Tropical cyclones generally occur between November and April. An average of 15 cyclones generally hit Niue per decade. Cyclones seem to be more prevalent during El Niño years (19 per decade) whilst La Niña years generally see a reduction in average events (nine per decade).

Drought is a threat for the country, especially for its agriculture and water sectors. Most household gardens rely on rainwater and drought periods can severely affect crops. Drought is also a threat to the main water supply source on the island: groundwater. Prolonged drought can affect the quality and availability of fresh groundwater.

Prolonged rainfall periods can also pose a threat to the country. Excessive moisture can result in an outbreak of fungal diseases (affecting, for example, yam crops) and mosquito-borne human diseases such as dengue fever (Australian BoM and CISRO, 2014).

## 2.3.2. Future trends

The Pacific–Australia Climate Change Science and Adaptation Planning Program (PACCSAP) has recently published new trends for Niue (Table 2). In summary, future climate in the 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 during the wet season;
4. Less frequent tropical cyclones but they may be more intense;
5. Sea level rise and ocean acidification will continue.

### Table 2. Trends in future climate for Niue. (Source: Australian BoM and CSIRO, 2014.)

| 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 |
| Increase in frequency of extreme rainfall days: this is a result of global increase in rainfall | 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 |
| Number of tropical cyclones is expected to decrease | Moderate |
| Dry season rainfall is not anticipated to vary | Low |
| Drought event occurrence is not expected to vary | Low |

# 3. THE WATER SECTOR IN NIUE

## 3.1. Water resources

Groundwater is the principal source of freshwater in Niue, along with rainwater. There is no surface water in Niue, except for some freshwater springs that can be found along the coastline of the island.

Niue's groundwater lens is estimated to hold about 1.75 gigalitres (GL) of freshwater. The lens covers nearly the entire island (200 $km^2$ out of 259 $km^2$) and the lens is estimated to be 35–40 m thick.

According to the latest groundwater assessments, the aquifer storage and porosity are not yet well understood, making it difficult to determine a sustainable yield of extraction (SOPAC, 2008). The porosity, or void fraction, is defined as the proportion of void (or empty space) within the rock volume. The water recharges, flows and discharges through the voids. Two main types of porosity have been identified in the aquifer: the karst conduits, which are highly connected voids through which the water flows quickly; and more diffuse voids called honeycomb type voids within which the water flows more slowly.

Knowing the predominant aquifer porosity is critical to understand the storage capacity of the aquifer and its resilience to drought periods. If the karst system dominates, the aquifer would be highly vulnerable to drought periods, with great reduction of freshwater volumes during an average dry season. If the more diffuse voids are predominant, the groundwater would be reasonably robust to even long drought periods.

Preliminary observations from SOPAC (2008) indicate that groundwater storage seems to be robust to drought periods and that total domestic water demand seems to be less than 2% of the estimated sustainable yield. However, the authors recommend treating these results with care as this assessment was made over a short period and longer monitoring is needed.

The vulnerability of the groundwater to drought periods is thus not yet fully understood, and precautionary measures have been recommended by the Government of Niue in order to best conserve groundwater resources (GoN, 2009a,b).

## 3.2. Water management

### 3.2.1. Public water reticulation

Groundwater is abstracted from 18 bores; most of these are attached to one or more storage tanks (Figure 3).

Each of the 13 villages has a reticulation system consisting of a borehole, a storage tank and a pressure or gravity fed distribution system to end users (Figures 4 and 5).

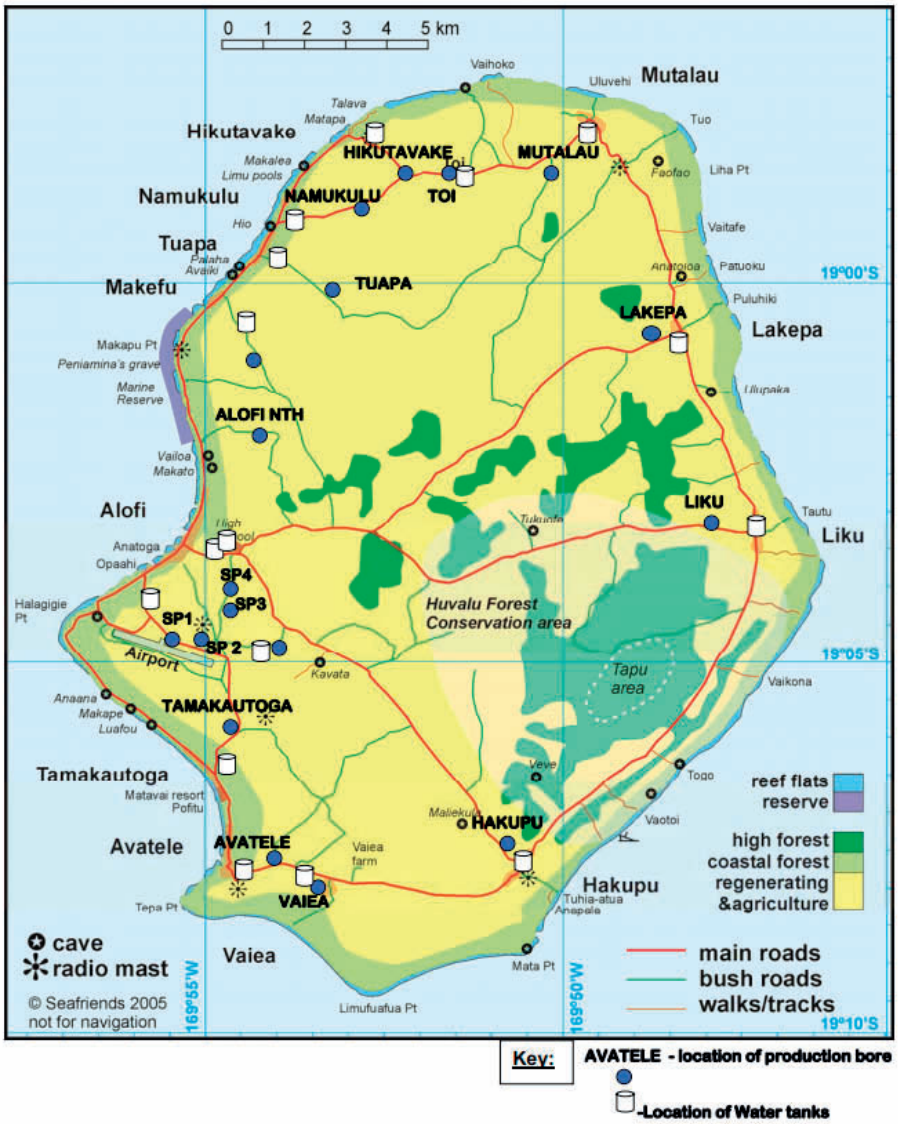


Figure 3. Location of production bores and storage tanks in Niue. (Source: Siohane and Chapman, 2009.)

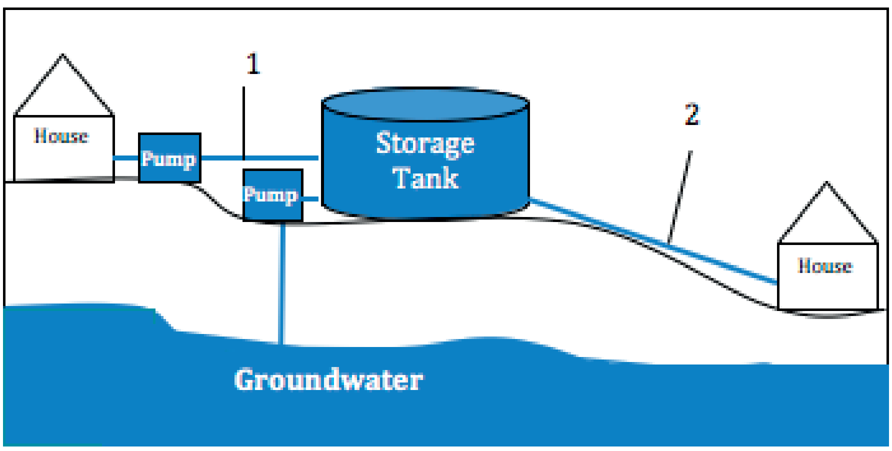


Figure 4. Simplified schematic representation of groundwater reticulation systems: powered (1) and gravity fed (2). (Source: Niue PACC Project.)


Figure 5. Storage tanks (old on the left and new on the right) in Tamakotoga. (Photo: Niue PACC Project.)

The groundwater is of good quality and is not treated pre-distribution. The water is tested regularly by the Public Health Department. Most of the water is used at the domestic level (85%), with the rest used for agriculture (10%) and industry (5%).

The water is subsidised by the government and distributed free of charge. The costs to operate the public water network (power only – excluding maintenance) are estimated to be up to NZD160,000 per year (Chapman, 2012).

According to the Water Division Infrastructure Plan, the public water supply is aging (30–50 years old) and is in need of urgent upgrade.

### 3.2.2. Rainwater

Prior to the PACC project, rainwater was used at the domestic level and also for small-scale agriculture. Rainwater harvesting systems were mainly concrete tanks with a capacity of 1,200 litres and with no filters or first flush devices. Most of these concrete tanks are no longer used as nearly all houses on the island (99.5%) are connected to the public water network, and most tanks have been left to deteriorate. The provision of water free of charge is likely to discourage households to invest in an additional water source and maintain their household water tanks (Chapman, 2012).

## 3.3. Institutional arrangements and legal framework

Three key agencies are involved in the water sector:

- The Public Works Department (Water Division): the Water Division of PWD is responsible for the operation and maintenance of the public water reticulation network. The department also administers the water legislation (i.e. Water Act 2012).
- The Department of Environment: the Department of Environment is responsible for the protection of the water resources. It administers the environment legislation (i.e. Environment Act 2003).
- The Department of Health: the Department of Health is responsible for hygiene, sanitation and wastewater management under the Public Health Ordinance of 1965. The department is also in charge of water testing and quality monitoring.

The water sector is essentially regulated under the Water Act 2012 and the Environment Act 2003. The Water Act defines the management of the public water network that relies on groundwater resources. It also defines protection measures for the groundwater. Part 7 of the Act also provides guidance for the development of an integrated water resource management plan (yet to be developed).

In direct relation to the water sector, the Environment Act regulates land uses and development of natural and physical resources to protect the groundwater from contamination.

Since the establishment of the PACC and Integrated Water Resources Management (IWRM) projects, the water sector is coordinated through the Niue Water Steering Committee (NWSC), as detailed in Section 4.1.3.

## 3.4. 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:

- Tropical cyclones: tropical cyclones could decrease in the next century (see Section 2.3.2). However, risk from cyclones will remain high, with potential damage to infrastructure, livelihoods and biodiversity as well as coastal erosion and inundation. Also, power and water supplies are closed down leading up to and during cyclone events, and can be down for a while afterwards when infrastructure has been damaged. Houses that are located on the upper terraces and that rely on power-pressured water systems can be left without running water for days.
- Extreme events: recent climate change scenarios are not projecting any significant change in the occurrence of drought events for Niue (see Section 2.3.2). However, an increase in drought intensity (duration and reduction in average rainfall) could threaten the availability and quality of freshwater abstracted from the groundwater lens. Heavy rainfall events bring the risk of lightning strikes on infrastructure, power surges, surface flooding and contaminants entering the water reticulation system.

## 3.5. Non-climate-related risks

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

- Pollution: although Niue's population and economic activities present a low risk to the environment, contamination of the groundwater from land-based activities can occur and should be considered. Contamination from solid waste and sewage effluent is of particular concern in Niue, due to the fast infiltration rate of the limestone. Some chemicals used for agriculture are also of concern.
- Low capacity to maintain the current water reticulation network: The public water reticulation network is 30–50 years old and in need of urgent upgrade. The government does not have the capacity to properly maintain the system and relies on donor funds for basic maintenance and operation.
- Reliance on a single source of power to supply water: the public reticulation system relies entirely on the Niue power station. Power is required to pump groundwater into storage tanks, and is also needed for those houses that rely on power-pressured systems. These houses are at risk of interrupted water supply whenever the power is down. In the case of major damage to the power supply infrastructure, such as in 2006 when the power house was destroyed by fire, the whole island is vulnerable to an interruption in water supply.

While the PACC project focused on the vulnerabilities due to climate, these non-climate factors were also considered and assessed in the early stages of the project, and efforts to address them incorporated where feasible.

# 4. THE DEMONSTRATION PROJECT

## 4.1. Preparatory phase

### 4.1.1. Selection of adaptation sector

The PACC programme focuses on three climate-sensitive sectors for climate change adaptation in the Pacific region: coastal management, food security, and water resources management. Each country project selected their priority sector at the beginning of the process. In-country consultations for the PACC project in Niue started in 2006. The following criteria were used for selection of the priority area for PACC Niue:

- The project should have a strong fit/alignment with the Niue Government's existing programmes;
- All necessary baseline assessments should have been carried out, and additional activities should be ready for implementation;
- Ability to co-finance and ability to deliver.

The consultation process revealed that the three sectors were of equal importance to stakeholders consulted, however only the water resources management sector would be able to provide sufficient co-financing, as required for GEF-funded projects. The water sector also had sufficient assessment information and this was thus selected as the focus for the PACC project in Niue.

### 4.1.2. Project planning

An overview of the project process is given in Figure 6.

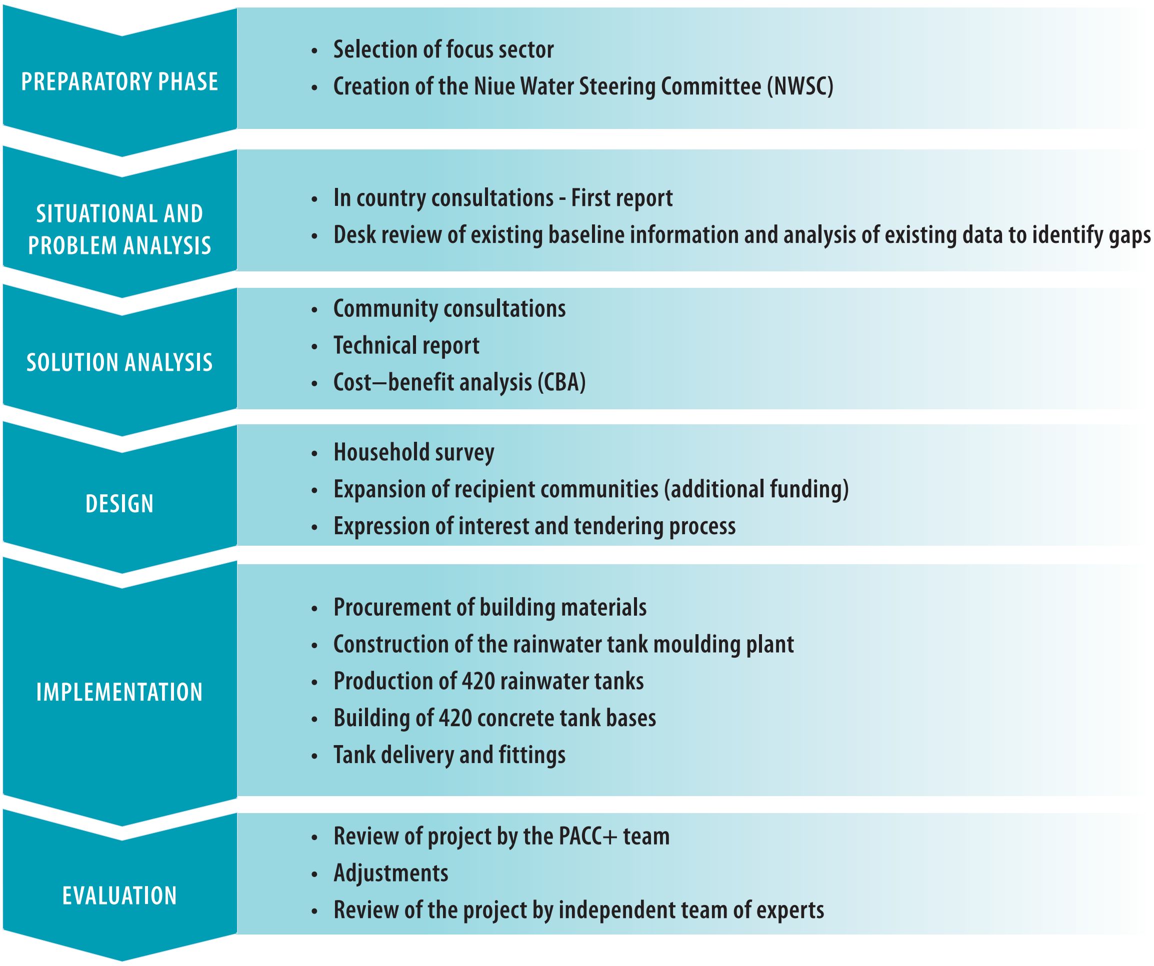


Figure 6. The project process.

### 4.1.3. Institutional framework for the PACC project

PACC Niue is hosted under the Department of Environment and is managed by the Niue Water Steering Committee (NWSC). The NWSC was created in the early stages of the project (2010) to manage both PACC and the Pacific IWRM projects. The NWSC is mandated to facilitate the projects, especially the decision-making process. The Committee is composed of key representatives from various government agencies as follows:

- Chairperson: Director of the Public Works Department (PWD);
- Vice-Chairperson: Director of the Department of Environment and GEF Focal Point;
- Secretariat: a representative of the IWRM/EU Project (from the PWD), Assistant IWRM Coordinator (PWD), the PACC Project Coordinator (from the Department of Environment), the former Technical Adviser for the Pacific Technical Assistance Mechanism (PACTAM) (from the Water Division of the PWD);
- Members: Director of Meteorology, Director of the Department of Agriculture, Forestry & Fisheries, a representative of the Treasury Department, Director of Community Affairs, Director of the Health Department, Manager of the Water Division (PWD), a representative of the Chamber of Commerce (COC) private sector, and a representative of the NGOs.

The NWSC provides guidance on key decisions for all three outcomes of the PACC project. It supports the development of policy and plans as part of Outcome 1. The Technical Working Group (TWG) is a subgroup of the NWSC. It provides technical guidance to the NWSC and also manages the implementation of the demonstration project (Figure 7).

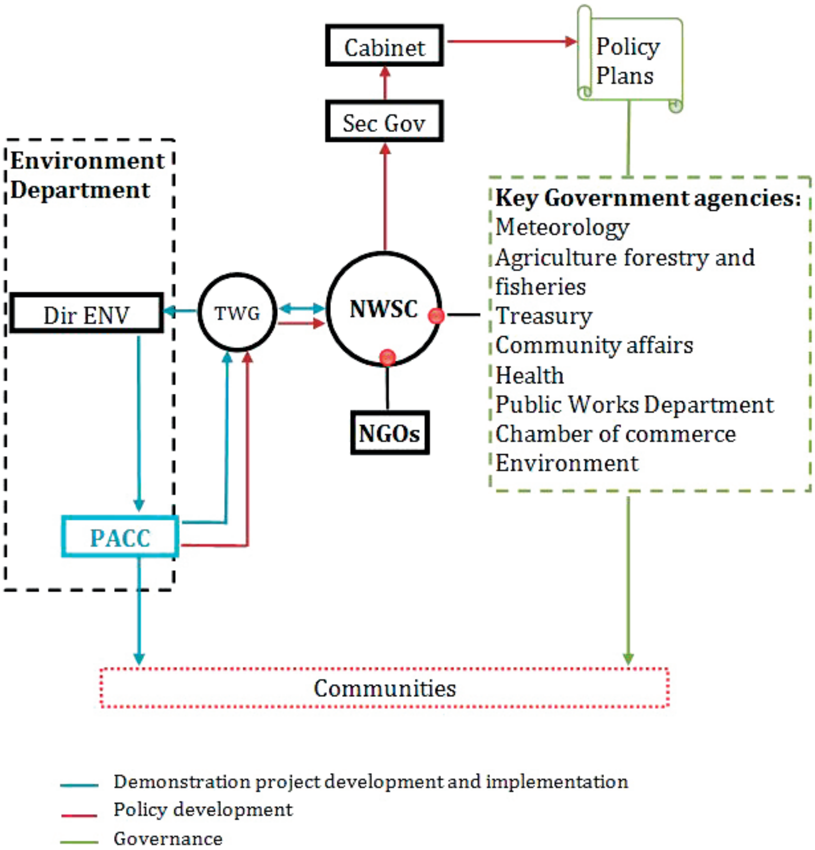


Figure 7. Institutional framework and key development processes for the PACC project.

## 4.2. Situational and problem analysis

The in-country consultation identified the main risks brought by climate change and climate variability for the water sector in Niue. These were identified as cyclones and extreme events such as drought and heavy rainfall events.

The PACC team undertook a baseline assessment of literature produced by SOPAC, i.e. technical reports and assessments with relevance to water management (SOPAC, 2007, 2008). This baseline assessment also confirmed that village water systems are vulnerable to cyclones and extreme events.

Power supplies are closed down leading up to and during cyclone events, and can be down for a while afterwards if infrastructure is damaged. This affects the water supply, as power is needed to pump water into village storage tanks. Houses that are lower down and have gravity-fed systems will still have water supply until the tanks are empty, but houses that are located on the upper terraces and depend on power systems will immediately have their water supply interrupted when the power is down. In the case of damage to the power supply infrastructure, such as in 2006 when the power house was destroyed by fire, the entire island faces interruption in water supply.

Long drought periods can also affect the quality of the groundwater due to saltwater intrusion. Heavy rainfall events can lead to flooding which carries the risk of contaminants entering the water network through different pathways, including breaks in the reticulation system and direct contamination of the freshwater lens (Table 3).

Table 3. Key issues of vulnerability for the water sector.

- Villages relying on power-pressured water supply are the most vulnerable to extreme events and natural disasters such as cyclones or fires (i.e. when there are power outages).
- The entire island water supply is vulnerable to extended power outages (i.e. when the village storage systems are depleted).
- The public water reticulation system is in need of urgent maintenance.
- The resilience of the freshwater lens to extended drought periods is not yet known. Saltwater intrusion and decrease in the amount of freshwater available can result from extreme drought events.
- Heavy rainfall events increase the risk of contaminants entering the public water system.

## 4.3. Solution analysis

### 4.3.1. Identification and selection of adaptation options

The selection of adaptation interventions took about 3 years from the official start of the project in 2009. The main reason for this extensive process was efforts by the Niue Government to secure additional funding in order to extend the project to the entire island.

The selection had three main phases (Figure 8):

1. In 2006, the in-country consultations with government and communities identified the water management sector and recommended developing climate-resilient water storage systems.
2. In 2010, the NWSC was created to facilitate decision making for both the PACC and IWRM projects. The PACC team undertook a baseline assessment, and held a series of meetings to present the findings and select the best adaptation solution. The option selected was rainwater harvesting at the domestic level. In 2012, a technical assessment was undertaken to identify the best design for domestic rainwater harvesting in Niue, as well as risks and recommendations for the project (see Section 4.3.2). Shortly after that, a cost–benefit analysis (CBA) was carried out to assess the most cost-efficient system, based on the designs and recommendations detailed in the technical report (see Section 4.3.3). Because of the PACC budget limitations, these domestic rainwater harvesting systems were primarily aimed at three villages on the upper terraces, which were particularly vulnerable to water shortages because of their dependence on power for their water supply.

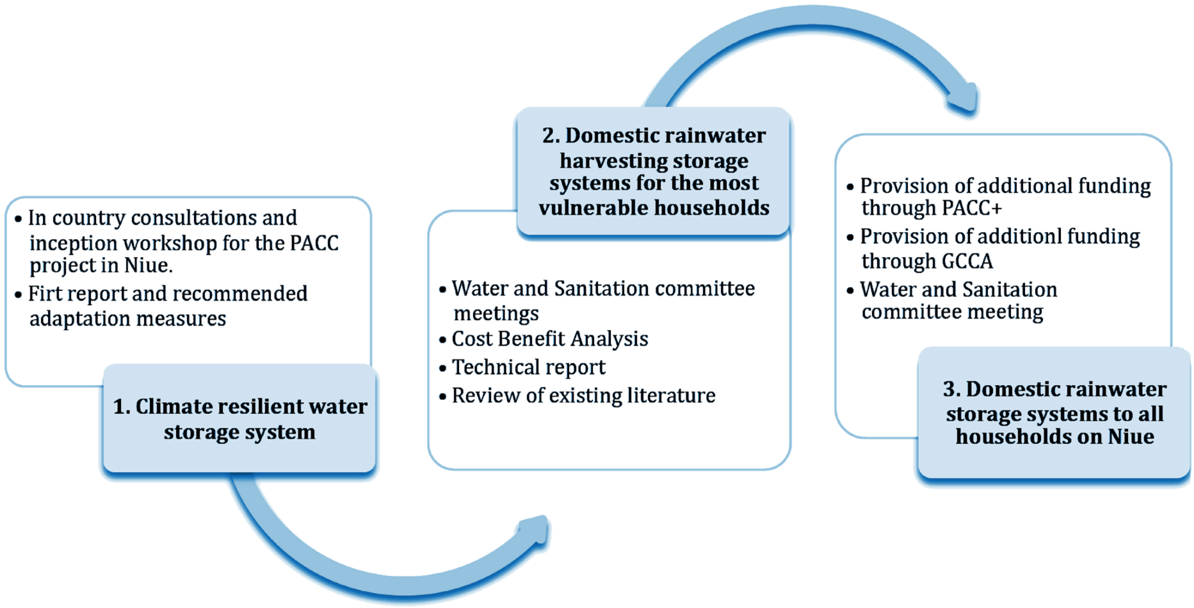


Figure 8. Adaptation measures – selection process.

3. The Government of Niue, which advocated the need for a national approach instead of a village approach, requested more funds to cover all six villages on the upper terraces that had similar vulnerability. The Niue PACC project team negotiated with SPREP to access more funding. Around that time, an agreement was reached with the Australian Government to create the PACC+, which is additional funding for selected PACC countries for replication of demonstration projects. This allowed the Niue project to include all vulnerable households on Niue. Later in 2012, the EU funded Global Climate Change Alliance-Pacific Small Island States (GCCA-PSIS) project approached Niue with additional funding under EDF10 for a water management project. The time available to implement the project, two years, was short. It was therefore decided by the Government of Niue to merge PACC and GCCA-PSIS and use GCCA-PSIS funds to replicate the PACC demonstration project. With this further funding, the project was able to target the entire island and provide the majority of households on Niue with a rainwater harvesting system.

### 4.3.2. Technical assessment: rainwater harvesting system design for Niue

A technical assessment was carried out in 2012 to identify the best design for domestic rainwater systems in Niue, and the approach to be taken (Chapman, 2012). The objectives of the technical assessment were to:

- Integrate quantitative and qualitative information to develop rainwater harvesting systems;
- Develop options and concept plans to construct and install rainwater harvesting systems for Niue households;
- Produce estimated costs to construct and install rainwater harvesting systems for Niue households;
- Consider increasing capacity of public system reservoirs;
- Examine procurement options;
- Develop policies for financing partnerships with the community;
- Set out operation, maintenance and repair requirements for the rainwater harvesting systems.

The assessment found that tanks should be available in two sizes, 5,000 L and 10,000 L, to fit different size households and building types. Where possible, the aged concrete storage tanks should be rehabilitated. A technical survey should be undertaken to determine physical attributes of each household and the condition of rainwater harvesting facilities. The tanks should be installed in a way that would allow for further development by the homeowner such as installation of a pump for a reticulated system. Each system should be provided with a first flush device to minimise water contamination. A backflow prevention device such as a valve should be installed at the outlet of the tank if the tank is connected to the household plumbing system. This is to avoid backflow entering the public water system.

The assessment report also stated that priority should be given to the villages on the upper terraces and eastern villages where the public water supply is pumped to the households through pressure pumps. These villages do not receive water in power outages compared with the villages on the western side of the island where supply is gravity fed. It also recommended to consider providing large buildings such as schools, community and government buildings with storage tanks. A strategy should be put in place to maximise the use of rainwater over the public water system when possible. For example, rainwater should be used when maintenance is scheduled to be done on the main system. Community training should be organised to support best maintenance of the harvesting systems.

Regarding the financing aspect, the report proposed that an expression of interest be sought from potential tank suppliers and manufacturers to test the market for tank specifications and building materials. If the project were to fund the installation of fascias and gutters the report warned that it could be viewed as being unfair on homeowners who have paid for the installation of their own fascias and gutters. The report recommended building ownership of the system by householders by asking them to contribute financially to the project. This would be limited to the installation of fascia and gutters by homeowners. The report also mentioned the possible use of micro-loans for homeowners through the Niue Development Bank.

The following key recommendations were made:

- The project should develop a workplan to minimise procurement risks;
- A risk assessment should be carried out on the tender document so that risks to the contractor and the PACC project are identified and priced accordingly;
- It is important to communicate and promote the reasons for choosing high density polyethylene (HDPE) tanks instead of concrete tanks to get community acceptance;
- Since rainwater has been progressively abandoned in favour of reticulated groundwater, it is important to widely communicate and promote the relevance of using rainwater when available;
- The project team should discuss the possibility for households to co-finance up to 30% of the costs;
- A more accurate budget should be drawn up once the exact number of 5,000 L and 10,000 L tanks is known.

### 4.3.3. Cost–benefit analysis

A CBA was carried out to assess the most cost-efficient systems, based on the designs and recommendations in the technical report (PACC, 2013).

Two main options were assessed as part of the CBA:

- Providing rainwater tanks to particular areas on Niue;
- Improving the current groundwater system network (repair/replace leaking pipes).

For the groundwater repairs, the entire system (all island) was considered. For the tank option, two types of tanks were assessed (5,000 L and 10,000 L) and two areas were considered: lower terraces and upper terraces.

The results of the CBA indicated that household rainwater tanks may be a worthwhile adaptation measure to be implemented under the PACC project providing certain complementary measures are implemented and only if certain design options are adopted.

Net present values (NPVs) calculated for a 5,000 L storage capacity rainwater tank located in upper terrace areas of Niue were shown to be small, ranging from NZD62 to NZD213 per tank, depending on the future groundwater contamination scenario. However, these results were not robust to sensitivity tests about household use of rainwater tanks—if households do not properly maintain their rainwater tanks and related infrastructure, as was the experience in Niue in the 1970s and 1980s, then the NPV is reduced to around –NZD2,107 per tank. This sensitivity result highlighted the importance of addressing barriers to behaviour change for project success for which complementary measures will be needed. Given the small size of net community benefits generated from the project option, the analysis also suggested a conservative approach to the demonstration (i.e. small scale) was warranted.

NPVs for the 10,000 L storage capacity tanks were shown to be negative for all of the groundwater contamination scenarios modelled. These larger capacity tanks were therefore assessed to be not worthwhile for the PACC demonstration project. NPVs for all tank storage capacity options (i.e. 5,000 L and 10,000 L) in lower terrace areas of Niue were shown to be significantly negative for all of the groundwater contamination scenarios modelled—primarily because public water supply to these areas is pressure-fed and so household rainwater tanks would not generate reduced water supply interruption benefits. Lower terrace areas of Niue were therefore assessed to not be a worthwhile demonstration site for household rainwater tanks under the PACC demonstration project.

With the installation of 5,000 L tanks for upper terrace areas, the CBA recommended:

- Developing awareness raising and education to ensure the use and proper maintenance of the rainwater harvesting systems;
- Introducing a water tariff system to encourage and develop rainwater harvesting;
- Limiting the PACC provision of rainwater tanks to a small-scale project to avoid any unintended effects on the Niue rainwater tank market.

### 4.3.4. Selected adaptation measure and recipient communities

As a result of the analyses above, domestic rainwater harvesting with 5,000 L tank systems was chosen as the adaptation measure for the PACC demonstration project in Niue. With the additional funding brought by PACC+ and GCCA-PSIS, the demonstration project was extended to the entire island with the exception of government and commercial buildings (including tourism accommodation) and non-residential accommodation. In total, 420 houses were selected as project beneficiaries (out of 477 occupied buildings in Niue).

Domestic rainwater harvesting is a sensible approach to reduce the vulnerability of households in the upper terraces who rely on power-pressured water supply. The opportunity to extend the project to the entire island through additional funding from PACC+ and GCCA-PSIS was also sensible as it allows to address some key issues for the sector (Table 4). It also enables the fulfilment of two targets identified in the Niue National Integrated Strategic Plan:

- Water storage capacity for households increased by 10% by 2013;
- The use of rainwater harvest for total water supply increased to 20% by 2013.

#### Table 4. Addressing key issues for the water sector under the PACC project. (Source: Siohane and Chapman, 2009.)

| |
|---|
| Provide communities with security of supply by having an alternative source of potable water |
| Have a back-up supply of water in cyclone events, low rainfall events and the unlikely but highly catastrophic event of contamination of the groundwater lens |
| Enable the community to have a continuous access to potable water while PWD undertake maintenance and repair works on the public water supply assets (identified under the Water Division Infrastructure Plan as needing urgent replacement) |
| Reduce reliance on costly fossil fuels by exploring and implementing cheaper alternative water supply options |
| Reduce $CO_2$ emissions by reducing fossil fuel consumption used to pump water from the water lens |

## 4.4. Design phase

This phase included three main activities:

- Gather additional information on recipient households through a survey, and create a database containing household characteristics in order to facilitate the implementation and monitoring and evaluation (M&E) process;
- Call for expressions of interest to identify potential suppliers and the best option for the provision of the 5,000 L tanks;
- Develop a technical design plan for the rainwater moulding factory (see below) and generic design plans for fittings of rainwater tanks.

### 4.4.1. Household survey and database

As recommended under the technical assessment, a household survey was undertaken in 2013 to confirm data from the 2011 census and gather additional data on house type, number of occupants, and states of rainwater facilities (tanks, gutters, fascias, downpipes). The survey questionnaire is provided in Appendix 1.

The household survey was used to:

- Identify recipient households;
- Locate best (preferred) location for rainwater tank;
- Assess the state of fascias and gutters and whether they need repair, replacement or new fittings;
- Develop a database to record householder names and related house and tank serial number.

### 4.4.2. Call for expressions of interest, tender process and selected option

As recommended in the technical assessment, expressions of interest were sought from potential tank suppliers and manufacturers to test the market for tank specifications and building materials. This process enabled the PACC project team to identify the most cost-effective option based on the recommendation from the option analyses (i.e. to provide 5,000 L tanks). The process also brought out the possibility of building a permanent rainwater tank moulding facility on Niue. It appeared this would be cost effective, and in addition would develop the island's technical capacity. It would also provide further business opportunities for the government and allow for the development of additional HDPE items such as septic tanks. The tendering process and resulting decisions are presented below.

#### CALL FOR EXPRESSIONS OF INTEREST

Expressions of interest were used to gather information from tank manufacturers and suppliers in the region and to ascertain what products were available in the marketplace. Three overseas firms and one local firm were identified as suitable manufacturers and were invited to submit tenders for the supply and delivery of tanks.

The recommended material for tank construction was plastic (HDPE). This material was preferred for its versatility, lightweight construction, structural integrity, ease of cutting in connections, and availability in different finish colours; it has also proven use in other islands in the Pacific and comparative unit cost. Materials are also able to be recycled to reduce waste. Manufacturers indicated that it would be possible to mould tanks on Niue so that freight costs could be minimised.

Following on from the above process, a pre-tender meeting was held in Auckland, New Zealand in December 2012 to guide the firms on the tender process and procedures. Firms were also able to ask questions or queries on the process.

### TENDER EVALUATION AND SELECTED OPTION

Each tender was reviewed by the tender evaluation committee and scored accordingly on the tender evaluation form.

Experience has shown that ready-made tanks freighted from New Zealand can cost as much as three to four times the original cost. The tenders demonstrated that it would be advantageous to produce tanks on site rather than ship tanks ready-made due to this cost. Stackable tanks, as suggested by some tenders, were not considered due to experience and lessons learnt in the region on their robustness.

The evaluation committee decided that the best option was to build a permanent tank moulding facility on Niue. This would have the following advantages:

- Freight costs reduced significantly;
- Quality control carried out locally;
- Revenue gained from use of local utilities, in particular power and telecommunication;
- Participation of local labour in production therefore building capacity and knowledge;
- Risk of delay in production due to shipping delays minimised;
- Use of moulding plant and equipment to produce other products such as septic tanks and recycling bins;
- Facilities built on site remain the property of the Government of Niue post-project.

### DUE DILIGENCE PROCESS AND CABINET APPROVAL

Following the tender evaluation and recommendations, the Cabinet reviewed the process, documents and recommendations. The results of the evaluation were considered by the Niue Tender Evaluation Board. Following the evaluation by Crown law, recommendation was sought again from Government for approval by Cabinet and this was granted for Galloways International Limited (Auckland, New Zealand) to supply the rainwater tanks for Niue. Shop Exports & Freight, based in Auckland but with an office in Niue, was granted the contract to provide the rainwater tank-moulding facility.

The overall process from tender closure to Cabinet approval took approximately five months, with another one month for mobilisation of resources.

## 4.4.3. Technical design

### RAINWATER TANK-MOULDING FACTORY

The decision to build a rainwater moulding factory was arrived at through the tendering process as described above. Galloways was awarded the tender in partnership with Shop Exports & Freight Limited. The arrangement was for Galloways to provide the machinery, the mould (Figure 9) and the raw materials, and Shop Exports & Freight to assist the PACC project team with building the external structure of the factory (shed).

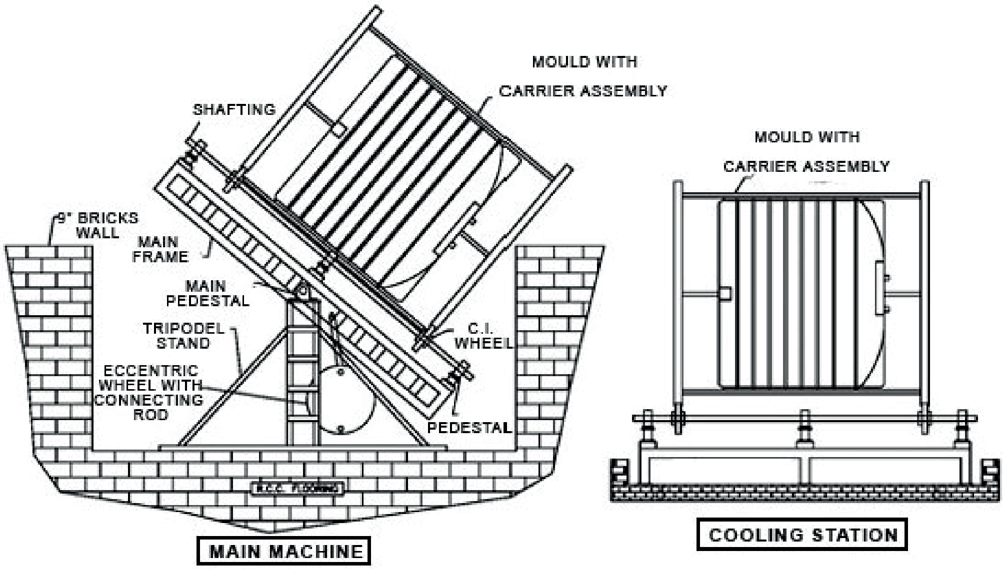


Figure 9. Tank moulding machinery. (Source: NAROTO: http://rocknrollmachine.in/)

The New Zealand based company Kiwi SPANNZ was contracted to develop plans and technical design for the factory building.

## RAINWATER TANK DESIGN AND FITTINGS

A computer graphic of the 5,000 L HDPE tanks to be built in Niue was developed to inform the community, donor partners and the Government of Niue (Figure 10).


Figure 10. Graphic, developed for awareness purposes, of the 5,000 L water tank to be built by the PACC project in Niue.

Each tank was to be fitted with imported components (Figure 11). The New Zealand firm Marley was selected to supply all components.

The gutters (1) are made of white PVC material.

The leaf diverter (2), Leaf Eater, has been designed for heavy rainfall areas. The box is made of white PVC material and contains two stainless steel screens of 0.6 and 0.99 mm.

PVC pipes and connections (3) are made of white and grey PVC material.

The first flush diverter (4) is available in two sizes. Details are provided in Appendix 2. The first flush diverter pictured here is the larger one, for roofs of over 80 $m^2$.

The calmed inlet (5) is made of black PVC material and allows water to enter the system from the bottom without disturbing the sediment in the bottom of the tank.

The floating out-take kit (6) allows withdrawal of water from the top of tank, where the water is the cleanest.

The outlet (7) is fitted with a tap and valve to allow closing of the system while using the public reticulation network (i.e. for houses also connected to the network). This prevents rainwater from the tank entering the public water system.

The overflow outlet (8) releases the overflow of water from the bottom of the tank, where the water is of lesser quality. Numbers 9 and 10, a vent with a grid to prevent pollutants entering the tank and a level gauge, respectively, are options that were not included in the harvesting systems in Niue.

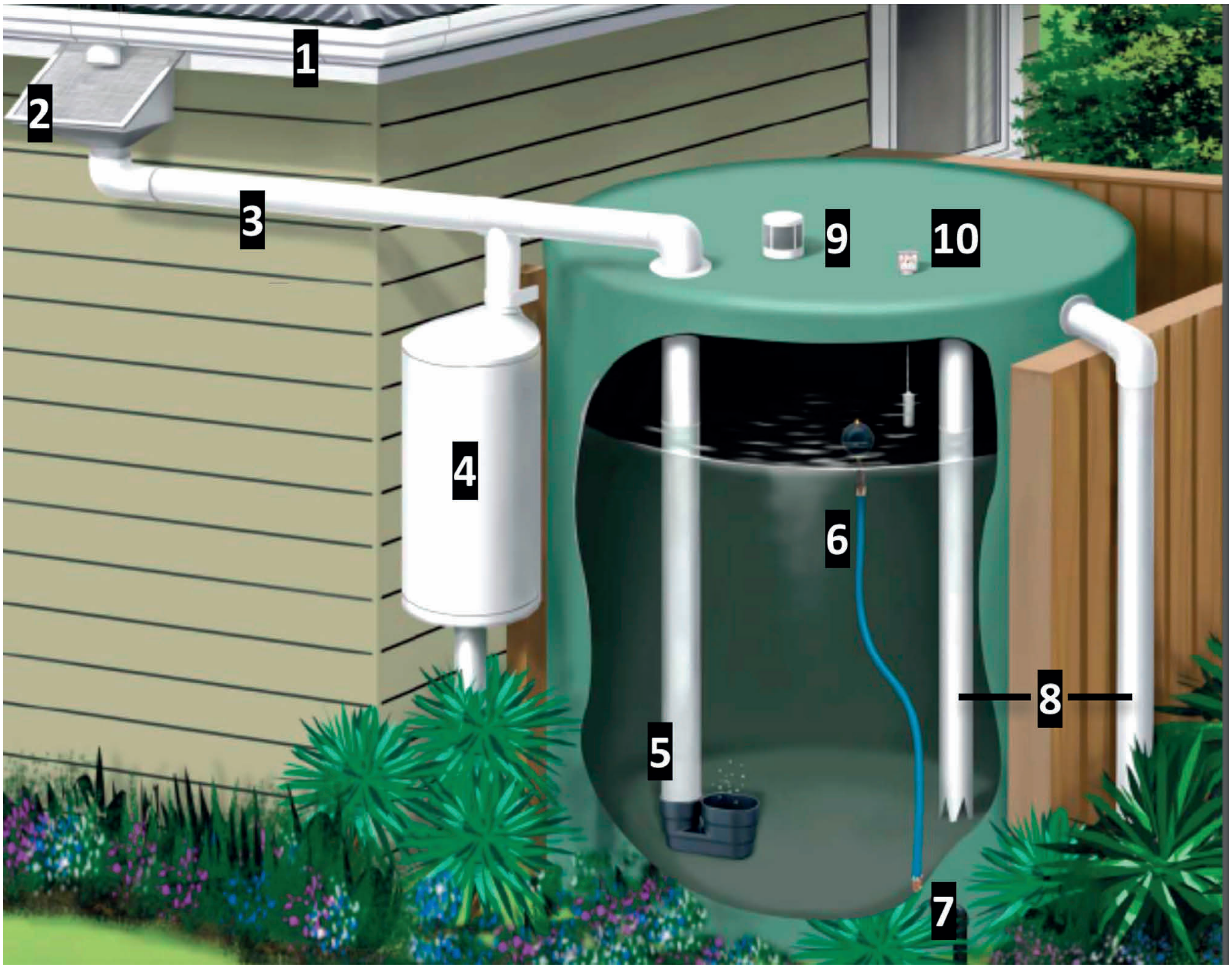


Figure 11. Rainwater tank fittings.
(Source: adapted from Marley's Rainwater Harvesting Guide - see Appendix 2.)

## 4.5. Implementation

### 4.5.1. Implementation process

The implementation process started in 2013 with the construction of the tank moulding factory. This process took six months and was followed by the moulding of the tanks. Once all tanks were produced, the local contractors started to build the concrete tank bases and deliver and install the tanks. This last process is still ongoing at time of writing (November 2014) (Figure 12).

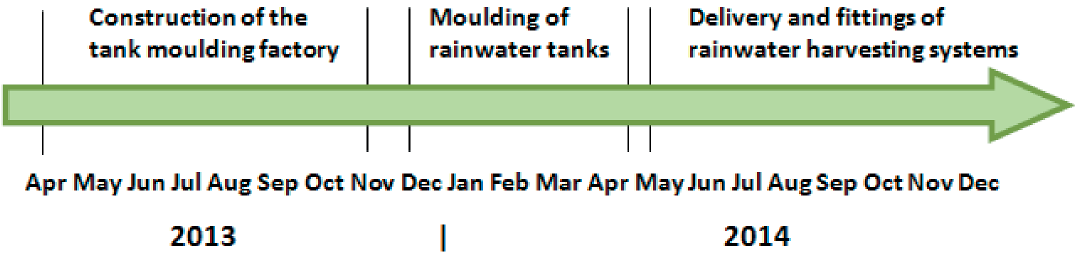


Figure 12. Implementation timeline.

### 4.5.2. Construction of the tank moulding facility

The tank moulding facility (shed) was designed and manufactured in New Zealand. The construction took six months. The PACC project contracted a local building company to build the foundation (Figure 13) and assemble the shed (Figure 14). A consultant from Galloways was on island to help set up the machinery (Figure 15). The building was delayed due to the parts being sent on two different shipments and heavy rainfall.

Figure 13. Building the foundations for the tank moulding factory. (Photo: Niue PACC Project.)

Figure 14. Building the shed. (Photo: Niue PACC Project.)

Figure 15. Installing the moulding equipment. (Photo: Niue PACC Project.)

### 4.5.3. Moulding of rainwater tanks

During the course of the project, 520 rainwater tanks were manufactured—420 financed by PACC and 100 additional tanks for homeowners wanting an extra tank, which they paid for. The raw material was supplied by Galloways. In order to speed up the moulding process, two extra moulds were provided by Galloways, however only one is set to remain on island.

The tanks are manufactured using raw material (HDPE) shipped in individual bags. Five bags are needed to make a 5,000 L tank (Figure 16).

Figure 16. Mould and raw material (HDPE) in original packaging. (Photo: Niue PACC Project.)

The plastic is poured in the mould and heated up uniformly using the rock and roll moulding machine (Figure 17). The mould is then left aside for cooling.

Figure 17. Moulding in process. (Photo: Niue PACC Project.)

Once removed from the mould, the inlet, outlet and overflow of the tank are pierced. The plastic removed is used to conduct an impact test. If the impact test is successful, the tank is further inspected using ultrasonic thickness measurement, to ensure an optimal thickness of the tank throughout.

Finally, each tank is assigned a serial number which enables identification of manufacturing details for each tank.

### 4.5.4. Delivery and fitting of rainwater harvesting systems

The delivery and fitting of the tanks is ongoing as of November 2014. To date, 272 tank bases (65% of target) have been built in the 14 villages of Niue, and 163 homes (38% of target) have been fitted with a fully functioning system (Figure 18).

Figure 18. Installed rainwater harvesting system.

## 4.6. Monitoring and evaluation

### 4.6.1. M&E process

In order to monitor progress on set objectives and expected outcomes, the PACC project uses a logical framework (logframe). For each outcome, a series of targets has been identified that should be achieved in order to reach the project outcomes. Each target is associated with an indicator that is measured and compared against the baseline value (i.e. value at the start of the project) to evaluate progress. As much as possible, quantitative indicators are used to monitor progress (Table 5).

Table 5. Logframe for the Niue PACC demonstration project (Outcome 2).

| Project description | Indicator | Source / data collection method | Baseline | Target |
|---|---|---|---|---|
| Outcome 2:<br>Increased access to alternative safe water supply (at household level) | % rainwater-water tank samples meeting Health Department (or WHO) standards | Water Division Records/data | No testing | 100% of samples taken meet standards by Dec 2014 |
| | Total number of households (HH) and people (gender disaggregated) benefiting from project by the end of Dec 2014 | Household assessment undertaken by the project<br>National census 2012 report | 60% (252) of HH had gutters prior to the PACC Project. Some HH had tanks but were not connected due to the tanks being damaged. Only 5 HH with gutters connected to the tanks and being used as a primary source of water | 420 HH have access to rainwater by end June 2015 |
| | Community satisfaction with PACC project (gender disaggregated) | Household assessment undertaken by the project | | At least 80% of HH that have received gutters and tanks satisfied with PACC project |
| Output 2.1:<br>Guidelines developed (technical synthesis) | (Gender-sensitive) technical guidelines developed | Assessments and reports produced since the start of the project | Guidelines not currently in place | Guideline developed and requirements incorporated into procurement of catchment systems and operation procedures of water utility and training of householders (taking into account gender considerations) |
| Output 2.2:<br>Demonstration project delivered to install household water catchment systems (reflecting guidelines) | Number of 5,000 L tanks produced<br>Number of 5,000 L tanks installed | Production data at facility<br>Contractors progress | 5 houses using water tanks as primary source of drinking water before PACC project | 250 HH with 5,000 L tanks by end Dec 2014; 420 HH by end June 2015<br>Total 420 tanks produced |
| | Number of infrastructure improvements (first flush/roofs etc.) installed | Household assessment data | 252 homes with guttering in various condition, only 5 with guttering connected to useable raintank | By end Dec 2014, 250 HH have improved guttering and first flush diverters and connections to rainwater tank |

### 4.6.2. Monitoring delivery, installation and tracking system

To monitor progress and facilitate the installation of the rainwater harvesting systems, the team also uses an Excel spreadsheet. The spreadsheet registers each household to be fitted with a system along with important information on the house gathered through the household survey. The tank serial number is also recorded in the database for each household. This allows to:

- Record progress of guttering installation (responsibility of householder) and readiness for tank delivery and fitting;
- Provide important information to the installation team prior to installation and delivery such as best location for the tank, type of household or guttering system in place;
- Follow the installation progress of individual households;
- Follow the progress of the entire project delivery;
- Allow for accountability and traceability with tank serial number attached to houses.

### 4.6.3. Project status – November 2014

As of November 2014, all the tanks have been produced, 65% of the bases have been completed and 38% of the tanks have been fitted (Table 6).

Table 6. Project status at November 2014.

| Activity | Status – November 2014 | Expected completion date |
|---|---|---|
| Building of tank moulding facility | 100% completed | – |
| Moulding of 420 rainwater tanks | 100% completed | – |
| Building of 420 concrete tank bases | 85% completed | Dec 14 |
| 420 fitted and fully operational tanks | 38% completed | Feb 15 |

## 4.7. Adaptive management

The PACC project team has dealt with significant challenges through the lifetime of the project:

- The government of Niue moved from a five day work week to a four day work week. This has contributed to delaying the project.
- The weather conditions have been difficult with heavy rain during the tank base construction and excessive humidity slowing down the drying process.
- The availability of machinery and labour was also an issue, with limited capacity on island (e.g. concrete truck) and competing projects.
- Reliance on shipping for most materials for the building of the facility and manufacturing of the tanks was also an issue. Misplaced item and mistakes in order incurred delays.
- Government transformation with changes in procedure also delayed the project, with the introduction of more lengthy procedures and the need to start new procedures.

The main issues and adaptive management response from the PACC project team are detailed in the table below (Table 7).

Table 7. Adjustments made during the Niue PACC demonstration project.

| Issue | PACC response |
|---|---|
| Working week reduced to 4 days | Proactive planning and maximised use of the 4 day week. Leaving all paperwork and reporting tasks to be done during the fifth (non-working) day |
| Heavy rain | As much as possible, activities that are the most sensitive to heavy rain such as laying concrete should be scheduled during the dry season |
| Lack of available machinery and labour | Prioritise tasks in accordance with available labour and machinery. Draw up a long-term plan for project implementation in order to book ahead the limited resources |
| Government changes in administrative procedures | Keep informed of changes in procedure and make sure to be up to date before starting an administrative process |

## 4.8. Training, knowledge sharing and awareness

At the national level the NWSC has developed a communication strategy (Chung, 2010). The strategy has been primarily developed to support the PACC and IWRM projects. Under the strategy, three campaigns have been developed:

- A water conservation campaign: Fix the leaks
- A water protection campaign: Keeping Niue's water pure
- A rainwater tank safety and maintenance education campaign.

The third campaign was designed especially for the PACC project. Awareness development and training are key components for the demonstration project, identified in both the technical assessment and the CBA. In order to train householders to maintain their rainwater tanks, workshops have been organised in each village. Along with practical demonstrations on how to keep a healthy system (i.e. cleaning of the roof and system components), maintenance instruction guides have been distributed (Appendix 2) as well as water safety kits to test water quality. The communication strategy also involved the use of local media such as TV and radio to disseminate information on rainwater tank safety.

Village representatives have been nominated to foster the use of the tanks and monitor the project once completed (i.e. use of the tank and quality of installation).

Youth and school students were also targeted as part of the awareness campaign. The youth community is a good vector of information and can foster change in their households in regard to water management. Poster competitions have been organised on climate change and water themes. For the demonstration project, the focus was on the relevance of using the rainwater harvesting system. Schools students have also visited the rainwater moulding facility (Figure 19).

Figure 19. School students visiting the tank manufacturing facility.
(Photo: Niue PACC Project.)

Outside Niue, other regional target audiences were identified by the project, and communications products were developed and disseminated. Examples include news stories published on the PACC webpages (www.sprep.org/pacc), and further circulated in the online magazine Climate Change Matters; a 'country brief' describing the project and targeting decision makers across the region; and various synthesis publications, in particular the PACC Experiences series (see for example PACC Experiences No. 4: Building resilient freshwater systems).

The PACC webpages (www.sprep.org/pacc), and in particular, the Niue project webpage (www.sprep.org.pacc.niue), was the main dissemination tool used to share information and knowledge generated by the project with regional and international audiences. Outputs are also being shared through the Pacific Climate Change Portal, and other online information hubs, such as the Climate & Development Knowledge Network (CDKN), Eldis and ReliefWeb.

# 5. SUSTAINABILITY, RELEVANCE, EFFECTIVENESS AND EFFICIENCY

## 5.1. Sustainability

As of November 2014, around 40% of the selected households have been fitted with a rainwater harvesting system. Although the project is still very recent and yet to be fully completed, some elements are reassuring that the project will sustainably enhance resilience to extreme events in Niue and provide a sustainable additional source of water to the entire Island:

- Rainwater is a sustainable and natural source of freshwater;
- The tanks are of high quality (New Zealand standards) and have a lifespan of 20 years;
- Tank materials can be recycled in the future;
- The tank factory on the island is able to produce tanks at a much cheaper cost than shipping in ready-made tanks. More tanks could be produced with additional funding or at the cost of homeowners to extend storage capacity;
- The project has developed knowledge and skills on the island for tank fabrication and repair;
- The project is providing an additional source of water for the entire island and has already improved the living standards of priority households located at the end of the public water network and with no constant running water;
- The tank factory can be used to mould other 'plastic' products and is set to be used on an upcoming project to produce septic tanks for the island.

Other factors relating to sustainability of the project are given in Table 8.

### Table 8. Factors affecting sustainability of project interventions.

| DOMAIN | FACTOR | DETAILS |
|---|---|---|
| Socio-cultural | Water demand | Each rainwater tank is providing an additional 5,000 L of water. For the average household size of three people and average water demand of 100 L per person per day, this represents an additional 16 days of water supply |
| | Cultural compatibility | Rainwater has been used on the past in Niue and there is no risk of the technology not being accepted by the community. However, because all households are connected to the groundwater public water supply, it is easier for them to use the running water inside the house than the rainwater. It is important to promote the use of rainwater, for any outdoor use but also domestic uses and not only when the public system is shut down |
| Infrastructure | Lifespan | Lifespan of the tanks produced in Niue is 20 years providing that they are properly maintained |
| | Required maintenance | Required maintenance is fairly low. Connections need to be checked regularly for leakages and might need replacement at some point. Guttering, first flush diverters and filters should be cleaned regularly |
| Political | Political support/ in line with public policy/political agenda | The project is in line with Niue's political agenda and directly contributes to objectives and strategies of three key policy documents for national development and the climate change sector |

| DOMAIN | FACTOR | DETAILS |
|---|---|---|
| Economic | Energy consumption | The system installed by the project does not include a pump and it is envisaged that most households (>90%) will not add a pump to the system. Thus for most systems, the project will reduce energy consumption for the water sector when rainwater is used instead of groundwater. The public water network requires pumping to abstract groundwater and for houses in the upper terraces, pumping is also required to pressurise the system |
| | Net benefit/return on investment | Although the system has not been designed to generate income, the moulding factory is already generating benefit for the government with 100 additional tanks ordered. It is expected that the factory will continue to generate benefits. The government is preparing a business plan to maximise benefit for the facility. The factory is also expected to significantly reduce the cost of procurement of additional HDPE products such as septic tanks and rubbish bins |
| Environmental | Withdrawal of freshwater | The project will contribute to reducing withdrawal of groundwater by providing an additional source of water |
| | Adverse effect on environment | Once their useable lifespan expires, HDPE tanks can become an issue with no recycling facility on island. However, it will be possible to cut them on island and stack them for shipping and recycling overseas, thus significantly reducing the cost of shipping. The factory uses LPG gas to heat up the tank, which if managed properly has very low likelihood of damaging the environment |
| | Climate resilience | Rainwater harvesting systems are vulnerable to very strong winds that can damage the infrastructure, especially gutters, fascias, pipes and connections |

The PACC project team has identified the main challenges that could affect the sustainability of the demonstration project. In order to increase the sustainability of the project, the PACC team needs to ensure that it further develops ownership of the project from each household in order to maximise the use and maintenance of their rainwater systems. The risk of failure from non-maintenance is relatively low as the systems need only little care. However, the main risk is from households not using their rainwater tank at all, given the availability of free water from the public water network.

PACC has also identified that the tank manufacturing facility would need to be efficiently managed and maintained to ensure its sustainability. PACC has proposed to develop a business plan for the facility and this is being developed with the Government.

## 5.2. Relevance

The PACC project is contributing to key national policy and strategy as detailed in Section 1.2 and Table 1.

The relevance of developing rainwater harvesting at the domestic level in Niue has been described in various technical reports and national documents (GoN, 2009a,b; Chapman, 2012; SOPAC, 2007). This is due to the need to develop an additional source of water for Niueans. As detailed in this report, cyclones and extreme events will remain a threat for Niue under future climate. During such events, relying solely on groundwater for water supply is not always possible because of likelihood of contamination (heavy rainfall), possible saltwater intrusion (drought) or interrupted supply (interrupted power). In providing individual rainwater harvesting to all households in Niue, the project is providing an additional source of water to all Niueans to be used all year round and to provide relief supply during extreme climate events.

## 5.3. Effectiveness

As the project is not yet complete, assessing its effectiveness is not possible at this stage. An independent team of experts will review the finished project in 2015 and provide more insight. Village representatives will also participate in the M&E process once the project is completed.

There are, however, encouraging signs that the project is effectively reaching its objectives:

- The factory has been correctly built and has already produced 520 tanks of high quality;
- Around 65% of households in Niue have been fitted with a concrete base to support the rainwater tank;
- Around 40% of households in Niue have been provided with fully operating systems;
- Around a dozen households located at the end of the public water supply lines and previously with very unreliable water supply are already seeing their water supply improved.

## 5.4. Efficiency

From the start of the project, PACC has sought to maximise efficiency by identifying the best design for the project. The technical assessment contributed to this, as did the CBA.

During the pre-implementation phase, the project also sought to increase ownership and fairness of the system by leaving the guttering installation at the charge of each homeowner.

Overall, the project has been particularly efficient in dramatically reducing the cost to purchase rainwater tanks by developing a local manufacturing plant. This will also continue to deliver benefit after the completion of the PACC project, providing the Government of Niue with the opportunity to produce rainwater tanks at a fraction of the cost to ship from overseas. The facility is also providing an additional source of income to the Government of Niue, which is currently developing a business plan to best exploit this.

# 6. LESSONS LEARNED AND BEST PRACTICES RECOMMENDED

## 6.1. Overall

The PACC demonstration project in Niue exemplifies good coordination between the Government of Niue and donor partners. The strong commitment of the Government to an all-of-island approach and the flexibility of donor partners through the PACC, PACC+ and GCCA projects have contributed to the success of the project.

Individually, none of the projects would have had sufficient funds to build the moulding factory and provide the entire island with rainwater harvesting systems. With the original PACC funding alone, the project would only have been able to cater for about 20% of the island's households, without the development of a permanent facility on island.

The initial intention of the government was to deliver a fair project that will not only benefit the most vulnerable households (as originally identified by the PACC project) but the entire island, thus fulfilling one of the government's key priorities for the water sector. The provision of the moulding facility was incidental: it became clear during the project development that it was cheaper to build a moulding factory and produce the tanks on island than to ship them from overseas. The flexibility and coordination between GCCA and PACC through the Environment Department and the PACC coordinator to identify the most cost-effective option and maximise benefits for Niue has equally contributed to the success of the project.

The success of the project should not undermine the challenges that the project has faced during its design and implementation stages. Valuable lessons learned and best practices are reported in the following section.

## 6.2. Step by step

As part of the M&E process, the project team made quarterly reports on progress, issues faced and lessons learned in dealing with these issues. Table 9 summarises the main lessons learned by the PACC team in this way.

Table 9. Lessons learned.

| Topic | Lesson learned/recommendation |
|---|---|
| Community engagement training and awareness | Dedicated communication post to implement activities, track activities and be creative with messages. This also includes branding and marketing strategies to make the project a success by keeping stakeholders aware and involved in the project. This was an important lesson for the Niue PACC project |
| Implementation | Processes often take time, with constant follow-up necessary. Integrated activities and documents involving different but key stakeholders who have a different perspective on issues often take time but timelines/deadlines need to be in place<br>Balancing replication and up-scaling by undertaking a stock-take to verify materials and track resources, raw materials, and machinery required to complete all households |
| Monitoring and evaluation | Simple logframes need to be developed and understood by each key stakeholder<br>Ideas, lessons, technology and projects evolve over the lifetime of the project. How you manage these changes should also evolve |
| Coordination | Link projects to national priorities and where necessary partner up between projects to share resources and be more effective and efficient<br>In terms of partnerships, you need to understand the different roles of partners in project design, development and implementation<br>It is important to have good consultation and integration with key stakeholders. This takes time and needs to be considered in the project design and timeframe |
| Project management | Appropriate stakeholders should be involved at the start and integrated into the process. If overseas consultants or advisers are involved, work with them closely<br>Keep track of funds at all times<br>Undertake training and capacity building for all staff involved in the project<br>Establish a technical advisory committee for projects, that includes a range of necessary expertise<br>There is a need for a dedicated financial officer to control the project. Responsibility fell back on the project coordinator to do the financials, report, undertake communications activities, field surveys, household assessments, attend meetings, workshops, provide briefing while also implementing. If you have financial controlling officer, activities would be more efficient and better managed<br>Training on key tools is important: CBA, gender toolkit, procurement and donor financial systems |

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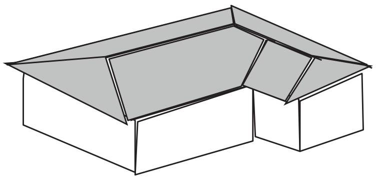
# APPENDIX 1. HOUSEHOLD SURVEY TEMPLATE

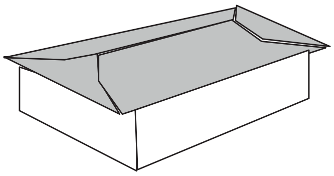
| NIUE PACC PROJECT HOUSEHOLD ASSESSMENT | | |
|---|---|---|
| Date | | Assessors: |
| Homeowner | | |
| Village | | |
| Area | | |

| | | | | ADDITIONAL NOTES |
|---|---|---|---|---|
| 1 | Is the house single or double storey? | Single | Double | |
| 2 | Does the house have an exisitng rainwater tank/s (Description and estimated volume) | Yes | No | |
| 3 | Does the house have fascias? | Yes | No | |
| 4 | Are the fascias in good condition? | Yes | No | |
| 5 | Does the house have gutters? | Yes | No | |
| 6 | Are the gutters in good condition? | Yes | No | |
| 7 | What material are the gutters made of (PVC, aluminum, steel, round or square)? | | | |
| 8 | Which side of the house is the tank best placed? | | | Indicate below |
| 9 | How many downpipes on the side where the tank will be placed (if there are gutters)? | | | Indicate below |
| 10 | What is the house floor dimension (m)? | | | Indicate below |
| 11 | How high (m) is the ground level to the fascia underside (where the tank will be)? | | | Indicate below (Note: tank inlet is 2.110m from base and base is 300mm (min) from G.L.) |
| 12 | Is the proposed tank base clear of anything that will likely cause damage (driveway, trees, fire, cyclone winds) to the proposed tank? | Yes | No | |
| 13 | Is the proposed tank base clear of any future / potential house extension? | Yes | No | |
| 14 | Is the proposed tank base near the mains water supply into the house? | Yes | No | |
| 15 | Is there an existing tank base that can be used / retrofitted? | Yes | No | |
| 16 | Does the homeowner want to have an additional tank, AT THEIR COST? | Yes | No | |

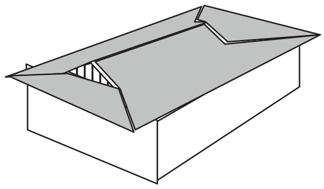
**SELECT THE HOUSEHOLD TYPE OF ROOF FROM THE DIAGRAMS BELOW**



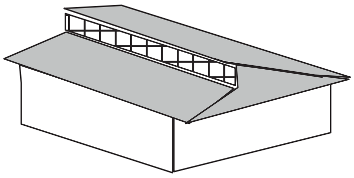
HIP & VALLEY ROOF



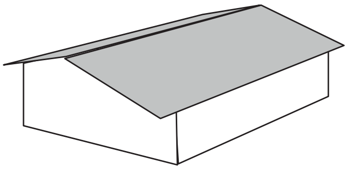
DUTCH HIP



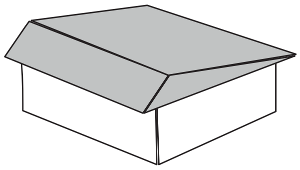
DUTCH GABLE



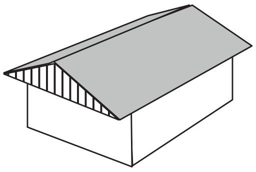
NORTH LIGHT ROOF



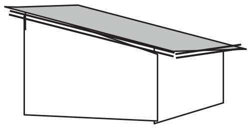
GABLE END



DUAL PITCH ROOF



BOX GABLE



SKILLION (LEAN-TO) ROOF

## APPENDIX 2. MARLEY'S RAINWATER HARVESTING GUIDE AND CATALOGUE ADJUSTED FOR NIUE

# Rain Harvesting Systems

## Safer solutions for rainwater collection

# **Marley Rain Harvesting Products**; safer solutions for the collection, storage and distribution of rain water.

## HOW SAFE IS THE WATER YOU ARE COLLECTING?

When collecting rainwater as a partial or total source for a water supply it is essential the design of the system meets the need for potable (safe drinking) water.

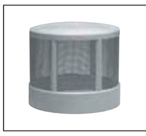
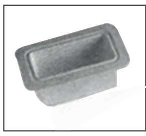
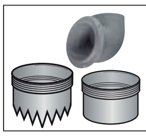
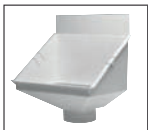
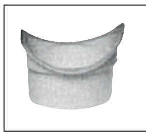
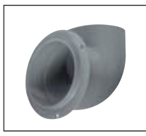
Water collected from a roof and stored and distributed from a water tank, can contain a nasty range of pollutants that can contaminate your water, for example bacteria from bird droppings, insects, rotting debris, airborne dusts (containing heavy metals).

The Marley Rain Harvesting System comprises of a number of unique and cost effective components that are designed to work with the Marley PVC range of spouting and downpipes to help make tank water as clean as possible. However, it is advisable to have your tank water analysed to check its potability.

## 7 STEPS TO RAIN HARVESTING POTABLE WATER;

1. Ensure the roof surface is suitable for collecting potable water
2. Ensure spouting is installed according to Building Code, allowing for adequate fall and installing suitable expansion outlets or gutter outlets to make certain water does not pond in the gutter
3. Install debris diverter rainheads with screens to direct leaf litter and larger debris items out of the flow of the water
4. Fit an appropriate sized first flush diverter, to divert the first most contaminated rain water from entering the tank
5. Attach tank overflows and vent flaps to tanks to ensure the tank is vented properly allowing air to circulate
6. Attach insect screens to rainheads and tanks to prevent insects and vermin entering the tank
7. To assist in cleaning the tank, install a tank vacuum kit to suck water from the bottom of the tank (anaerobic zone – dirty 'zone') when the tank is full to overflowing.

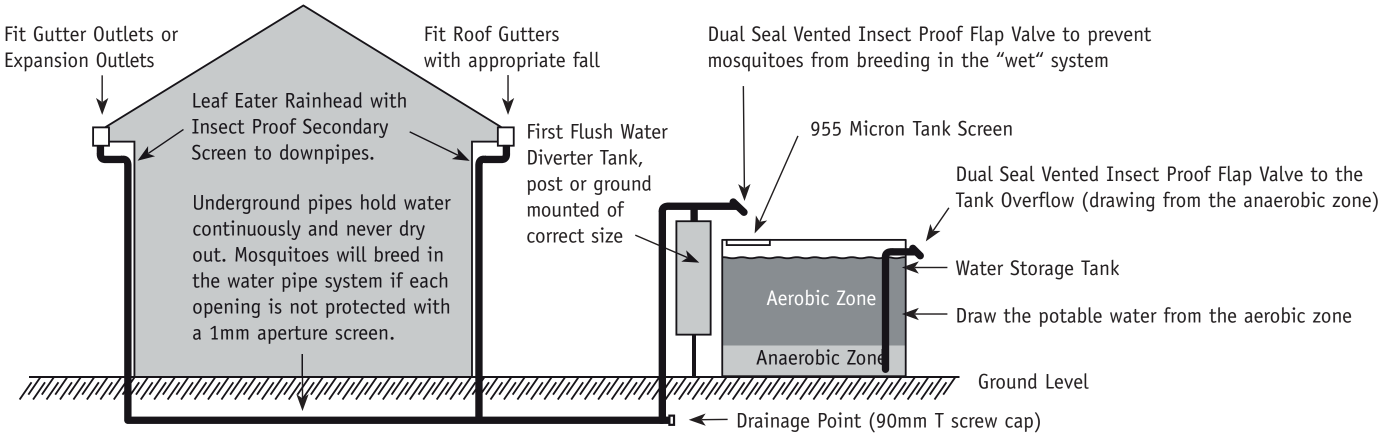
## RAIN HARVESTING SYSTEM COMPONENTS

| | | | | | | | |
|---|---|---|---|---|---|---|---|
|  | Leafslide Rainhead<br>**Code: RWLS** |  | 50mm diameter PVC Insect Proof Flap Valve<br>**Code: RH8118-4** |  | 90mm diameter, Female Gutter Outlet<br>**Code: RH8118-5** |  | 50mm diameter Vent Cowl PVC & S/Steel Insect Proof Screen<br>**Code: RH8119-9** |
|  | Leaf Beater Rain Head 80/90mm Dual Fit<br>**Code: RH8120** |  | 90mm diameter Insect Proof, Vented Flap Valve PVC/Stainless Steel<br>**Code: RH8119-3** |  | 100mm diameter Gutter Outlet<br>**Code: RH8118-6** |  | 100mm diameter Vent Cowl PVC & S/Steel Insect Proof Screen<br>**Code: RH8119-2** |
|  | Leaf Catcher Rain Head 90/100mm Dual Fit<br>**Code: RH8117** |  | 100mm diameter Insect Proof, Vented Flap Valve PVC/Stainless Steel<br>**Code: RH8119-3-100V** |  | 100 x 50mm rectangular Gutter Outlet<br>**Code: RH8153** |  | 90mm Tank Vacuum Kit - Poly/F-Glass/Flat wall Tank<br>**Code: RHFWTV90**<br>Concrete Tanks<br>**Code: RHCONTV90** |
|  | Leaf Eater Rain Head 80/90mm<br>**Code: RH8119** |  | 90mm Tank Corrugated Overflow Outlet<br>**Code: RH8123** |  | 90mm diameter Gutter Outlets for HALF ROUND Gutters<br>**Code: RH8118-9** |  | Downpipe Diverter<br>**Code: RWDD** |
|  | 90/100mm Dual Fit First Flush Water Diverter Post or Wall KIT (Kit only add 300 diam pipe to suit volume required)<br>**Code: RH8121-1** |  | 90mm 304 Stainless Steel M&F Insect Proof Screen (Fits RH8123, RH8124-1, RH 8124-2)<br>**Code: RH8116** |  | Flanged Tank Overflow Outlet 90mm X 90 degree bend M&F<br>**Code: RH8124-1** |  | 100mm Roof Outlet<br>**Code: RV369**<br>150mm Roof Outlet<br>**Code: RV482** |
|  | 90mm First Flush Water Diverter - Downpipe<br>**Code: RH8119-5** |  | 90mm diameter, Male Gutter Outlet<br>**Code: RH8124** |  | Plain Tank Overflow Outlet 90mm X 90 degree bend M&F<br>**Code: RH8124-2** |  | Outlet Strainer<br>**Code: RWST** |

Choosing the most suitable components for a rain harvesting system will be based upon whether the tank is set up as a wet or dry system.

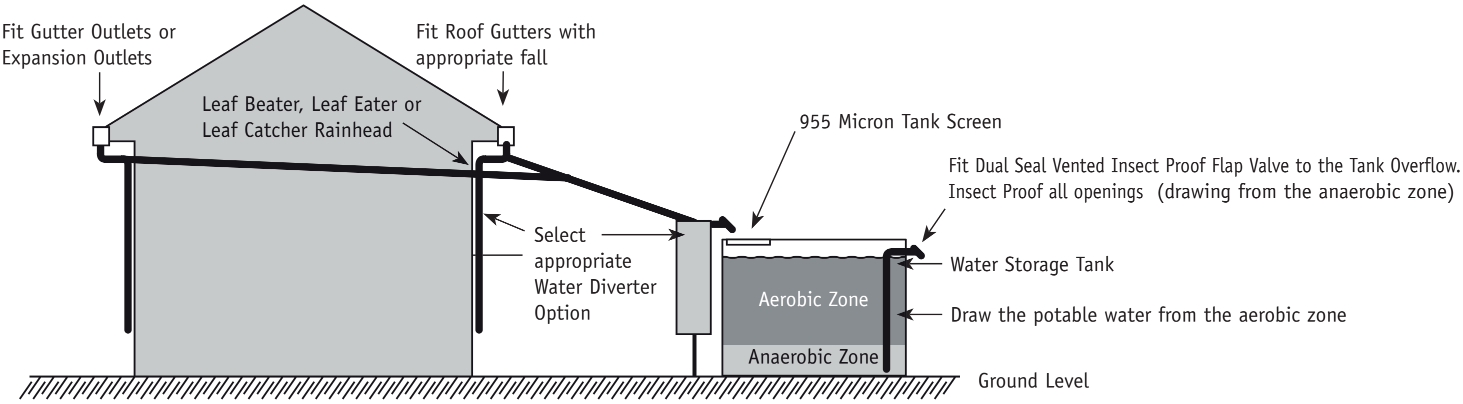
## A TYPICAL "WET" SYSTEM (syphonic system)

A "Wet" System is a system where the pipes are fitted in such a way that when the rain stops the pipes to the tank do not drain out. They hold water. With this type of system, the pipes must be fitted with screens at each end to ensure that insects cannot enter and breed in the system. A "wet" system needs to be fitted with a First Flush Water Diverter at the tank, with a capacity equal to that of the pipes plus whatever amount is to be diverted from the roof. To lessen the amount of water to be diverted at the tank, a Downpipe First Flush Water Diverter can be fitted on the building to take the required first flush from the roof.



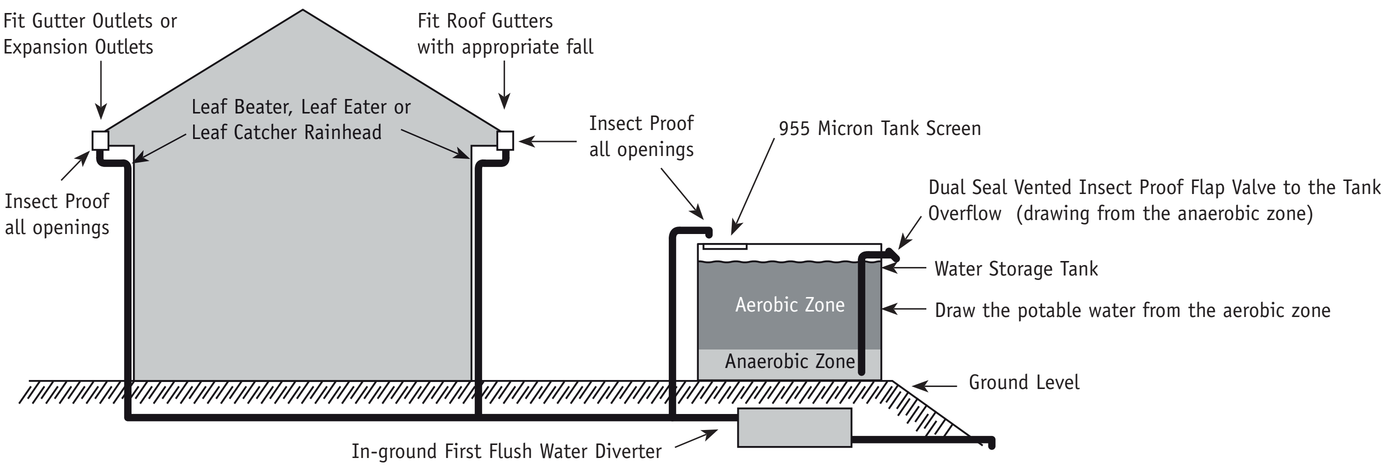

## A TYPICAL "DRY" SYSTEM

A "Dry" System is a system where the pipes drain out and dry out after rain. A system where pipes do not hold water after the rain stops. Large buildings normally make it near impossible to have "dry" systems. For slightly sloping sites an In-Ground First Flush Water Diverter will turn a "wet" system into a "dry" system.




## A TYPICAL "WET" SYSTEM CONVERTED TO A "DRY" SYSTEM

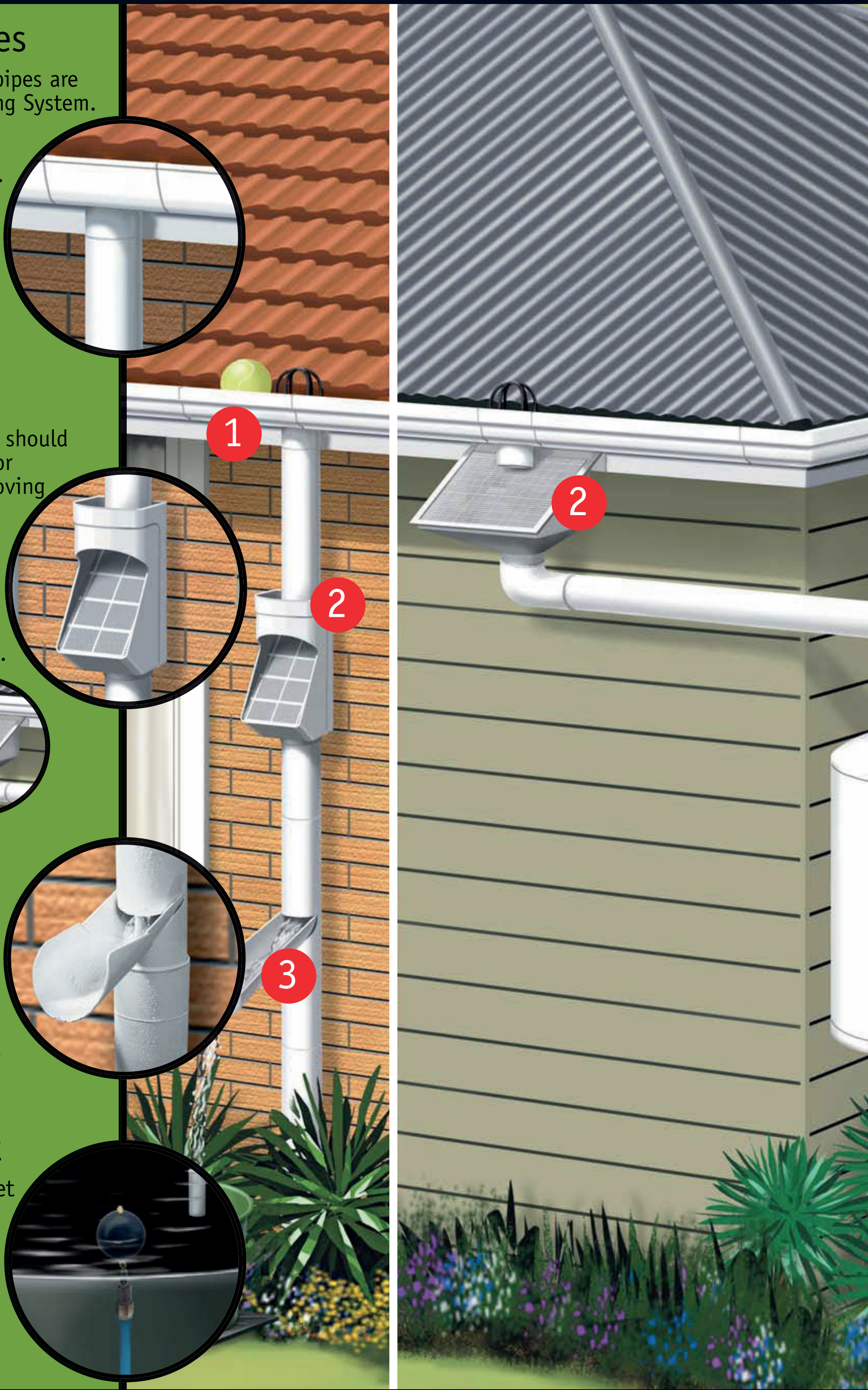
For slightly sloping sites an In-Ground First Flush Water Diverter will turn a "wet" system into a "dry" system.




**Regular maintenance is extremely important. Clean rainhead and filter screens. Check to ensure that all insect proofing is in place and is effective. Check that the roof is free from overhanging branches and that there are no snags in the roof gutter.**

# Rain Harvesting Systems

## safe solutions for the collection,




## 1 Spouting & Downpipes

Marley spouting systems and downpipes are key components in a Rain Harvesting System. Fit roof gutters and downpipes in compliance with Building Code E1 and Marley installation instructions. Ensure adequate fall is provided for and the correct number of downpipes are installed. Marley PVC spouting and downpipes do not rust, therefore metal contaminants from the gutter do not end up in water storage tank.

## 2 Leaf Diverters

Leaf and debris diversion rainheads should be fitted where water is captured for storage in tanks or as a debris removing device in urban areas. As the water flows from a gutter it brings the small pieces of debris with it. As water washes over the angle screen of the leaf diversion system the debris is forced away and the water continues through the screen.

**Code: RH8121, RH8117, RH8119, RWLS**

## 3 Downpipe Diverter

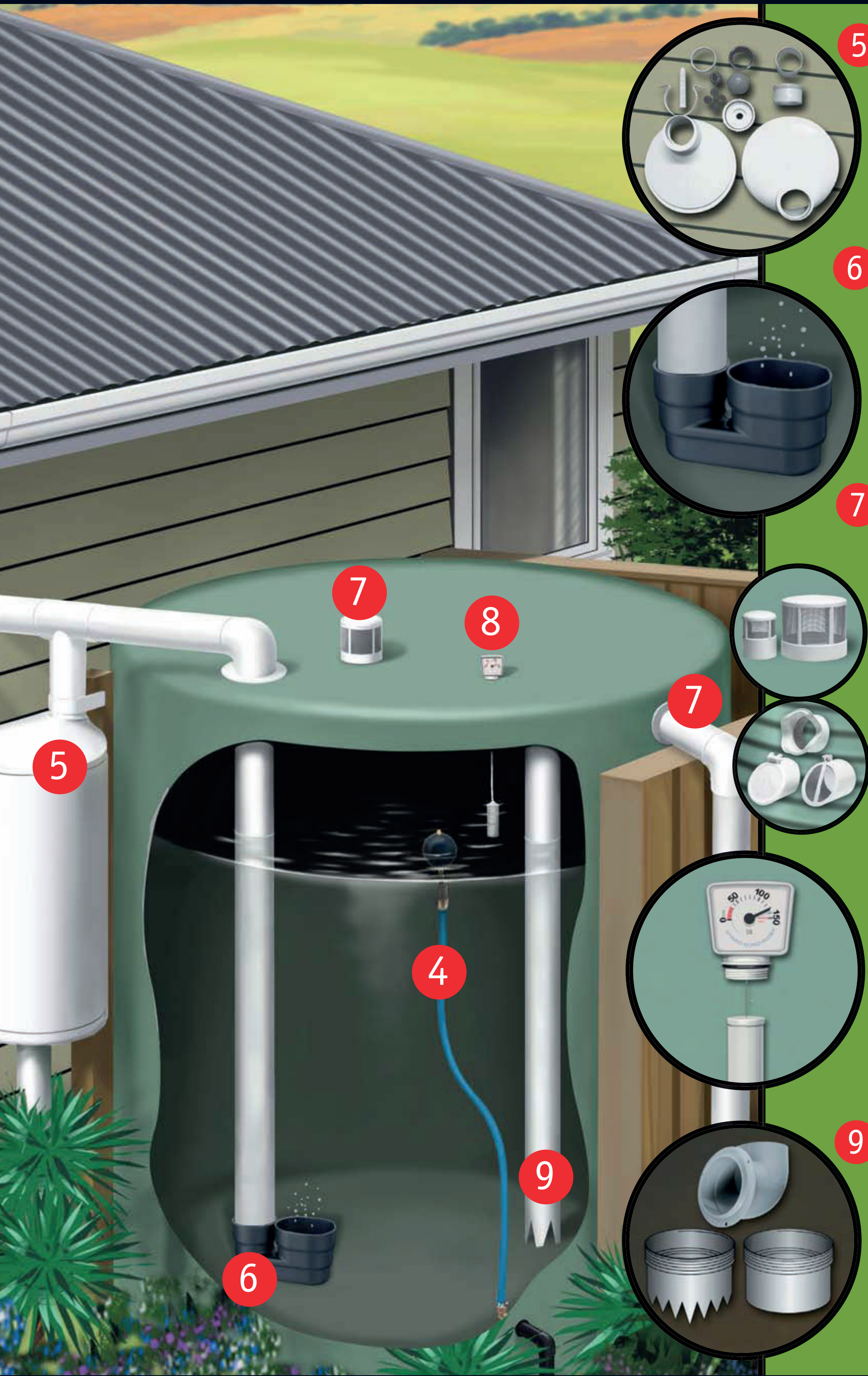
The Marley Downpipe Diverter can be installed easily to PVC downpipes allowing collection of fresh rainwater for tank filling, garden watering, aquariums etc. to reduce dependance on town supply.

**Code: RWDD**

## 4 Floating Out-take Kit

This is connected to the tank outlet to the house and ensures you are drawing the cleanest water in the tank. The Floating out-take floats inside the tank, suspended just below the water surface where the cleanest water lies.

storage and distribution of rain water.




## 5 First Flush Diverter

The First Flush Diverter reduces pollution of tank water by diverting the first flush of contaminated water away from the tank.

**Code: RH8121-1, RH8119-5**

## 6 Calmed Inlet

Provides a calmed inlet for rainwater enetering the storage tank. The calmed Inlet avoids distributing sediment in the bottom of the tank.

**Code: RH8119-9, RH8119-2**

## 7 Vent Cowls, Flap Valves & Overflow

Vent Cowls reduce the possibility of pressurising inside the tank allowing a flow of fresh air into the tank, so the water can breathe. Fitting insect proof flap valves and tank overflows to a storage tank ensures the tank is vented allowing air to circulate while protecting it from insects.

**Flap Valved Code: RH8118-4, RH8119-3, RH8119-3100V, Corrugated Tank Overflow Code: RH8123.**

## 8 Tank Gauges

Used to measure water levels in the tank.

## 9 Tank Vacuum Kit

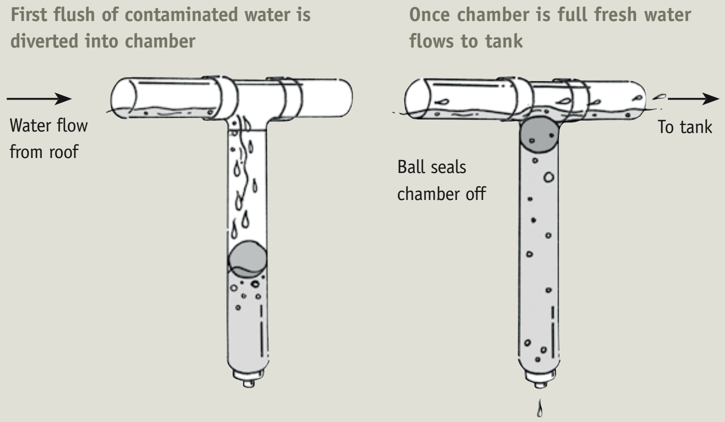
By fitting a Tank Vacuum Kit, when the tank fills up the overflow will be sucked from the bottom of the tank (from the "Anaerobic Zone" - dirty zone).

**Code: RHFWTV90 (Poly/F-glass/Flat tanks), RHCONTV90 (Concrete tanks)**

## Water diversion is a key component to water quality. The main function of the first flush diverter is to prevent the first flow of water from the roof from entering the water storage tank.

When it begins to rain, the first flow of contaminated water is diverted into the diverter chamber. Once the chamber is full, the fresh water automatically flows into the storage tank.

The type of first flush diverter to be fitted should be chosen by assessing the quantity of water to be diverted.




# FIRST FLUSH DIVERTERS

## 90/100MM DUAL FIT FIRST FLUSH DIVERTER – WALL MOUNTED OR FITTED UNDERGROUND

Can be installed to a new or existing downpipe system.

Add the appropriate length of 300mm diameter pipe to suit the quantity of water you wish to divert (see table below).

**Calculation Method:** $m^2$ Roof Area x Pollution Factor x 1000 + (length of wet pipe m x pipe cross section factor) = litres to be diverted

**Pipe Allowance**

| Pipe Size | Pipe Cross Section Factor |
|---|---|
| RP65 | 3.30 |
| RP80 | 4.40 |
| 90SW | 5.75 |

Pollution Factor 0.0005 Minimal Pollution; open field
Pollution Factor 0.0020 Substantial Pollution; leaves, debris, bird droppings, various insect matter.

| PRODUCT CODE | DESCRIPTION | VOLUME IN LITRES |
|---|---|---|
| CHR.300.1 | 300mm x 1metre | 80 Litres |
| CHR.300.1.5 | 300mm x 1.5metre | 120 Litres |
| CHR.300.2 | 300mm x 2metre | 160 Litres |
| CHR.300.3 | 300mm x 3metre | 240 Litres |

### Installation instructions

**Step 1** - Determine the length of the Diverter Chamber (see table above). Make sure the Screw Cap is at least 150mm from the ground to allow for cleaning.

**Step 2** - Bevel both ends of the 300mm pipe with an angle grinder so that the pipe fits easily onto the end caps.

For Post/Wall mounting glue (Marley Gold) the caps on each of the chamber making sure the cap outlets are both at 12 o'clock.

For an underground unit (horizontal) glue one cap at 12 o'clock and the other at 6 o'clock.

**Step 3** - Attach the wall/post bracket in position.

Place the diverter chamber into the bracket and secure the chamber to the wall at the top with a 100mm pipe bracket.

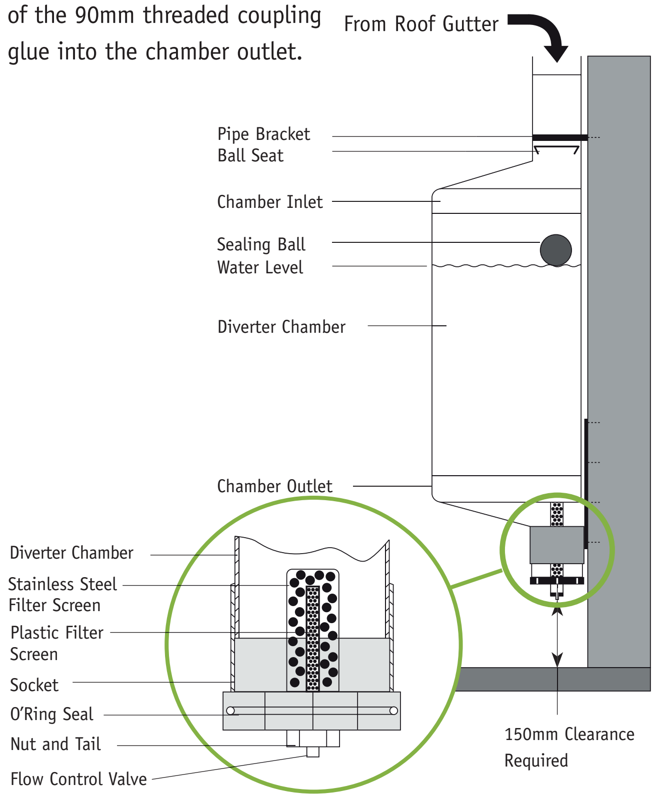
**Step 4 - Connecting to the Chamber Inlet**

If connecting to 90mm pipe; insert the ball seat with the small end (seat) down into the top of the chamber inlet and insert the infeed pipe directly hard down on the diverter seat.

If connecting to a 100mm pipe: Insert the ball seat with the small end (seat) down into the top of the chamber inlet and insert and glue the 20mm (long) 90mm spacer (provided) and push the spacer hard down on top of the seat to hold it in place. Attach the 100mm infeed pipe.

**Step 5 - Connecting to the Chamber Outlet**

Glue the 100mm long 90mm diameter pipe provided into the plain end of the 90mm threaded coupling and glue into the chamber outlet.



Insert the Stainless Steel filter into the socket with the open end of the filter facing downwards, insert the 20mm (long) 90mm pipe (spacer) into the socket to hold the filter in place.

Fit the Screw cap to the socket making sure that the "O" Ring is in place in the cap. Insert the plastic screen into the cap, select the appropriate Flow Control Valve (rubber seal with holes) with the smallest hole giving slowest flow. Place Flow Control Valve in the Nut and Tail and screw the Nut and Tail into the cap.

To install the unit underground, ensure that before Chamber Inlets and Outlets are glued to the Chamber, the Chamber Inlet is at 12 O'clock and the Chamber Outlet at 6 O'clock to ensure water can drain out effectively.

Hint: Make sure diverter water flows away from house or tank. Use diverted water for gardens.

### Maintenance

To ensure continuing function, unscrew the screw cap on a regular basis to allow debris to fall out. Hose or wash the filter screen if needed and check and clean the flow control valve.

## 90MM FIRST FLUSH DIVERTER – DOWNPIPE

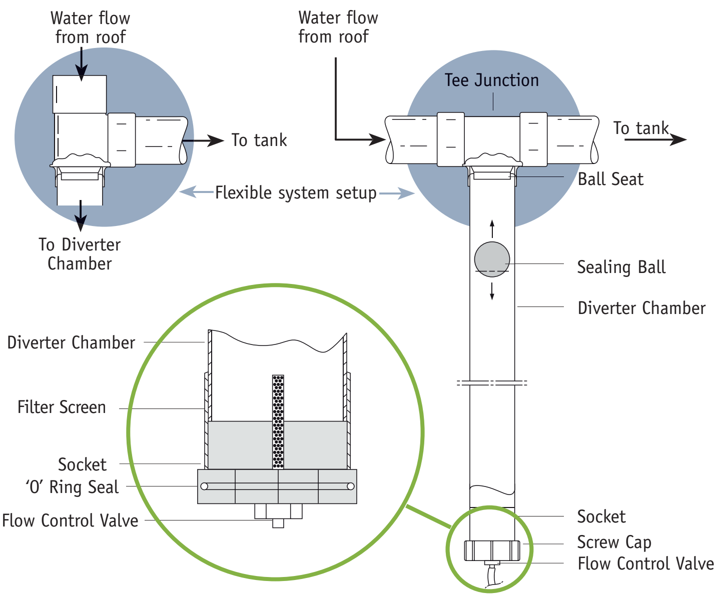
A simple First Flush Diverter requiring minimal maintenance.

Can be installed to a new or existing downpipe system. Use a Marley adaptor to install with a 65mm or 80mm downpipe system (RA65.90 or RA80.90).

Add the appropriate length of 90mm diameter pipe to suit the quantity of water you wish to divert.

### Installation Instructions

**Step 1 -** Determine the length of the Diverter Chamber (cut 90mm pipe as long as possible) making sure the Screw Cap is at least 150mm from the ground to allow for removal and cleaning.




**Step 2 -** Place the Ball Seat into the Tee Junction and then fit the Diverter Chamber up against the Ball Seat and hold until the glue sets. Then fit the socket to the bottom end of the Diverter Chamber.

**Step 3 -** Fix the assembled chamber to the wall in the desired position using the steel Pipe Brackets.

**Step 4 -** For wall mounting, connect a M & F Elbow to the Diverter Chamber and connect the downpipe. Bracket if necessary. Fit an elbow to the Tee Junction inlet and connect to the bottom of the selected Leaf Diverter.

**Step 5 -** Place the Sealing Ball into the Diverter Chamber and attach the Screw Cap.

**Step 6 -** Select the appropriate Flow Control Valve and insert into the Nut and Tail. Insert plastic Filter Screen into Screw Cap and attach the Nut and Tail.

### Maintenance

To ensure continuing function, unscrew the screw cap on a regular basis to allow debris to fall out. Hose or wash the filter screen if needed and check and clean the flow control valve.

## DOWNPIPE DIVERTER

The Marley Downpipe Diverter can be installed easily to Marley PVC downpipes allowing collection of fresh rainwater for tank filling, garden watering, etc.

The Downpipe Diverter is especially useful for those wishing to reduce dependence on reticulated water.

The Downpipe Diverter should not be used in a 'wet system'.

**Dimensions -** 80mm pipe that can easily be adapted to fit all Marley downpipe profiles.

### Installation Instructions

Cut a 320mm gap in the downpipe, join the Downpipe Diverter to the enclosed attachment.

Attach the Diverter to the downpipe, starting at the top with the diverter offset slightly, then push up and across.

Let the Diverter then slide down into the downpipe.

**To Use -** Simply lower the side arm and ensure it is clipped in and on a downwards slope.

Leaf and debris diversion rainheads should be fitted where water is captured for storage in tanks or as a debris removing device in areas on reticulated water.

As the water flows from the spouting it brings the small pieces of debris with it and as water washes over the angle screen of the leaf diversion system the debris is forced away and the water continues through the screen.

## LEAF SLIDE

The leafslide has been designed for ease of installation. The filter box has anchor tabs provided for screwing or nailing it to the wall or fascia. The leafslide has a standard 90mm stormwater outlet which is easily adapted to fit Marley downpipe.

Best performance is achieved by using 65mm diameter downpipe above the filter screen.

**Dimensions -** 280mm in length. The top of the Leafslide is 120mm by 100mm deep.

## LEAF EATER - for high rainfall areas

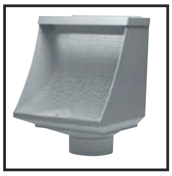
The ultimate high performance rainhead for use in heavy rainfall areas. Primary screen of 6mm aperture and an insect proof secondary stainless steel screen of 0.995mm.

To install mount the main box evenly under the gutter outlet or expansion outlet by securing it to the fascia with pop rivets or screws, making sure the backing plate fits snugly up to the bottom edge of the gutter but not between the fascia and back of the gutter.

Place the insect screen in the main box over the outlet ensuring that the screen clips into place. Replace the primary screen, making sure the screen fits inside the front lip of the Leaf Eater®, and secure in place with the clips provided. The Leaf Eater® is now ready for connection to the downpipe. Do not glue the Leaf Eater® to the down pipe. Secure downpipe with a screw for easy replacement.

**Dimensions -** 290mm in length, 270 wide and 190mm in depth

## LEAF BEATER - for low rainfall areas



A high performance rain head with a 4mm aperture adjustable elliptical primary screen. Sheds leaves from the gutter onto the ground. Comes complete with an integrated directional gutter outlet and an insect proof stainless steel low flow rate secondary screen. For midmounting remove the top directional outlet. Bevel the entry downpipe at 60° and allow 50mm clearance between the pipe and screen.

**Dimensions -** 280mm in length, 210mm wide and 180mm in depth.

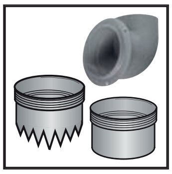
## LEAF CATCHER - gutter or wall mounted

A budget leaf and debris catcher with two horizontal internal screens.
Screen one: 6mm aperture screen
Screen two: 0.955mm stainless steel insect proof screen.

Cleaning - Simply lift the screen out and empty and replace when cleaned. Perfect for low rain fall, low leaf areas where tank water is required. Fits both 90 and 100mm PVC pipe.

**Dimensions -** 210mm in length, 290mm wide and 190 mm in depth.

## TANK VACUUM KIT



Fine sediment, which can contain harmful bacteria and heavy metals, eventually builds up in the bottom of the tank and some can find its way out the outtake pipe and into the home and can be ingested. This can be removed by using a tank vacuum kit.

### How the Tank Vacuum System Works

Water flows into the tank through your existing pipework. The 90mm diameter Tank Vacuum Kit becomes charged with water and a suction action starts as the excess water exits the tank. This exiting water sucks the sediment/waste from the bottom of the tank (from the "Anaerobic Zone" - dirty zone) up the syphon pipe and out the tank. Position the tank vacuum kit directly over the outtake. Cut the vacuum pipe so that the serrated pick up rests on the bottom of the tank. The anti syphon feature prevents all the water in the tank from syphoning.



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**Contact Centre:** 0800 222 922

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Shands Road, Hornby, PO Box 16233 Christchurch
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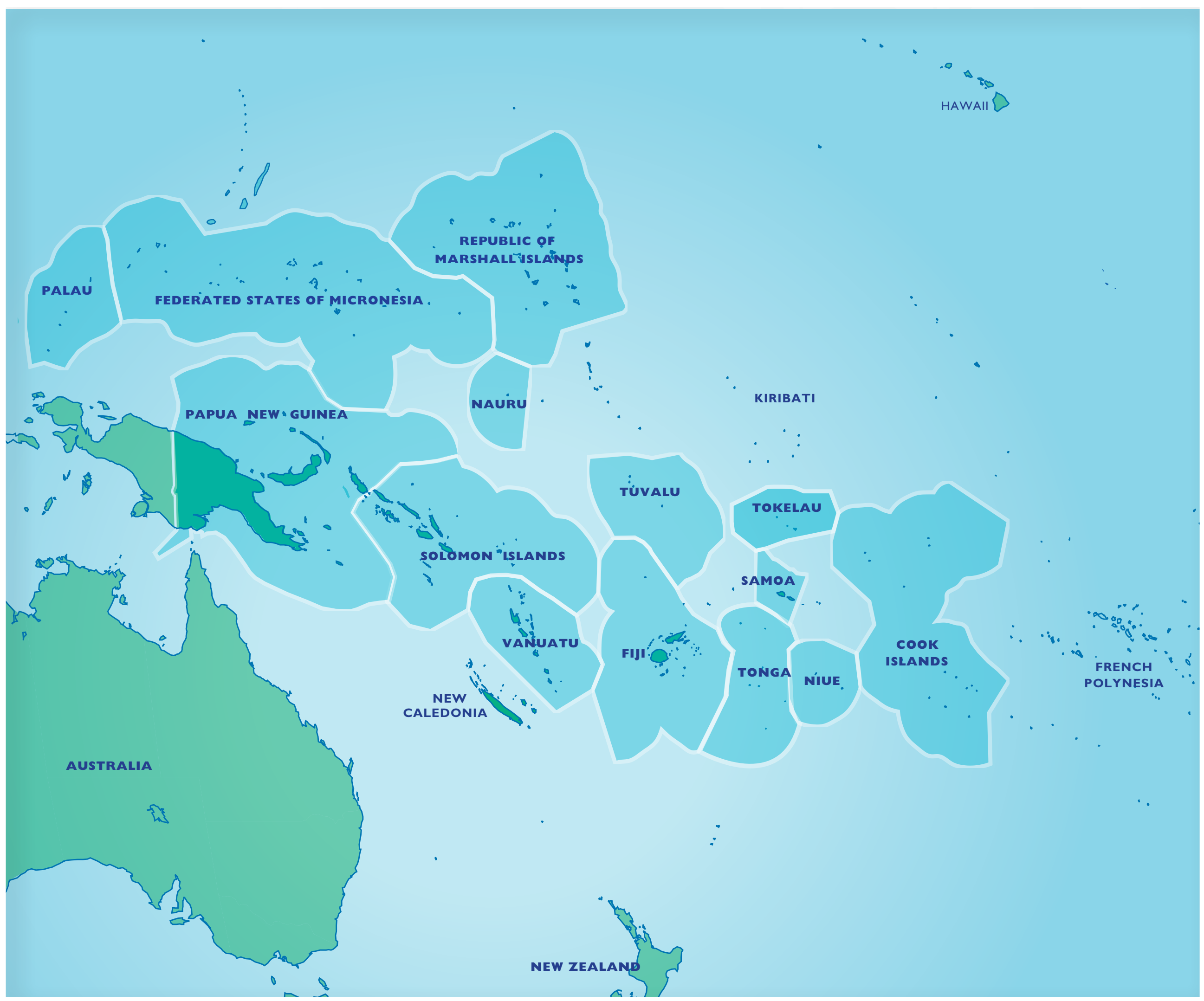
For a quotation, installation or more information call free
**0800 MARLEY (0800 627 539)**




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 (GEF)'s Special Climate Change Fund (SCCF) 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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