Sustainable Integrated Water Resources and
Wastewater Management in Pacific Island Countries

National Integrated Water Resource Management Diagnostic Report

Nauru

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Acronyms

ADB	Asian Development Bank
ACIAR	Australian Centre for International Agricultural Research
ARCS	Atmospheric Radiation and Cloud Station
ARM	Atmospheric Radiation Measurement
AusAID	Australian Agency for International Development (previously known as AIDAB)
BPC	British Phosphate Corporation
CCA	Climate Change Adaptation
CHARM	Comprehensive Hazard and Risk Management
CIR	Ministry of Commerce, Industry and Resources
DCC	Development Coordinating Committee
DPPD	Development Policy and Planning Division
EU	European Union
ECD	Environment and Conservation Division (within MELAD)
EHC	Eigigu Holding Corporation
ENSO	El Niño- Southern Oscillation Index
EVI	Environmental Vulnerability Index
GDP	Gross Domestic Product
GEF	Global Environment Facility
GON	Government of Nauru
HSA	Hot Spot Analysis
HYCOS	Hydrological Cycle Observing System
ICWM	Integrated Coastal and Watershed Management
IHP	International Hydrological Programme (of UNESCO)
IWRM	Integrated Water Resource and Sanitation Management
MABS	Multi-Agent Based Simulation
ML	Megalitre
NGO	Non-government organisation
NIANGO	Nauru Island Association of NGOs
NFMRA	Nauru Fisheries Marine Resource Authority
NPC	Nauru Phosphate Corporation
NRC	Nauru Rehabilitation Corporation
NZAID	New Zealand International Aid and Development Agency
NSPRAU	National Strategic Policy and Risk Assessment Unit
NWSCC	National Water and Sanitation Coordination Committee
OFM	Oceanic Fisheries Management
PIC	Pacific Island Country

PROC	Peoples Republic of China (Beijing)
PUB	Public Utilities Board
RAP	The Pacific Regional Action Plan for Sustainable Water Management
ROC	Republic of China (Taiwan)
RON	Republic of Nauru
RPU	Rural Planning Unit (within MISA)
SAP	The Strategic Action Programme, International Waters of the Pacific Small Island Developing States
SAPHE	Sanitation, Public Health and Environment Improvement Project
SIDS	Small Island Developing States
SIWRWMPIC	Sustainable Integrated Water Resources and Wastewater Management in Pacific Island Countries
SOI	Southern Oscillation Index
SOPAC	Pacific Islands Applied Geoscience Commission
SPC	Secretariat of the Pacific Community
TDS	Total Dissolved Solids
UN	United Nations
UNCDF	United Nations Capital Development Fund
UNDP	United Nations Development Program
UNDTCD	United Nations Department of Technical Cooperation for Development
UNDESA	United Nations Department of Economic and Social Affairs
UNEP	United Nations Environment Program
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNWWAP	United Nations World Water Assessment Programme
WB	World Bank
WHO	World Health Organisation
WUE	Water Use Efficiency
WWF	World Water Forum

Table of Contents

Acronyms ii

Executive Summary i

Acknowledgements ii

Introduction 1
Sustainable Integrated Water Resources and Wastewater Management in Pacific Island Countries 1
Linkage with the Pacific Regional Action Plan on Sustainable Water Resource Management 2
Aim of the SIWRWMPIC 3
Scope of this Report 3

1. General Overview 5
Country Background Information 5
Location and topography 5
Geology and soils 5
Freshwater resources 7
Potential groundwater resource 7
Rainfall 8
Winds 9
Temperature 9
Vegetation 9
Population 9
Socio-economic conditions 10
Economy 10

2.0 Integrated Water Resources Management Situation for Nauru 13
2.1 Water resources management 13
2.1.1 Types of freshwater resources 13
2.1.2 Types of freshwater use 15
2.1.3 Major issues and concerns 16
2.1.4 17
Methods to manage impacts and concerns (IWRM) 17
2.2 Island vulnerability 17
2.2.1 Types of disasters 17
2.2.2 Major issues and concerns 18
2.2.3 Measures to manage impacts and concerns (IWRM approaches) 20
2.3 Awareness 21
2.3.1 Type of awareness campaigns, advocacy initiatives currently being undertaken in the area 21
2.3.2 Major issues and concerns 21
2.3.3 Measures to manage impacts and concerns (IWRM approaches) 22
2.4 Technology 22

2.4.1 Types of water supply systems 22
2.4.2 Types of wastewater/sanitation systems 23
2.4.3 Major issues and concerns 24
2.4.4 Measures to manage impacts and concerns (IWRM approaches) 25
2.5 Institutional arrangements 26
2.5.1 Types of institutional arrangements 26
2.5.2 Major issues and concerns 26
2.5.3 Measures to manage impacts and concerns (IWRM approaches) 27
2.6 Financing 29
2.6.1 Types of financing arrangements 29
2.6.2 Major issues and concerns 29
2.6.3 Measures to manage impacts and concerns (IWRM approaches) 30

3. Linkages to other areas 31
3.1 Landuse and Agriculture 31
3.2 Habitats and ecosystems 31
3.3 Health and hygiene 31
3.4 Watershed and coastal management 32

4. Stakeholder Engagement 33

4. Stakeholder Engagement 33

5. Other programmes, projects and activities related to IWRM 34

6. Capacity Development Needs for Removing the Barriers 35

7. Introducing an Integrated Approach towards Barrier Removal 36

References 38

Annexes 40

LIST OF FIGURES

Figure 1: Location of the Republic of Nauru 6
Figure 2: The Island of Nauru 6
Figure 4: Annual Rainfall for Nauru, 1946 – 2006 8
Figure 5: Map of Mined Area of Nauru 12

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Executive Summary

Integrated Water Resource Management (IWRM) offers a systematic approach to address the sustainable development, allocation and monitoring of water resources for Pacific island Countries (PICs). The key concept of IWRM is that it provides a framework to integrate societal, economic and environmental considerations in water resource management. It recognises that all water use is interdependent and therefore should be managed in an integrated manner.

The Republic of Nauru is an isolated, uplifted limestone island located 41 km south of the equator at $0^{o}32'$ S latitude and $166^{o}56'$ E longitude. The total land area of Nauru is only 22 km^2 (2,200 ha).

Small island nations in the Pacific, such as Nauru, have critical water supply problems. Nauru is a permeable island with very little surface runoff and no rivers or reservoirs. Potable water is collected in rainwater tanks from the roofs of domestic and commercial buildings. Water for non-potable uses is obtained from domestic bores at houses around the island. There are four small desalination plants on the island, of which two are operating and supply Menen Hotel and the refugee camp.

Shallow groundwater is the major storage for water between rainy seasons. There is increasing salinity in the groundwater bores around the perimeter of the island, and increasing demand for groundwater water due to development. Groundwater is contaminated by wastewater disposal from houses, shops, commercial buildings and the refugee centre.

For Nauru the key water resource management issues that would benefit from an IWRM approach are:

- The lack of a legal and policy framework for water resource ownership and management. Groundwater is owned by the landowners and not the nation. There is no legislative framework for water resources, sanitation and environmental matters.
- Capacity building in the area of integrated management. There is a shortage of capable people for water management and for maintenance of existing facilities.
- Poor wastewater treatment in septic tank systems and cess pits, seepage of nutrients to groundwater and into the lagoon.
- Climatic vulnerability in water supply, particularly to drought.
- High power demand for desalination.

Some of these issues are being addressed through current projects (e.g. new water tanks) but there are many issues that would benefit from IWRM.

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Introduction

Water is essential for life. The health and well-being of humans, plants and animals depend on a satisfactory supply of safe, potable water, with low levels of contamination.

Small island nations in the Pacific, such as Nauru, have critical water supply problems. Nauru is a permeable island with very little surface runoff and no rivers or reservoirs. Potable water is collected in rainwater tanks from the roofs of domestic and commercial buildings. Water for non-potable uses is obtained from domestic bores at houses around the island. There are four small desalination plants on the island, of which two are operating and supply Menen Hotel and the refugee camp.

Shallow groundwater is the major storage for water between rainy seasons. There is increasing salinity in the groundwater bores around the perimeter of the island, and increasing demand for groundwater water due to development. Groundwater is contaminated by wastewater disposal from houses, shops, commercial buildings and the refugee centre.

Sustainable development requires that the demand for water – for all uses including maintenance of environmental biodiversity – is managed so that community needs can be met without threatening the long term health and sustainability of terrestrial and coastal ecosystems.

Integrated water resources management (IWRM) is essential to provide a sustainable water supply for the island, to protect the environment and improve community health. Water policy and management need to recognise the interconnected nature of water resources, including the management, reuse and discharge of wastewater from households, commercial establishments and the phosphate mining industry.

This Diagnostic Report uses an IWRM approach to examine water and sanitation in the Republic of Nauru (RON).

Sustainable Integrated Water Resources and Wastewater Management in Pacific Island Countries

The Sustainable Integrated Water Resources and Wastewater Management project in Pacific Island Countries (SIWRWMPIC) is coordinated by the Pacific Islands Applied Geoscience Commission (SOPAC). It evolved from the Strategic Action Programme (SAP) for the International Waters of the Pacific Small Island Developing States carried out in August 1997. The SAP identified the priority concerns, imminent threats and root causes, and provided solutions and the proposed activity areas to implement those solutions.

The goal is to achieve integrated sustainable development and management of international waters in the region. The priority concerns for Pacific Island International Waters arise from imminent threats to the health of those waters:

1. Pollution of marine waters, freshwater and groundwater from land-based activities;
2. Physical, ecological and hydrological modification of critical habitats; and
3. Unsustainable exploitation of living and nonliving resources.

The SAP provides a regional framework within which actions are identified, developed and implemented. Targeted actions within the SAP are envisaged in two linked and complementary consultative contexts:

1. Integrated Coastal and Watershed Management (ICWM); and
2. Oceanic Fisheries Management (OFM).

Through the ICWM and OFM approaches, the SAP sets out a path for the transition of the Pacific islands from sectoral to integrated management of international waters as a whole.

The regional SIWRWMPIC proposal is focussed on Integrated Coastal and Watershed Management. It is noted that, for Nauru, as for many Pacific Islands with low topography, the major community water resources are rainwater and shallow groundwater, with recharge from the surface of the entire island.

Linkage with the Pacific Regional Action Plan on Sustainable Water Resource Management

The regional SIWRWMPIC project assists Small Island Developing States (SIDS) to implement the Pacific Regional Action Plan (RAP). It is consistent with that Plan which is now being incorporated into the Pacific Plan (SOPAC and ABD 2003). The Pacific RAP on sustainable water management was endorsed by all Pacific countries in 2003 at the Pacific Ministerial and Heads of State level in Auckland, New Zealand. The Pacific RAP on sustainable water management aims to improve the assessment and monitoring of water resources, to reduce water pollution, improve access to technologies, strengthen institutional arrangements, and influence financial resources to IWRM.

The Pacific RAP is structured around six thematic areas, drawn from the discussions of the respective working groups at the High–Level consultation in Sigatoka Fiji in 2002 as a precursor to the Third World Water Forum held in Kyoto in March 2003. The six thematic areas in the RAP are:

1. Water Resources Management;
2. Island Vulnerability;
3. Awareness;
4. Technology;
5. Institutional Arrangements; and
6. Finance.

The Pacific RAP provides a framework for integrated management of water resources in small island nations and calls for:

1. National water sector assessments;
2. Broadly-based national water vision;
3. National water action agenda and plans;
4. Empowerment of communities;
5. Design of capable institutions;
6. Integrated investment plans;
7. Regional support; and
8. Dialogue with investors and donors.

The Pacific RAP was submitted as a Type 2 Partnership Initiative on Water, Sanitation and Hygiene to the Commission for Sustainable Development in Johannesburg during the World Summit on Sustainable Development in August 2002 and announced at the Third World Water Forum (WWF) in Kyoto, Japan in March 2003. This Partnership initiative has since evolved into the Pacific Partnership Initiative on Sustainable Water Management with support from the Asian

Development Bank (ADB) and is the implementation vehicle for the regional SIWRWMPIC with its many island partners.

Aim of the SIWRWMPIC

The aim of the regional SIWRWMPIC is to assist Pacific Island countries achieve sustainable, equitable, safe and efficient management of water resources and wastewater through IWRM and Water Use Efficiency (WUE) plans based on best management practices that are appropriate to the region and take into account local cultural, climatic and environmental conditions.

Scope of this Report

This report provides background information on the Republic of Nauru and analyses the current state of integrated water resource and sanitation management within the country under the six themes of the RAP. It describes the links between the various sectors, including human health, engagement with stakeholders, other activities related to IWRM, capacity development and resource needs for removing barriers to implementation of IWRM.

The report summarises the policies of the Government of Nauru (GON) in regard to the management of water and wastewater, and reports on various aspects of water supply and environmental conditions on Nauru.

The overall policy direction is:

> *"To ensure a sustainable water supply which provides water of satisfactory quality and appropriate quantities, and appropriate sanitation to meet all reasonable health, environmental, and development needs"[1].*

In September 2001, a meeting of government departments, community representatives and the private sector was convened by the Director of Public Health. The Nauru Water Plan was adopted at that meeting with the following objectives:

1. To provide safe potable water to the residents of Nauru;
2. To ensure that the water supply is sustainable in perpetuity;
3. To provide an amount of water adequate for the needs of all residents;
4. To ensure a reliable water supply even during prolonged droughts;
5. To safeguard the environment and the ecology of Nauru;
6. To ensure potable water is affordable by all residents;
7. To have efficient distribution of water;
8. To make best use of existing resources, facilities and skills;
9. To conserve resources and energy; and
10. To provide a culturally acceptable water system.

It is clear from these objectives that the provision of adequate, sustainable safe water supplies to ensure human health and well-being is the overwhelming priority in Nauru.

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[1] Nauru National Sustainable Development Strategy 2005 – 2025. *Partnerships for Quality of Life.*

As the next step, improved knowledge of the quality and quantity of the nation's freshwater resources is required. This allows development of plans to manage the use of freshwater in a sustainable manner, recognising the effects of climatic extremes and change, and increasing community awareness and understanding of water resource and sanitation issues.

1. General Overview

Country Background Information

Location and topography

The Republic of Nauru is an isolated, uplifted limestone island located 41 km south of the equator at 0°32' S latitude and 166°56' E longitude (see Figures 1 and 2). The total land area of Nauru is only 22 km^2 (2,200 ha).

The island has a fringing coral reef between 120 m and 300 m wide. The reef drops away sharply on the seaward edge, at an angle of about 40 degrees, to an ocean depth of about 4,000 m.

The land area consists of a narrow coastal plain or "Bottomside", ranging from 200 m to 400 m wide, which encircles a limestone escarpment rising 30 m to a central plateau, known locally as "Topside".

The elevations on Topside vary between 20 m and 45 m above sea level, with occasional pinnacle outcrops of 50 m to 70 m above sea level. The highest point on the island is Command Ridge in the west at an elevation of 71 m above sea level.

Geology and soils

The coastal perimeter inshore of the reef comprises a zone of sandy or rocky beach on the seaward edge, a beach ridge or foredune, behind which is flat ground or, in some places, low-lying depressions or small lagoons filled by brackish water where the surface level is below the water table. The most extensive system of these landlocked lagoons is found near the border of Ijuw and Anabar Districts. Scattered limestone outcrops or pinnacles also can be found on the coastal plain and on the intertidal flats of the fringing reef, particularly in the Anibare Bay area.

The escarpment between the coastal plain and Topside comprises vertical cliffs interspersed with gradually-sloping areas of colluvial soil (sediment that accumulates at the base of slopes) with occasional limestone outcrops and pinnacles.

Topside is a raised central plateau that consists of a matrix of coral-limestone pinnacles and limestone outcrops, between which are (or were) extensive deposits of soil and high-grade tricalcic phosphate rock (Tyrer 1963, Viviani 1970). The area of Topside is approximately 1,600 ha (over 70 % of the island) and most of the area has been mined for phosphate for over 80 years.

The scarred landscape remaining after completion of phosphate mining is a matrix of tall limestone columns in a network of connected pits. The pinnacles stand 2 m to 10 m above the base level of the pits. Most of the mined landscape is unusable at present for any purpose, but some areas have remained filled and are used for roads, mining activities and the refugee camp.

The Nauru Rehabilitation Corporation (NRC) has a long term plan to rehabilitate the 1,400 ha of land that has been mined. Given the scale of the project (three-quarters of the land area of Nauru) and the limited resources available, it should be understood that rehabilitation is a long term project.

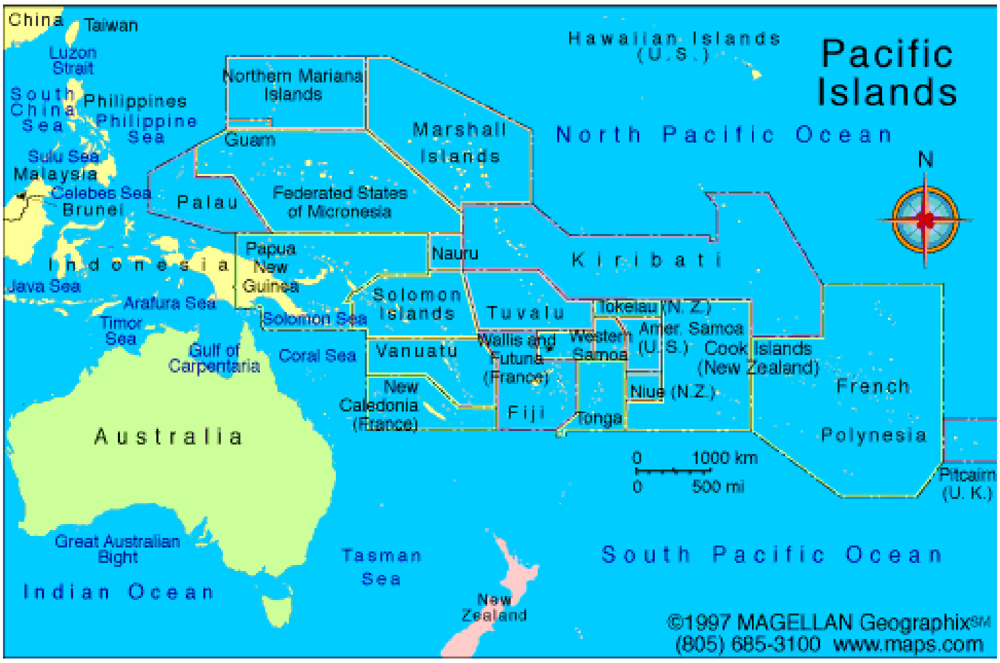


Figure 1: Location of the Republic of Nauru

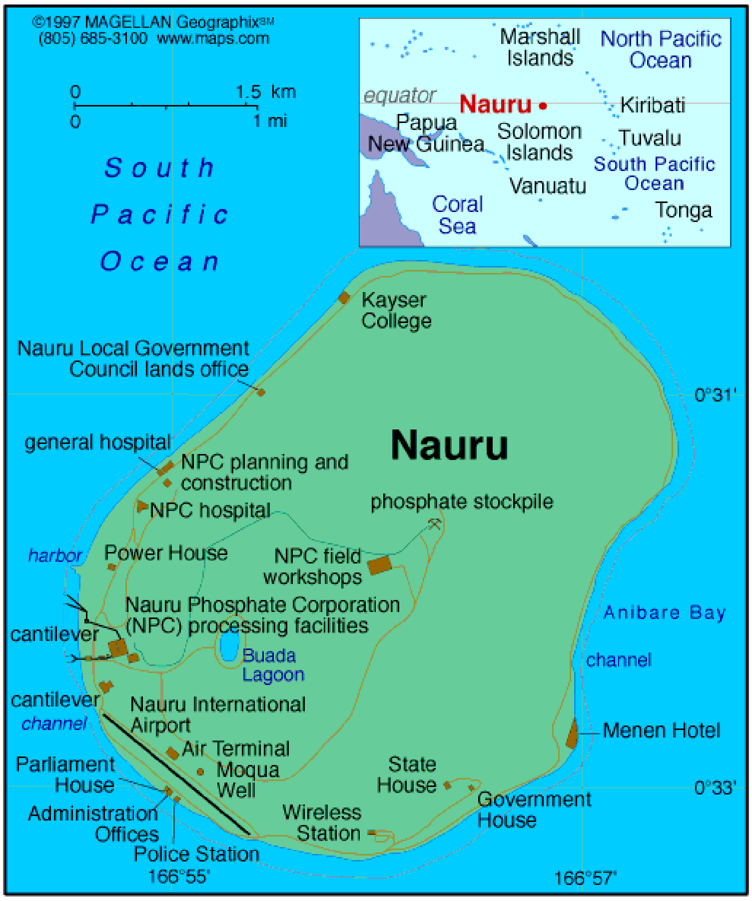


Figure 2: The Island of Nauru

Freshwater resources

Buada Lagoon is a slightly brackish, freshwater lake. It is located in the south-central area of the island at an elevation of about 5 m above sea level (Figure 3), and has an associated fertile perimeter (about 12 ha in area).

Apart from Buada Lagoon, there are no surface freshwater resources on Nauru apart from a few brackish ponds near the base of the escarpment, mostly on the north-east of the island in Ijuw and Anabar Districts, and an underground lake in Moqua Cave in the southeast (Viviani 1970).

The only significant permanent freshwater resource is groundwater in the form of a "lens" of often slightly brackish freshwater, hydrostatically "floating" on higher density saltwater beneath it. The height of the freshwater lens above sea level and the level of salinity vary in relation to rainfall, the distance from the ocean, and with the geological character and composition of the rock near sea level. Exploratory drilling shows that the groundwater is in permeable limestone rock which has fissures and caves.

Figure 3: Buada Lagoon and the Southwest Coast of Nauru

Potential groundwater resource

In October 1987, Jacobson and Hill conducted a groundwater investigation on behalf on the Commission of Inquiry on Phosphate Mining. They drilled 12 exploratory boreholes, from 30 m to 70 m deep, and used geoelectrical soundings to estimate the thickness of the fresh layer of the groundwater. The estimation of the thickness of the fresh layer was not accurate (estimates ranged from 0.5 m to 7 m for the northern bores and 3.5 m to 7 m for the southern bores), but overall the results indicated a fresh water layer at least 3 m thickness beneath most of the island. The salinity of the groundwater rapidly increases with depth – being too salty for potable water uses only 2 m below the assumed base of the freshwater.

Jacobson and Hill stated that “The thinness of the freshwater layer (4 – 5 m) precludes the use of pumping bores because of the likelihood of upconing saltwater disrupting the freshwater layer”. Because of the risk of upconing, they suggested that groundwater should be skimmed from the surface of a multiplicity of bores at very low extraction rates (< 0.1 L/s) or by a long horizontal gallery.

They measured TDS (total dissolved solids) at 25 coastal wells. The median TDS was 1,480 mg/L, just within the acceptable range. However 30 % of the wells had a TDS over 1,500 mg/L, above the normally accepted upper limit for drinking water.

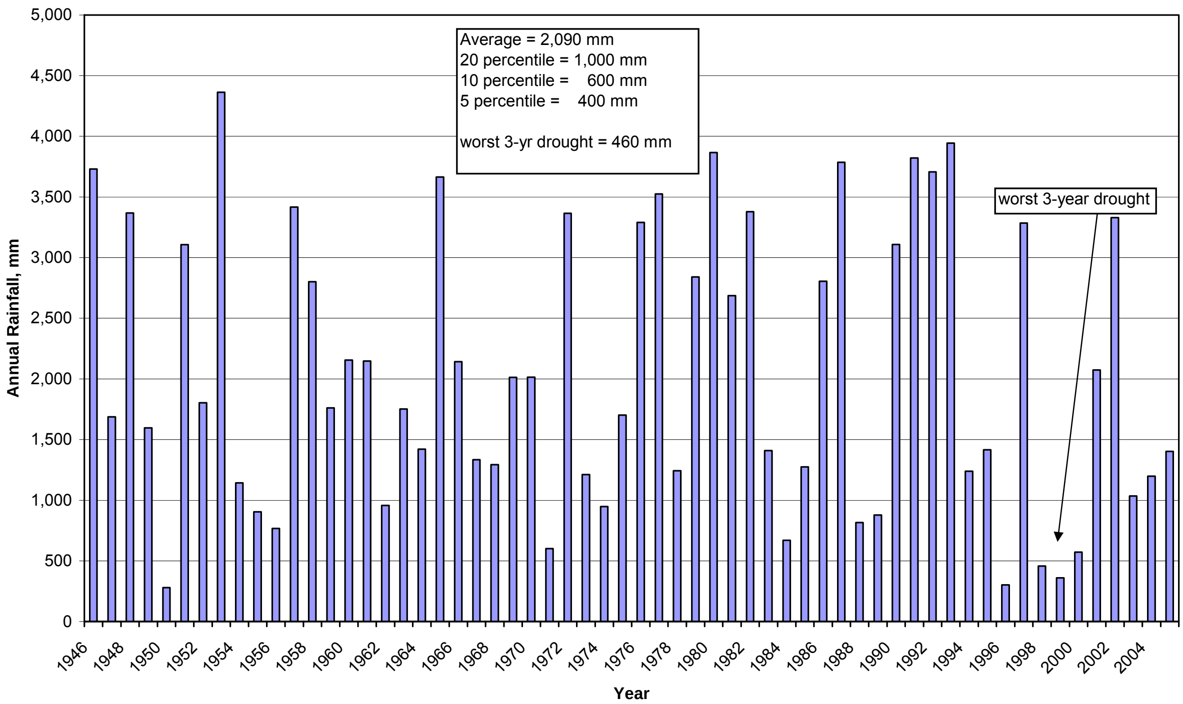
Replenishment or recharge of the freshwater lens is dependent on rainfall. A first approximation of the average groundwater recharge for Nauru is 800 mm per year: *rainfall (2,100 mm) - evapotranspiration (1,300 mm) = groundwater recharge (800 mm).*

Rainfall

Although Nauru receives a moderate to high average annual rainfall, it also experiences severe droughts associated with La Niña episodes.

Using data for the period 1946 – 2006, the average annual rainfall is 2,090 mm with a high degree of variability (see Figure 4). The official (daily read) rain gauge is situated outside the Nauru Phosphate Corporation (NPC) laboratory near the main NPC office in Aiwo.

Figure 4: Annual Rainfall for Nauru, 1946 – 2006



Source: Department of Health

The lowest 12 months of rainfall on record was only 218 mm from December 1949 to November 1950 (only 10% of the average annual rainfall). The worst 3-year drought on record was the recent 1998 – 2000 drought which severely impacted on Nauru and nearby Kiribati. During this period, the annual rainfalls were only 457 mm, 360 mm and 572 mm; an averaging only 22% of the average annual rainfall.

Rainfall has a large impact on the design of roofwater storage systems and the assessment of the groundwater resource, thus key features are:

Average annual rainfall	2,090 mm/yr
20 percentile rainfall	1,000 mm/yr
10 percentile rainfall	600 mm/yr
5 percentile rainfall	400 mm/yr
Worst 3-year drought average rainfall	460 mm/yr

The annual rainfall pattern for Nauru was compared with a measure of El Niño – La Niña conditions, namely, the Southern Oscillation Index (SOI). There is a very strong relationship between annual rainfall and the annual value of the SOI; and generally a strong relationship between monthly values of rainfall and the monthly SOI. This is a significant observation as it can enable reasonable predictions of rainfall conditions based on predictions of SOI trends.

Additional rain gauges (daily read and automatic) are located at the Atmospheric Radiation and Cloud Station (ARCS-2) site adjacent to the Nauru General Hospital. Operation of these gauges and other instrumentation at the site are funded under the US Department of Environment's Atmospheric Radiation Measurement (ARM) Program. Additional data interpolation will be undertaken as part of the HYCOS[2] programme.

There is no rain gauge located in Topside. As the island is relatively small and does not have significant elevation, it could be expected that the rainfall variation across the island would not be significant. There may be a minor orographic effect of Nauru on rainfall but the increase would be very small because of the low elevation of Topside. As most of Topside is bare rock, it produces a plume of hot air during the day, which could lead to rising plumes of air and a possibility of more thunderstorm activity.

Winds

The wind direction during the drier months from May to November is generally from the easterly sector at speeds of 5 knots to 10 knots (2.6 m/s to 5.1 m/s), and during the wetter months (December to April) is generally from the westerly sector at speeds of 10 knots to 18 knots (5.1 m/s to 9.3 m/s). During squally weather, wind speeds of up to 30 knots to 35 knots (15.4 m/s to 18 m/s) have been recorded. Nauru does not experience tropical cyclones.

Temperature

Nauru is located in the dry belt of the equatorial oceanic zone, with diurnal temperatures ranging from 26^{o}C to 35^{o}C, and nocturnal temperatures between 22^{o}C and 28^{o}C.

Vegetation

The only currently fertile areas are part of the narrow coastal belt, where there are coconut palms and pandanus trees, and the land surrounding Buada Lagoon, where bananas and some vegetables are grown. Little secondary vegetation grows on Topside over the coral pinnacles.

Population

In 1999, the estimated population on the island was 11,300. It was estimated that there were approximately 8,300 Nauruans and 3,000 non-Nauruans (mostly other Pacific Islanders). Most people lived and worked around the coastal margin, while others lived around Buada Lagoon. A temporary refugee camp is situated on Topside, to the east of Buada Lagoon, at a former athletic field.

The 2002 Nauru census recorded 10,065 persons, comprising 7,572 Nauruans; 2,300 other nationalities (mainly from Kiribati, Tuvalu and China), and 193 short term visitors. The net population growth rate for Nauru between 1992 and 2002 was 1% per annum. The area known

[2] Hydrological Cycle Observing System

as “Location” provided housing for mining company and government expatriate workers (in apartments, single quarters and married quarters) for a population of 2,381 persons in 2002.

Owing to the financial crisis of 2002/04, most of the expatriates from Tuvalu, Kiribati and China left as the Phosphate Mining Corporation could not afford to pay them. The Republic of China paid out their salaries and travel costs to leave Nauru.

By 2005, the population of Nauru was estimated to be a total of 8,500 persons, comprising 7,700 Nauruans and 800 other nationalities. In addition there are 70 refugees and about 80 camp staff.

For long-term planning purposes, a population projection of 11,000 persons in 2027 (corresponding to slightly above the median population forecast by Booth in 2007) is considered reasonable for planning water supply and sanitation services.

Socio-economic conditions

The current population of 8,500 live in approximately 1,250 residences giving an average of 7 persons per residence. According to the 1992 census, average household income was AU$180/week and a quarter of households earn less than AU$100/week. Income was higher in 2002, but has decreased again due to the 2002/04 financial crisis. Thus money is limited, and many people do not have the financial resources to buy a house.

For decades, housing and utilities (power, roads, water, and education) have been provided for and maintained by the government or the NPC, which acted as the equivalent of government until the recent financial problems, when even now, more than half the electricity supply is not paid for.

The previous water supply arrangements were affordable as rainwater was available at low cost while desalinated water was produced and distributed at well below the cost of production.

The supply of desalinated water (or stored rainwater) without charge (or at a subsidised delivery charge) should be seen in the social context of a benevolent national system sharing and distributing part of the income from phosphate mining to all persons in society. Householders, as landowners, draw brackish water from the shallow groundwater from beneath their land. Thus the recent water supply system may be seen as culturally acceptable and part of the social framework in Nauru linking the NPC/government to the family network.

Demographics

The age structure of the Nauru population is as follows:

0 – 14 years	41 %
15 – 64 years	57 %
65 and over	2 %.

It is apparent that there is a very young aged population and this reflects the current life expectancy of 58 years for females and 51 years for males.

Economy

Revenue for Nauru has traditionally come from export of phosphate, but reserves are expected to be exhausted in a few years. In the years after Independence in 1968, Nauru had the highest GDP per capita in the world. Substantial amounts of phosphate income were invested in trust funds but the government borrowed heavily from these funds and there have been major losses in various development projects. As a result, almost all of the funds have been lost. The National Sustainable Development Strategy 2005 – 2025 (GON 2005) describes it as a *“result of* *mismanagement and corruption that life* (as a result of the phosphate exports*) could not be sustained"*.

In the early 1990's Nauru encouraged the registration of offshore banks and corporations. Tens of billions of dollars passed through these financial shells, but as a result of international pressure, such money-transfers have become illegal. Nonetheless, it still is difficult to obtain comprehensive statistics on the underlying national Nauruan economy.

Current estimates on the economy of Nauru indicate the following:

- Government revenue of about AU$23 million (including substantial aid);
- Main industries – phosphate mining, offshore banking, coconut products;
- Exports – about AU$25 million, mostly phosphates;
- Imports – about AU$21 million, mainly food, fuel, building material, small manufactured goods, cars, machinery; and
- Government expenditure of about AU$25 million.

Local industries are mostly wholesale distribution, retail trade, restaurants and two hotels. Nauru continues to have an international airline, with two services to Brisbane, Honiara, Tarawa and Majuro each week.

Figure 5 shows the area of Nauru that has been mined for phosphate. It can be seen that this area covers most of Topside, apart from Buada Lagoon, and a few small patches yet to be mined. The rehabilitation of the mined land and the replacement of income from phosphate mining are serious long term concerns.

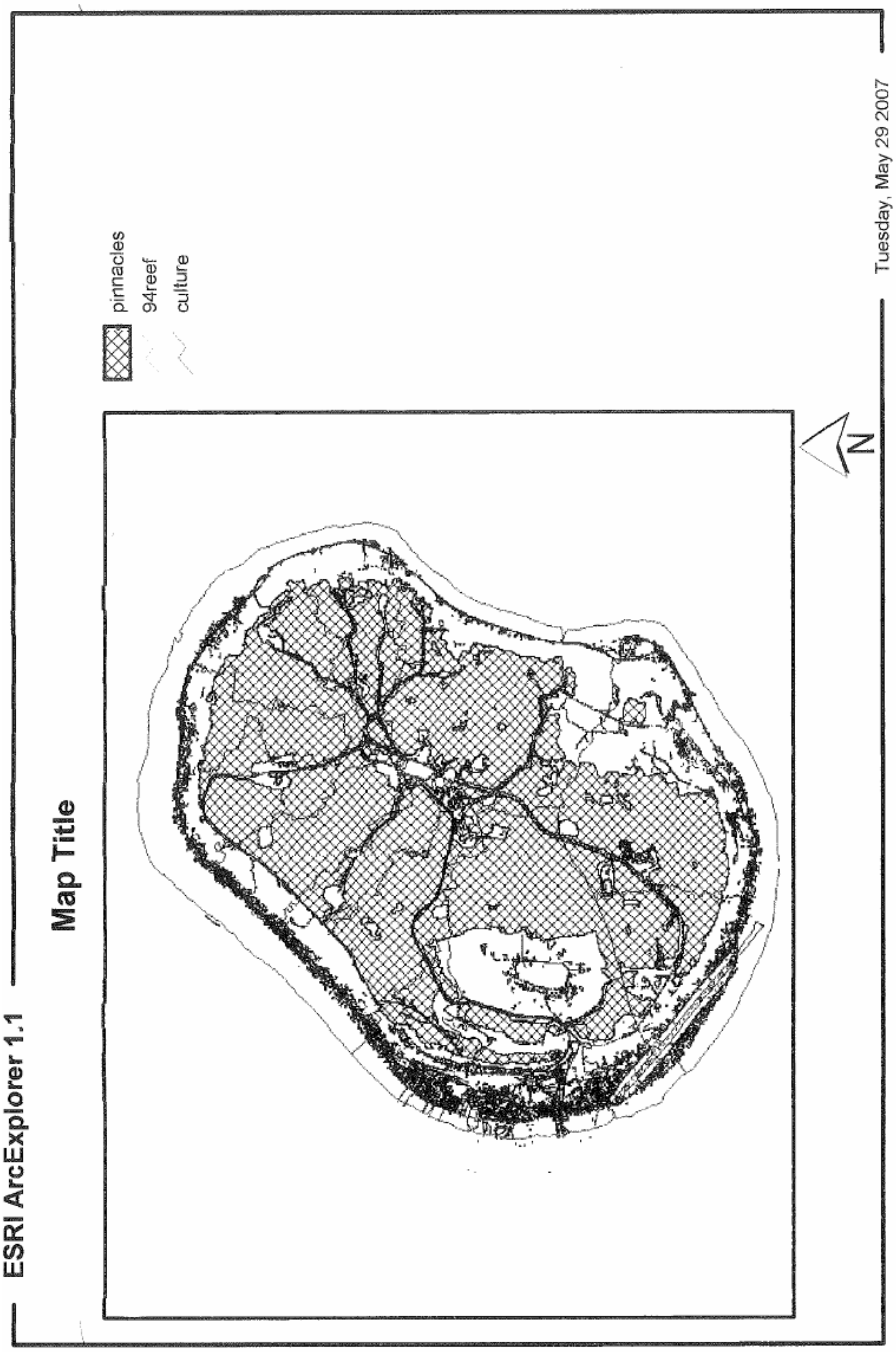


Figure 5: Map of Mined Area of Nauru

2.0 Integrated Water Resources Management Situation for Nauru

2.1 Water resources management

2.1.1 Types of freshwater resources

Sources of freshwater for Nauru's island communities are restricted to:

1. Rainwater;
2. Imported water;
3. Shallow unconfined groundwater (generally within less than 2 m of the surface); and
4. Desalination (one large evaporative desalination plant and four small RO desalination plants).

Seawater and non-potable well water (from shallow groundwater bores next to houses) are used by many for bathing. The need for reliable power supply to run the large desalination plant means that it has been out of action for several years.

Rainwater Collection

Historically there was an extensive rainwater collection system on houses and large buildings of the phosphate works and related buildings (stores, sheds, hospital, etc.). A series of large steel and concrete tanks were constructed for storage of the collected rainwater. This system has fallen into disuse and been allowed to deteriorate, although two tanks are still used to store water from the desalination plant.

Most houses were built by NPC or the government and generally include guttering and rainwater tanks of various materials (concrete, galvanised iron, steel). Since the commissioning of the large desalination plant, much of the guttering and tanks have been allowed to deteriorate. This was a reasonable response to the situation that: (1) the phosphate mining and processing operations made the roofs dusty; and (2) high quality desalinated water was readily available either free or at a minor cost. To provide a cost comparison, new guttering and a 20 kL water storage tank costs about AU$7,000 (installed) per house; the equivalent to the cost of over 4,600 kL of desalinated water delivered by government truck (a supply sufficient for one household for 50 years).

Some householders have installed large (22.5 kL to 45 kL) polyethylene storage tanks; others have installed small tanks (2.2 to 5 kL). The recent series of years with low rainfall have encouraged householders to upgrade their guttering, although more than half the buildings in Nauru collect very little rainwater. There are no building regulations or requirements concerning the size, design, maintenance or testing of rainwater collection at residences or offices.

Another rainwater collection system was from the roof of the blocks of units housing the 3,000 mostly foreign workers in the NPC Location Compound. There was a water storage tank on each building and other large underground storage tanks to collect overflow from the building tanks. The building tanks were topped up at times with desalinated water using the water tanker owned by the fire department, and standpipes provided a direct supply of desalinated water. These buildings are no longer used as the foreign workers have been repatriated, and the rainwater collection and storage system has fallen into disuse.

Overall, the historical policy with respect to water supply was for island-wide supply of desalinated water, either free or for a minor delivery charge, with no restrictions on groundwater extraction or requirements for rainwater collection.

Imported water

For many years during the phosphate mining days, Nauru relied on imported water for much of its supply which came as a 'back load' on the phosphate delivery ships.

During 2001-2002, imported water from Kosrae supplemented rainwater and desalinated water as the supply of potable water. One shipment of 1.5 million litres (1,500 kL) was reported to cost AU$87,000. The unit cost of this shipment of water was AU$58 per kL, or about 10 times greater than the estimated costs of desalination (AU$5.19–AU$5.30 per kL) as reported by AusAID (2002). The unit cost of water from a new 500 kL/day reverse osmosis desalination plant was estimated by WHO (2001a) to be AU$4.00 per kL.

Desalinated water

The large desalination plant was installed by the NPC as an integral part of the power generation plant. The waste heat from the generators was used in a six stage distillation process to produce desalinated (distilled) water from seawater. The large desalination plant was commissioned in 1992 and had a rated capacity of 1,200 t/d of desalinated (distilled) water.

The generators are aging and can only be operated at less than full capacity, which results in a lower waste heat output. As a result, the daily output from the desalination plant in 2001 was in the range of 900 to 1,000 t/d of desalinated water. The large desalination plant operated from 1994 to 2002. When the large desalination plant first stopped operating, there was widespread shortage of potable water on the island.

Desalinated water is delivered by truck to households on request. The delivery charge was AU$1.50/kL and has recently been increased to AU$3.00/kL. Desalinated water may be collected without cost or restriction in containers from a storage tank. This is the principal backup source of potable water for households without a large storage tank for desalinated water/rainwater.

Two smaller (reverse osmosis) desalination plants were installed in 2005 to provide a backup supply. These were operating in 2006/07 and supply water to the hotel and refugee camp.

Brackish water wells

There is no restriction on, or permit necessary for, digging or extracting fresh or brackish water from a well, nor any restriction on the location of wells or bores or of pumping from them. In general terms, it is considered that the underlying groundwater belongs to the landowner. Most households have a well (some with pumps) and a small proportion of households have a bore.

Groundwater

Shallow groundwater from a few selected wells has been used in drought periods as a source of potable water. There are some wells which are known to remain fresh (low salinity) in drought periods, mainly in the Ewa and Anetan districts in the north of the island. The water is normally disinfected by boiling.

Fresh groundwater is known to occur under Topside, based on previous groundwater investigations (Jacobson and Hill 1988; Jacobson et al. 1997). The groundwater under Topside, in the form of a freshwater lens extending under much of the island, is largely untapped except for some of the wells near Buada Lagoon.

The groundwater under the Topside area is a possible supply of high quality potable water. However a detailed investigation is required to establish the extent of the resource and the sustainable extraction rate. It would be catastrophic to lose this resource due to over-extraction and seawater intrusion.

Long term potential threats to the quality of the groundwater resource include contamination by cadmium (from phosphate processing), leachate from the rubbish dump and sewage from the refugee camp (on Topside) and residences on Bottomside. The brackish groundwater from wells used as an alternative supply has high coliforms and high dissolved solids and the brackish groundwater is not suitable as a potable supply.

Non-potable water sources

The main source of non-potable water is shallow groundwater adjacent to houses and other buildings in the coastal margin and around Buada Lagoon. This water is either pumped or bailed from wells dug below the water table. Non-potable water is primarily used for toilet flushing and for other purposes such as washing, bathing when potable sources, primarily rainwater, are not available.

Groundwater on the Bottomside is tapped by several hundred wells, about one-third of which exceed the WHO recommended limit of 1,500 mg/L TDS. These wells are the major source of water for household use, and even though brackish and often contaminated, are used for washing and cleaning.

In some areas, the shallow groundwater is known to be polluted (high bacteria counts), with the most likely sources being effluent from sanitation systems and animal wastes. It is often referred to as 'brackish water' but, in fact, there are some locations (e.g. in the wider coastal margin in the Ewa and Anetan districts) where the groundwater is fresh and within the potable limit according to WHO drinking water guidelines (WHO 1993).

It is considered that increased extraction of groundwater from wells around the perimeter of the island could lead to seawater intrusion as well as threatening the supply of freshwater to the roots of coastal plants.

Another source of non-potable water was seawater, which was used for toilet flushing in the NPC area. The seawater system consisted of intake pumps, storage tanks on Command Ridge and a distribution pipeline system to connections in houses, the hospitals and other locations. This system has gradually fallen into disrepair and is no longer operating.

2.1.2 Types of freshwater use

Water is used by the community for domestic drinking consumption, cooking and washing, for agriculture, and for industry.

An estimate of the distribution of desalinated water in the dry period of 1998/2001 (WHO 2001) provides an introduction to water demand on Nauru:

▪ Truck supply to households	350 kL/d
▪ Hospitals and related buildings	140 kL/d
▪ NPC houses and foreign workers	130 kL/d
▪ NPC location housing by tender	45 kL/d
▪ Menen Hotel	40 kL/d
▪ Other hotel and restaurants	20 kL/d
▪ Laundry, workshops and settlement	95 kL/d
▪ Losses and unaccounted water	130 kL/d

TOTAL	950 kL/d

The 350 kL/d distributed by truck to the 8,280 Nauruan residents corresponds to less than 40 L/capita/day, after taking account of transportation losses. This is less than the water requirement for a healthy life.

As noted above, the households around the perimeter of the island (about 5,000 persons) use rainwater and brackish well water to supplement the desalinated water. The condition of the rainwater collection and storage systems is good in some households, moderate to poor in most and very poor to non-existent in the remainder. Until recently, maintenance of houses was carried out by the government and the present conditions of these houses reflect the resource limitations of the government maintenance agency. Virtually all households have water storage tanks and during prolonged dry periods rely on the periodic delivery of desalinated water for their potable water.

The main source of non-potable water at these households is brackish water from shallow wells. Almost every household has a well or access to a well. The brackish water is used for all non-potable purposes (washing, washing clothes, toilet flushing, cleaning) and, at times of potable water shortage, as drinking water. Tests show that many wells have a salt level (TDS) above that recommended by WHO for potable water.

People living near the phosphate works (3,280 persons in 2002) drew most of their potable water from the desalination plant. These houses had storage tanks and a piped gravity supply of desalinated water filled the tanks as required.

Approximately half these households also had a reticulated seawater supply for toilet flushing. Note that most of the expatriates living in Location have now left Nauru. There is only a remnant of the former water reticulation system for desalinated water – restricted to the hospital and a few adjacent buildings. The supply is not reliable.

The new government offices/Parliament House complex has an extensive rainwater collection system with a large storage tank under the building. Brackish water was initially used for toilet flushing; this has now been changed and stored rainwater is now used for toilet flushing. A small quantity of desalinated water was supplied during the drought.

The Menen Hotel, which is the largest hotel on the island, has two desalination plants (one supplied by AusAID) each of 100 kL/d capacity. The hotel and the refugee camp are supplied with water from the desalination plants.

Restaurants and commercial buildings rely on a mixture of rainwater and desalinated supply. Health inspectors try to minimise the quantity of brackish well water used in restaurants, as the well water is often contaminated. Take-away restaurants play a major role in Nauruan life. Most restaurants use a combination of brackish water, rainwater and desalinated water, although generally too much brackish water (which is not a safe supply).

The hospital relies entirely on desalinated water and faces major difficulties obtaining water. The hospital does not have the funds to repair and use its former rainwater collection system.

2.1.3 Major issues and concerns

The major issues and concerns are as follows

- There is not a secure supply of drinking water available to maintain health and wellbeing;
- High energy input is required for the desalination plants;
- There may already be over-extraction of groundwater around the Bottomside;
- There is some contamination of the groundwater occurring now, even though it is the best source of future water supply;
- The sustainable yield of the groundwater has not been determined (but a study is planned for the near future);

- There is a need to control the discharge of wastewater adjacent to wells used to extract non-potable water and to upgrade local sanitation practices to composting-type toilets or similar arrangements;
- There is very little monitoring or information collection on water quantity and quality, and hence no strong base for future planning;
- There has been very little investigation of the environmental implications of the changes in land use and water use on the island;
- Droughts have a major effect on the supply of water – particularly for roofwater catchments;
- There is a need for improved water governance and local skills; and
- Land and water ownership are still to be resolved for groundwater extraction.

2.1.4 *Methods to manage impacts and concerns (IWRM)*

Nauru faces a major problem – there is not a sustainable, safe and adequate supply of potable water. A related problem is that existing sanitation systems are rudimentary and comprise either overloaded cess pits/septic tanks which pollute the local shallow groundwater, or discharge of raw sewage via pipes onto the reef which pollutes the coastal resources.

The water resources must be managed in an integrated way, based on a scientific understanding of the sustainable supply, a good appreciation of the demand for water, a sustainable delivery system and an integration of cultural perceptions, ownership rights and practical economics. The first step is to extend the draft National Water Plan of 2001 into a complete strategic plan to match water supply with water demand. This will take additional specialist resources (from outside Nauru) to explore and prove the groundwater resource, expand water delivery and increase the reliance on rainwater tanks in average and wet years.

Community needs and behaviour are essential in defining the best solution for Nauru. The interdependencies and complexities in the water and sanitation sector is best managed as a complete sector, bringing together all aspects under one coordinated, strategic action program under the framework of IWRM.

Clearly there must be a major change in community attitudes to water, including further development of self-reliance for maintenance of domestic rainwater systems.

A second and equally important step is to extend the draft National Sanitation Plan into a complete sanitation plan. While the National Plan does not envisage any substantial moves in sanitation technology, it is important to make gradual improvements in the operation of existing systems, including removal of solids from septic tanks, increasing the separation of cess pits/septic tanks from wells and gradually introducing aerated treatment/composting toilets.

The third issue is to recognise the inter-dependency of water and sanitation systems, including the interconnection via the local groundwater, seepage of nutrients into coastal waters and seawater intrusion into the Bottomside groundwater due to over-pumping of non-potable water.

2.2 Island vulnerability

2.2.1 Types of disasters

Severe droughts

Many households rely on rainwater harvesting for a substantial portion of their freshwater supply but tank storage volumes are seldom sufficient to last through a major drought. The table below highlights the shortage of water during dry periods assuming an average roof area of 190 m^2.

Season	Rainfall	Water Collected	L/c/d
Average year	2,090 mm	360 m^3	140
1 in 5 year	1,000 mm	170 m^3	65
1 in 10 yr	600 mm	100 m^3	40
1 in 20 year	400 mm	67 m^3	26

To live a healthy life, the amount of potable water required is estimated to be 100 L/c/d, and as a minimum this can be reduced to 80 L/c/d. The table above shows that, with average rainfall, it is possible to collect enough water to live a healthy life. However, even for a one in ten dry year (where the rainfall is less than 50% of the average rainfall) there would not be enough roofwater collected to sustain a healthy life. For severe drought conditions, with an annual rainfall of 400 mm, there would be a severe shortage of water.

In addition, global warming may increase the severity of droughts. Thus planning for the future water supply must take into account the present variability in climate and adopt a prudent plan to cope with possible future changes in climate.

Sea level rise

Sea level rise is a potential threat to Nauru and could inundate the low-lying barrier reef, leading to more damage to the coastline in storms. The effects of sea level rise on the coastal groundwater resource could be greater seawater intrusion.

Other Impacts of global warming

Other mooted consequences of global warming which could have adverse consequences on Nauru include changes in the rate of oceanic circulation in the central Pacific, leading to changes in the frequency of drought, coral bleaching due to increased sea temperatures and changes in the abundance of fish.

Oil shortages and power failures

Measures to increase the use of solar power and other renewable energy resources are being considered. Nauru needs to import all fuel. As a consequence of the limited financial resources, Nauru suffers from diesel shortages and daily power failures. This restricts the output of the reverse osmosis desalination plants which have a high energy input and, at present prevents the use of the large desalination plant as there is insufficient power being generated to create the waste heat to operate the large desalination plant.

Pollution of groundwater

In addition to the adverse effects of human wastewater, there are major concerns about the possible pollution effects of the waste dumps (not lined), refugee camp (discharge of effluent above groundwater resource) and phosphate processing (aluminium slimes stored above groundwater).

2.2.2 Major issues and concerns

Inadequate water supply in droughts

This issue has been discussed earlier in this report. With expansion, roofwater can supply sufficient potable water in years with high or average rainfall, but not in dry periods, when an alternative source of water (groundwater or desalination) will be needed.

Groundwater pollution

Groundwater pollution threats include:

- Seawater intrusion due to over-pumping.
- Contamination by leaks from seawater sewerage systems.
- Contamination by sewage and other wastewater.
- Leachate from garbage and waste dumps.

In addition, there is potential for hydrocarbon contamination from sources (e.g. bulk fuel tanks) in the Aiwo district. This may also be an issue in other parts of the coastal margin (e.g. near fuel tanks at service stations). Evidence of fuel pollution, possibly from many years ago, was found during excavation in the NPC area (SOPAC 1998).

Over-pumping is considered to be the cause of saline intrusion into private wells in the coastal margin (Jacobson and Hill 1988). The extent of this problem is not well known as there are no meters on these pumps. The occurrence of saline intrusion can also be due to natural influences.

Seawater contamination can also occur in the NPC area due to leaks from the seawater reticulation pipe system and possible overflows from the tanks. Again the extent of the problem is not known.

Leachates from rubbish disposal areas and waste dumps (e.g. cadmium slimes dumped on Command Ridge) are possible further sources of groundwater contamination. These sites are not lined and pollutants can easily move through the porous soils and underlying limestone to the groundwater table. There are no groundwater monitoring boreholes to assess potential groundwater impacts at these sites.

It is recommended that appropriate monitoring boreholes be installed to establish the extent of present contamination. An alternative waste disposal site, closer to the coastline, with lower potential impact on fresh groundwater should be commenced. A proposed location for a future landfill site is considered reasonable from a fresh groundwater pollution viewpoint. This site is on the north-east part of the island in a depression near the brackish Anabar lagoons. Ideally this would be properly lined and include leachate control, but it is recognised that this may not be possible on Nauru. The existing landfill site should be sealed and graded over the top to minimise rainfall moving through the landfill and mobilising stored contaminants. Further discussion of waste disposal is contained in the GHD and ActewAGL inspection reports (Falkland 2002).

Water for agriculture

The Nauru diet is generally deficient in fresh fruit and vegetables and efforts are being made to establish garden plots and, later, larger scale horticulture. This water will be needed for agriculture.

Integrated approach

As discussed earlier there is no integrated plan for water and sanitation services in Nauru. Thus Nauru is not yet in a position to plan the management of water resources in a sustainable manner taking account of climate change development and natural events.

2.2.3 Measures to manage impacts and concerns (IWRM approaches)

2.2.3.1 Management of water resources. At present there is no integrated planning of water resources on a national basis. This means that droughts can create disasters in terms of acute water shortages and public health risks. Management of water supply to match water demand on an efficient and ongoing basis is essential.

Rainwater tanks

Rainwater storage systems need to be designed on a rational basis to collect and store water efficiently. The capacity to maintain tanks and upgrade guttering systems needs to be developed.

Groundwater

Based on the review of existing groundwater information, and inspections and discussions during visits to Nauru, it is essential that a groundwater investigation programme be implemented. The aims of this programme would be to:

- Assess the sustainability of fresh groundwater resources for potential potable use by the population.
- Investigate pollution sources as a means of determining if remediation or other measures are necessary.
- Develop policies to protect groundwater.
- Establish a long term monitoring programme for groundwater.

Proposed groundwater investigations for Nauru could include:

- Comprehensive survey of all current groundwater sources in the coastal margin and near Buada Lagoon.
- Drilling of a network of permanent monitoring boreholes for salinity profiling and pollution monitoring.
- Implementation of a groundwater monitoring programme in both Topside and the coastal margin.
- Re-estimation of groundwater recharge.
- Re-estimation of sustainable yield.
- Assessment of water supply options including pumping, storage and distribution, if there is potential for fresh groundwater development.
- AusAID have plans to fund the survey of groundwater at Nauru.

Backup water supplies

The backup water supplies for drought periods will need to come from groundwater and desalination. An affordable and socially acceptable system to ensure the backup supply is available still needs to be developed.

Water for agriculture

Food security is almost as important as water security. Thus future water plans need to take into account the future expansion of water use for agricultural purposes (both for house gardens and larger scale agriculture).

2.3 Awareness

The water supply arrangements are changing from the system of a decade ago – when almost all water was imported or produced (by desalination) by national utility, and supplied (by tankers) at a minimal cost to small tanks at residents households. In many cases, the tanks were maintained by the utility rather than the householder, and the maintenance of gutters and downpipes (to add rainwater to the tanks) was also seen by many as the utility responsibility.

During the recent water crisis, householders have made a transition to privately owned tanks and rainwater systems. Most households have a well (some with a pump) and a few have a local bore, and these supply non-potable water which is used for a wide range of household purposes. Some hotels and restaurants also have their own bores.

The future water supply arrangements are for the primary supply to be private water tanks, and households will be responsible for their own maintenance and repairs. The backup during droughts will be water from the desalination plants and groundwater, supplied at a cost commensurate with the actual cost to produce and deliver the water.

The transition from the historical water supply system to the future water supply arrangements will involve substantial change in the attitudes of householders, government agencies and the Nauru society in general. Further changes are required to move to a sustainable, well-planned and widely acceptable system.

2.3.1 Type of awareness campaigns, advocacy initiatives currently being undertaken in the area

Price is being used as the signal to convey the cost of backup delivered water. The charge has been increased from AU$1.50/kL to AU$3.00/kL and will continue to increase in coming years until a substantial economic system for production and delivery of water is achieved.

The transition situation is somewhat clouded by the “free” tanks being supplied to some households by aid donors. The recipient households have been selected by community leaders in each district. Nonetheless, while recognising that tanks are generally going to the most needy households, it would be better if loan and other community input obligations were attached to the supply of tanks. An opportunity to raise community awareness and improve the social network may be lost in an outcry about unfairness and favouritism.

Other tanks are to be installed to service community buildings and garden plots. These sites have been developed following community consultations.

2.3.2 Major issues and concerns

As there is no agency or government department with responsibility for planning or delivery of water, there are the following concerns:

- There is no plan which shows how water supply will meet water demand, after allowing for variations in rainfall, droughts, population growth or climate change.
- As a consequence the community do not have input into the formulation of the plan and the opportunity to express preferences.
- There is little scope to raise community awareness of their future pathway to integrated water resources management.

The supply of tanks by aid donors is a considerable benefit, but it should be noted that the planning had little community input and the execution may lead to strife because of lack of clarity about the responsibilities of the recipients. The “free” tanks are not arriving with the appropriate message about self-sufficiency.

2.3.3 Measures to manage impacts and concerns (IWRM approaches)

A program to involve the community in integrated water resources management needs to:

- Be based on facts of water needs and potential water supplies;
- Offer choices, so people can select the combination of supplies and risks that best meet their needs;
- Encourage self-reliance and build up an understanding of the need for maintenance and the skills necessary to carry out maintenance;
- Include external monitoring and reporting back to the community on pollution or other issues; and
- Be integrated with the community sanitation programme.

2.4 Technology

2.4.1 Types of water supply systems

Distribution system

The piped water reticulation network serves only a very small area on Nauru. There was a reticulated pipe network within the NPC area. The condition of this network, some of it installed many years ago by the BPC and NPC, is poor. SOPAC (1998) reported that in October 1998 (during a very dry period) there was possibly about 30% 'unaccounted for' water. It was suggested by SOPAC (1998) that a leak detection program be conducted on the reticulation system. Since then, the pipe network and storage tanks have deteriorated.

Much of the reticulated pipe network system on Nauru consists of asbestos cement and galvanised iron pipe. The condition of the pipe network is so bad that much of it needs repair or replacement.

Water from the desalination plants is delivered by tanker to residents on Nauru (except in 2007, when all tankers are currently out of service). Until recently, there were two tankers operated by NPC (capacity of about 10,000 litres) and two trucks with smaller capacity operated by private contractors.

Water is presently supplied by tanker from the desalination plant at the Menen Hotel to the hospitals, refugee camps and houses. When available, water from the large tanks in the Aiwo district also is delivered on request to houses.

Groundwater – Domestic water wells

These are generally in poor to moderate condition.

Groundwater – infiltration galleries

There are none in Nauru.

Groundwater – Reticulated water supply systems

There is no reticulation of groundwater in Nauru. There was some piping of desalinated water and roof water in the accommodation area for foreign workers and expatriates.

Rainwater – storage tanks

During the period of major phosphate mining on Nauru, when emphasis was placed on rainwater collection and imported water from phosphate ships, an elaborate system of potable water storage tanks was built for the NPC working and living areas in Aiwo and Denigomodu districts.

Many large storage tanks were built to ensure that stored water was sufficient to cope with long droughts when the main source of potable water was inevitably bulk imported water.

In the NPC area (Aiwo and Denigomodu districts) there are:

- Six large in-ground concrete tanks with total capacity of approximately 2,400 kL in the ‘Timber yard’ near the power station and desalination plant. These were fed by rainwater collected from nearby catchments. These catchments have either fallen into disuse or have been replaced with new buildings which are not connected to the tanks.
- 13 steel tanks with an original storage capacity of approximately 58,000 kL. Due to the poor condition of most of the tanks, as reported in the GHD report to AusAID (2002), the estimated useable storage capacity is approximately 23,000 kL (only 40% of the original capacity). The volume actually in use is approximately 6,800 kL or 12% of the original capacity (AusAID 2002b).
- Other concrete and steel tanks are distributed around the ‘Location’ (NPC housing area) and golf course above the hospital. These are generally in poor condition.

Other areas:

- Underground concrete tank (approximately 2,500 kL) at the Menen Hotel for storing water from the desalination plant. This is in poor condition.
- Underground storage tanks at the government building complex adjacent to the airport in good condition.
- Rainwater tanks at houses and other buildings ranging in size from 2 to 45 kL. Materials range from steel, concrete, fibreglass to polyethylene. Conditions range from bad to good.

Desalination

A desalination plant was operated by NPC, using the waste heat generated from the power station. This is the island's largest potential supply of water. Water was delivered in tank-trucks to individual household and other storage tanks. Storage facilities for potable water are restricted to household and institutional storage tanks, because the high porosity of the soil and bedrock rules out the easy construction of reservoirs.

Based on NPC records for the dry period of 1998/2001, the large desalination plant supplied 950 t/d of high quality potable water to residents, institutions, hotels and other buildings and settlements. When the plant is not in operation due to maintenance or power failure the island faces a severe water shortage. The large desalination plant has not operated since 2002. It has been repaired (June 2007) and is ready for operation when the power station can supply a sufficient quantity of waste heat.

There are two small reverse-osmosis desalination plants at the Menen Hotel producing about 200 kL/d of freshwater. These supply the hotels and the refugee camp. There are two 125 kL/d reverse-osmosis desalination plants in containers next to the power plant and large desalination plant. These supply a small amount of water to commercial establishments and some houses, but the lack of tankers means that only 3% of potential production in 2005/06 was actually delivered to consumers.

2.4.2 Types of wastewater/sanitation systems

There are no wastewater reticulation or treatment systems in Nauru. A seawater sewerage system was developed by the phosphate mine, but this is no longer operational. Raw sewage continues to drain to the sea from many houses in the Location area, conveyed by groundwater used for flushing toilets and greywater. Elsewhere, greywater from washing and cooking is returned to the ground where it recharges shallow groundwater and discharges to the coast.

Thus, apart from a small urban area where wastewater is piped to the ocean, the sanitation systems throughout Nauru comprise septic tanks and cess pits. The seepage from the septic tanks and cess pits enters the shallow groundwater.

2.4.3 Major issues and concerns

Supply versus demand

Based on estimates of current supply and demand for potable water, there is an urgent need for additional potable water supply. Exceptions occur in years of high rainfall when rainwater catchments (public and private) and desalinated water (if the main distillation plant is operating) can supply potable water needs.

Leakage from the domestic reticulation system

When water is in short supply, leakage from the tanks and the household plumbing systems is a major concern.

Lack of systematic monitoring, analysis and reporting

The lack of systematic monitoring, analysis and reporting by all the key Ministries is a major problem throughout all water supply systems, both public and domestic, as well as the sewage system.

It is very difficult to manage a system if there is no information available on its performance.

Brackish water

There is no shortage of brackish water or seawater to meet the demand for non-potable purposes. However, issues related to these supplies are corrosion due to high salinity, high costs of pumping seawater and possible contamination of fresh groundwater from leaks in seawater pipelines (NPC area only) and possible over-pumping in the coastal margin causing some reduction in available fresh groundwater resources.

Rainwater

Although many households have tanks, a proportion of them have inadequate gutters. A recent SOPAC survey found that:

- 32% of houses have only fair or poor roof conditions;
- 16% of houses have no guttering, and 24% have poor guttering; and
- Only 41% of houses capture water from the whole roof area.

Encroachment on water reserves

The modern theory of water supply systems is to have multiple barriers between the consumer and any contaminants. An uncontaminated water source area is a major cost-effective barrier.

Human and financial resources

Nauru lacks the skills base to operate, maintain and monitor sophisticated water reticulation and sanitation systems.

In addition, economic sustainability is a critical issue because of the high level of unemployment and low income levels.

2.4.4 Measures to manage impacts and concerns (IWRM approaches)

There are very few measures in place to prevent pollution from poorly managed household wastewater treatment and/or discharges.

Consideration has been given to options for improving sanitation in Nauru and in particular to the following aspects:

- Contamination of brackish groundwater by wastewater from household cess pits and septic tanks;
- Possible future contamination of fresh groundwater lens by housing planned to be built on the 'Topside' of Nauru following restoration of the mined areas;
- Treatment and disposal of pumpouts from septic tanks, cess pits, holding tanks and restaurant grease traps;
- Possible adverse health and environmental effects of sewage discharge from outfalls extending only to the edge of the reef (low tide line); and
- Feasibility of treatment and reclamation of wastewater for subsequent reuse.

In response, a draft Nauru Sanitation Plan was prepared in 2001 for consideration by government agencies of Nauru.

Future water distribution will be dependent on a number of factors including water demand (total and distribution throughout the island) and water sources (type and locations).

If groundwater is found to be a sustainable source of potable water, then the distribution of water to areas outside the NPC area (Aiwo and Denigomodu districts) could change to local area piped reticulation systems. This would reduce the need for and costs of road transporting of water. In the long-term, road transporting of water could possibly be entirely replaced by a number of independent water supply systems based on groundwater and rainwater. Alternatively, the concept of a 'ring' pipeline around the island, supplied from a number of water storages (at the same elevation), could be considered. This has been mentioned in SOPAC reports (1998).

Water conservation

Water conservation means using water without wastage or luxury use. Many households in Nauru already conserve water, particularly those dependent on the supply of water by truck.

However there is significant loss of water in the area which has reticulated desalinated water, mostly from leaks in tanks, pipes and plumbing fittings.

The present arrangements for the distribution of desalinated water does not encourage water conservation as there is no community storage or opportunity to reduce production; hence excess water must be used or wasted. Measures suggested to encourage water conservation are:

1. Development of a 20-day storage for desalinated water, with a high priority given to maintaining water in storage;
2. Investigation of the potential for storing excess production in wet periods in the fresh groundwater lens;
3. Introduction of cost recovery charges for water, which will encourage consumers to address water conservation measures to reduce expenditure;

4. Provide assistance to households in connecting and using rainwater storage tanks and guttering; and
5. Educate consumers in water conservation measures and advantages (this programme would be of particular benefit to the women of Nauru).

There appears to be significant leakage and loss of water from the existing water tanks and distribution pipes. Locating and repairing these leaks would be an important water conservation measure.

2.5 Institutional arrangements

2.5.1 Types of institutional arrangements

There is no single department or agency on Nauru with responsibility for water and sanitation planning or delivery of services. The present arrangements and responsibilities are as follows:

Utilities: Operation of large and small reverse osmosis desalination plants at power station and delivery of water by trucks (when trucks available).

Nauru Rehabilitation Corporation (NRC): Exploration (and possible future development) of groundwater resource on Topside, to the stage of production bores and storage tanks adjacent to the bore. No responsibility for distribution of the water. Note that the NRC does not "own" the groundwater – it is most likely to be the property of the landowners on whose land the bores and tanks are located. Also, NRC does not have a mandate to monitor and plan the use of the groundwater resource.

Ministry of Health and Medical Services: Monitoring and testing of water quality from the public health perspective. Oversight of sanitation facilities.

Aid Coordination Unit: Facilitation of aid projects in the water and sanitation area.

Eugigu: A private agency (formerly part of the Ministry for Works) involved in community surveys for the location of water tanks and installation of large water tanks provided by AusAID.

There is no agency with responsibility for planning and managing water use, water shortage, preparing and implementing drought contingency plan, coordinating with water customers and developing strategic plans for integrated water management in the future.

2.5.2 Major issues and concerns

Many of the issues and concerns in this section have been already raised in previous sections.

Lack of unified national water and sanitation policy, legislation and approved plans

Governance is a constraint in achieving better and more equitable water sharing and improved water supply and services in many water-stressed countries (Solanes and Jouravlev 2006; UNWWAP 2006). A clear national policy will provide the framework for the conservation, sustainable use and management of Nauru's water resources and for the provision of safe and adequate water to the island community. Without national policy, it is difficult to implement national water and sanitation plans.

Lack of coordination and cooperation

Previous attempt to coordinate sector activities in government agencies have experienced loss of initial enthusiasm, disputes over responsibilities, a traditional reluctance to share knowledge, and a lack of clear definitions of responsibilities and terms of reference. Instead project-specific steering committees have been formed, but these lack continuity and strategic direction and are driven by the goals of the proponents (generally aid donors) rather than by national priorities.

Lack of community participation

A key to improved water governance is community participation in planning and decision making (UNWWAP 2006). In Nauru, there is very little community involvement in water or sanitation planning and implementation.

This is a particular concern for groundwater, where the water ownership must be resolved.

Human and other resources

As there is no agency with responsibility for water and sanitation, there are few (almost no) persons in Nauru with the expertise and experience to carry out the tasks necessary for managing the future water supply, upgrading sanitation, resolving competing demands for water, and planning for droughts.

Public engagement and support

As previously noted, Nauruans are only now coming to terms with the need for self-reliance in storing potable water. The aid program is a benefit, but could be improved in terms of achieving the engagement of the public and emphasising the importance of maintenance and self-reliance.

2.5.3 Measures to manage impacts and concerns (IWRM approaches)

A Hot Spot Workshop was held in Nauru on 30 May 2007. At the workshop it was concluded that more resources were essential to achieve a sustainable, safe and adequate water supply, and a sustainable, non-polluting sanitation system. The actions listed below were seen as of high priority. All actions have been allocated to existing entities on Nauru, to reinforce existing roles and responsibilities. The tasks are consistent with the goals and milestones in the National Sustainable Development Strategy for the water and sanitation areas, and the directions currently being taken by aid donor funding.

Task	**Responsible Agency**
1. Obtain and install 150 large water tanks in 2007, with associated guttering and plumbing.	Aid Coordination Unit/Eigigu Holdings
2. Obtain and install 45 tanks of 6,000 litres in community areas as backup storage and for irrigation of community garden plots.	Aid Coordination Unit, CIR
3. Obtain and install 150 large water tanks in 2008, with associated guttering and plumbing.	Aid Coordination Unit/Eigigu Holdings
4. Obtain and install 150 large water tanks in 2009, with associated guttering and plumbing.	Aid Coordination Unit/Eigigu Holdings
5. Strengthen local skills and capacity in tank installation, plumbing and repairs.	Aid Coordination Unit/Eigigu Holdings
6. Conduct water efficiency audits at all households with large tanks and other households that volunteer.	Aid Coordination Unit, CIR
7. Conduct water efficiency audits at all commercial premises supplied with desalinated water.	Aid Coordination Unit, CIR

8. Re-commission large desalination unit at low capacity to match generation of waste heat from the power station.	Utilities
9. Purchase and operate 2 trucks to deliver desalinated water.	Utilities
10. Purchase and operate 1 truck to collect and dispose of septage.	Utilities
11. Complete survey of households, roof area, tanks, and sanitation systems.	SOPAC/Survey and Mapping
12. Twice annual monitoring of household wells and bores (EC, turbidity, E Coli).	Health
13. Establish legal framework for ownership of boreholes and groundwater extraction.	Nauru Rehabilitation Corporation
14. Drill 20 boreholes, including test holes, monitoring bores and production bores.	Nauru Rehabilitation Corporation
15. Develop several production bores and associated storage tanks for drought supply and for agricultural use.	Nauru Rehabilitation Corporation
16. Update National Water and Sanitation Plan.	Health/WHO
17. Public awareness programme.	CIR/Health/Utilities
18. Annual audit and review of progress on water and sanitation tasks, and refinement of future strategy.	Health/WHO/Aid Coordination Unit

National Water and Sanitation Coordination Committee (NWSCC)

The tasks for a NWSCC are:

- Coordination of government agencies with responsibilities in the water and sanitation sector;
- Development of broadly-based policies on water and sanitation which are consistent across sectors and with other related government policies;
- Identification of priorities;
- Provision of broadly-based advice to government on water and sanitation;
- Better understanding of the condition of the nation’s freshwater resources, water supplies and sanitation services through coordinated monitoring and assessment;
- Provision of a single forum for interaction and information dissemination between agencies, the GON and the community;
- Coordinated and thoroughly reviewed water and sanitation proposals for the Government of Nauru and for donor and investment organisations;
- Increased confidence of donor and investment organisations in the sector.

If successful, this committee will address the issues and concerns identified in 2.5.2.

2.6 Financing

2.6.1 Types of financing arrangements

The operating costs of the desalination plants operated by Utilities are in the range of AU$4.00 to AU$5.00/kL. The current delivery charge for water to households has recently increased from $1.50/kL to $3.00/kL (including delivery cost) and it is intended to gradually move to full cost recovery.

There is no national government control or ownership of natural groundwater. All bores and wells are the responsibility (and at the cost of) the landowners and/or householders.

The two desalination units at the Menen Hotel (which supply the refugee camps and the hotel – largely occupied by refugee camp personnel) are operated at the cost of AusAID. Likely cost is about AU$4.00/kL, although it should be noted that the cost of diesel for the power station (and hence power costs for these reverse osmosis plants) is subsidised by AusAID.

All sanitation systems are now privately owned and maintained (although the latter involves little activity).

Socio-economic constraints on household and government budgets are critical issues in Nauru, and limit the options that can be implemented and maintained in the near future.

2.6.2 Major issues and concerns

Financial unsustainability of water and sanitation systems

The income from the supply of desalinated water is well below the cost of production and delivery, so there are no funds for maintenance. There are no funds for testing wells or groundwater quality, so the Government of Nauru must rely on donor or loan funds for any major water and sanitation project.

Sanitation services

There is no charge for sanitation services.

A fair water tariff system

Without a reasonable tariff to limit the demand for desalinated water, and an equitable and efficient procedure for collecting revenues, demand is likely to outstrip the systems' supply capacity. Consumer dissatisfaction will inevitably result.

Using water pricing to control demand has social implications. Firstly there are many households who cannot afford to pay for water. Secondly, most households have domestic wells, and if the price is too high households will simple increase use of dubious quality well water. Finally, there is the question of landowner rights to groundwater to be resolved.

Improved financial reporting

The Government of Nauru and the general public need to be informed regularly of the running and replacement costs of water and sanitation systems in rural and urban areas.

Agricultural use

No system has been implemented to charge for water supplied for agricultural uses.

Environmental allocations

No procedure is in place to allocate water (or retain water) for environmental benefits.

2.6.3 Measures to manage impacts and concerns (IWRM approaches)

At the Hot Spot Workshop held in Nauru in May 2007, it was concluded that more resources were essential to achieve a sustainable, safe and adequate water supply, and a sustainable, non-polluting sanitation system. The actions listed below were seen as of high priority. The tasks are consistent with the goals and milestones in the National Sustainable Development Strategy for the water and sanitation areas, and the directions currently being taken by aid donor funding.

1. Obtain and install 180 large water tanks in 2007, with associated guttering and plumbing.
2. Obtain and install 45 tanks of 6,000 litres in community areas as backup storage and for irrigation of community garden plots.
3. Obtain and install 180 large water tanks in 2008, with associated guttering and plumbing.
4. Obtain and install 180 large water tanks in 2009, with associated guttering and plumbing.
5. Strengthen local skills and capacity in tank installation, plumbing and repairs.
6. Conduct water efficiency audits at all households with large tanks and other households that volunteer.
7. Conduct water efficiency audits at all commercial premises supplied with desalinated water.
8. Re-commission large desalination unit at low capacity to match generation of waste heat from the power station.
9. Purchase and operate two trucks to deliver desalinated water.
10. Purchase and operate one truck to collect and dispose of septage.
11. Complete survey of households, roof area, tanks, and sanitation systems.
12. Twice annual monitoring of household wells and bores (EC, turbidity, E Coli).
13. Establish legal framework for ownership of boreholes and groundwater extraction.
14. Drill 20 boreholes, including test holes, monitoring bores and production bores.
15. Develop several production bores and associated storage tanks for drought supply and for agricultural use.
16. Update National Water and Sanitation Plan.
17. Public awareness programme.
18. Annual audit and review of progress on water and sanitation tasks, and refinement of future strategy.

The list of tanks has an emphasis on water and sanitation. However it must be appreciated that there is very little agricultural activity in Nauru, no natural discharges and a low level of economic activity.

3. Linkages to other areas

3.1 Landuse and Agriculture

To date, phosphate mining has disturbed or destroyed 1,400 ha of the 2,200 ha of Nauru. Hence it has had a massive impact – initially positive because of the large royalties which could have created a sustainable infrastructure and economy – but now negative, as the mined land is now unusable.

It is planned to rehabilitate the mined land over the next 20 to 30 years, and replant it. An area of 124 ha has been allocated to agriculture. This area could require 700 ML/yr of water which would involve a very large demand on the groundwater resource and the risk that the groundwater may not be available in sufficient quantities for potable water in drought conditions.

Groundwater reserves

The groundwater reserve is yet to be defined.

Customary land use

Landowners have rights over groundwater and this may limit development of the resource for widespread community use.

Impacts of traditional crops and livestock

There is very little agriculture on Nauru, apart from near Buada Lagoon.

3.2 Habitats and ecosystems

At present, most wastewater enters the shallow groundwater near the coast and flows to the costal waters. There is evidence of nutrient enrichment near the shore, but no scientific studies have been conducted of the extent of the environmental impact.

Discussions with the Fisheries and Environment agencies indicated that no baseline study has been carried out for the fringing reef. There is concern that reef ecosystems are stressed and there has been a substantial reduction in the number of fish caught on the reef. This is attributed to the increase in fishing pressure for subsistence, as a consequence of the recent financial crisis. The priority of Fisheries is on fish as a food, as well as obtaining income form the natural pelagic fish resource.

The Topside groundwater resource is under the mined out area. There is little vegetation cover and no soil layer to filter the water. Hence the quality of the underlying groundwater is questioned by some.

There are no discharges to coastal waters other than seepage from groundwater and a small number of pipelines discharging sewage.

3.3 Health and hygiene

There is no routine testing programme for household potable water (tank or non-potable water (from wells and bores). The MHMS advised they do not have the personnel or reagent supplies to carry out the tests.

The hospital is under-resourced (no power or water for half the time) and hence the incidence of water borne diseases is not documented.

Previous studies have found elevated levels of TDS and E coli in potable and non-potable water supplies. Direct links to the contaminated groundwater cannot necessarily be inferred from such statistics, although it appears to be the probable cause. It is estimated that many more people suffer from the effects of water-borne diseases than are reported in the health statistics.

3.4 Watershed and coastal management

There is a hydrological balance on Nauru wherein the increment to groundwater due to infiltration equals net groundwater use by households around the perimeter of the island plus the net seepage of groundwater into the ocean at the coast. There also may be minor use of groundwater by coastal vegetation. There are no monitoring bores or studies to record the volume or quality of the outflow of groundwater.

Discharges to the marine environment from Nauru other than groundwater seepage are the outlet pipes which discharge raw sewage.

The Nauru Fisheries Marine Resources Authority (NFMRA) has responsibility for commercial fishing – which occurs in deep ocean waters, ad also is encouraging milk fish production in coastal waters and ponds. The NFMRA has drafted coastal legislation for management from the reef to the high water mark - seemingly the NFMRA does not have responsibility for the beach area.

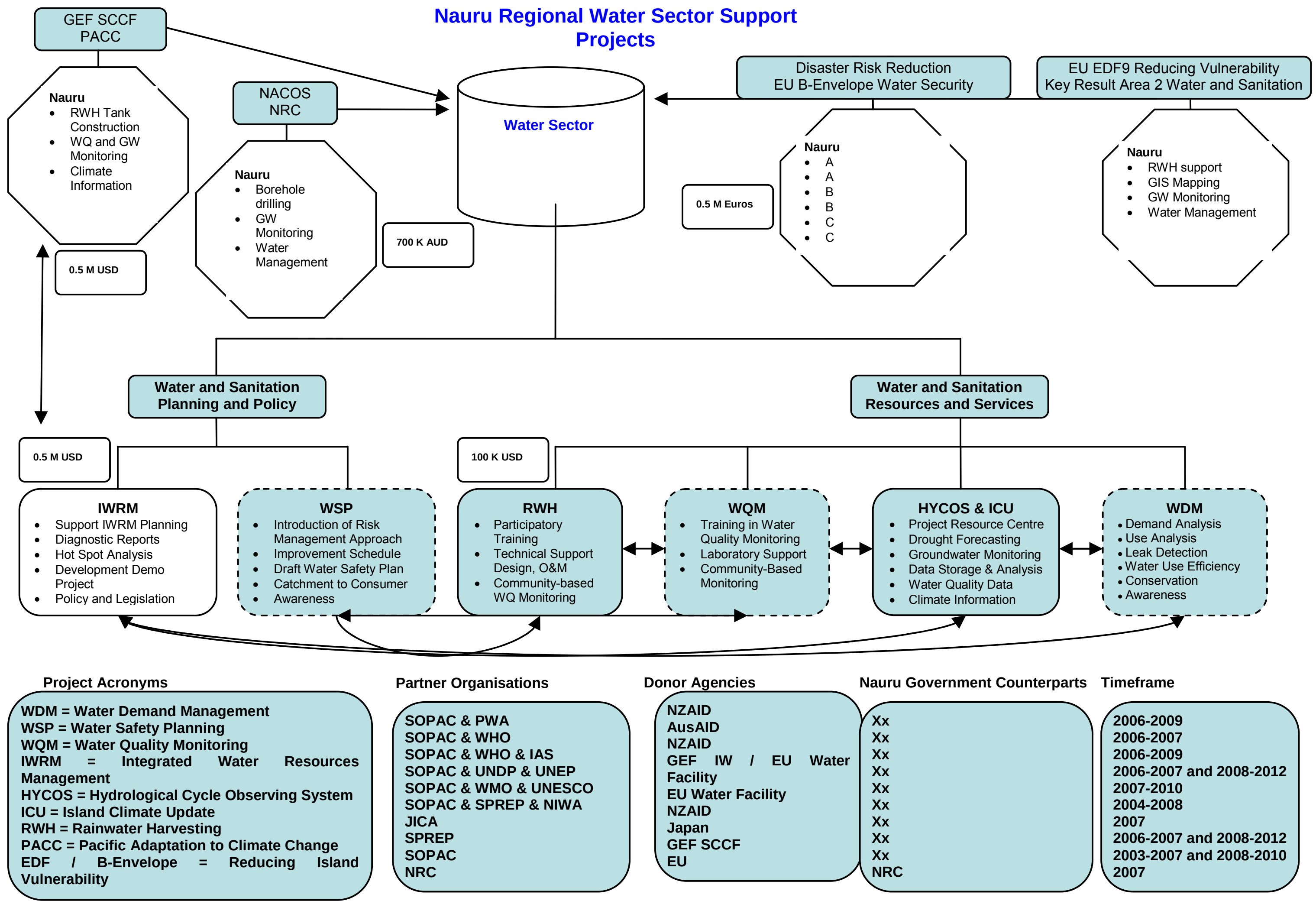
The Ministry of Commerce, Industry and Resources (CIR) is the agency responsible for environmental management and has draft environment management legislation which needs to be endorsed and launched to enable the authority to carry out impact assessments on terrestrial activities. Both agencies have linkages and have harmonised their legislations to ensure appropriate management in both terrestrial and coastal areas. It is important to note that until CIR and NFMRA has appropriate authority through the endorsement and launching of their legislations there is potential for serious impacts from terrestrial activities near the coastal area and no measures in place to manage these issues.

4. Stakeholder Engagement

The following persons were consulted in the preparation of this report.

ARM/CIR	Andrew Kaierua	Manager
DoA/CIR	Claudette Wharton	A/Director
NFMRA	Margo Deiye	Manager
NFMRA	Ebelina Tsiode	Community officer
DPPD/GoN	Nelson D Tamakin	Director
EHC	Lesi Olsson	Chairman
EHC	Don Olsson	Board of Director
EHC	Joske Teabuge	Board of Director
NRC	Dempsey Detenamo	Waste Management Superintendent
NRC	George Joram	Trainee
NIANGO	Cindy Kephas	NIANGO Rep
Education	Bernard Grundler	A/Director
Statistics/GoN	Ramrakha Detenamo	Deputy Assistant – Govt statistician
Utilities	Raphael Ribuaw	Senior Supervisor
NRC	Vince Clodimum	CEO
Sector Planning	Samuel	Director
CIR	Neidel	Environment Unit
SOPAC	Peter Sinclair	HYCOS Project
Aid Coordination Unit	Chitra Jeremiah	Manager
Utilities	Raphael Ribauw	Water Supervisor
CIR	Bryan Star	Director of Projects
CIR	Pere Agutua	Environmental Officer

5. Other programmes, projects and activities related to IWRM



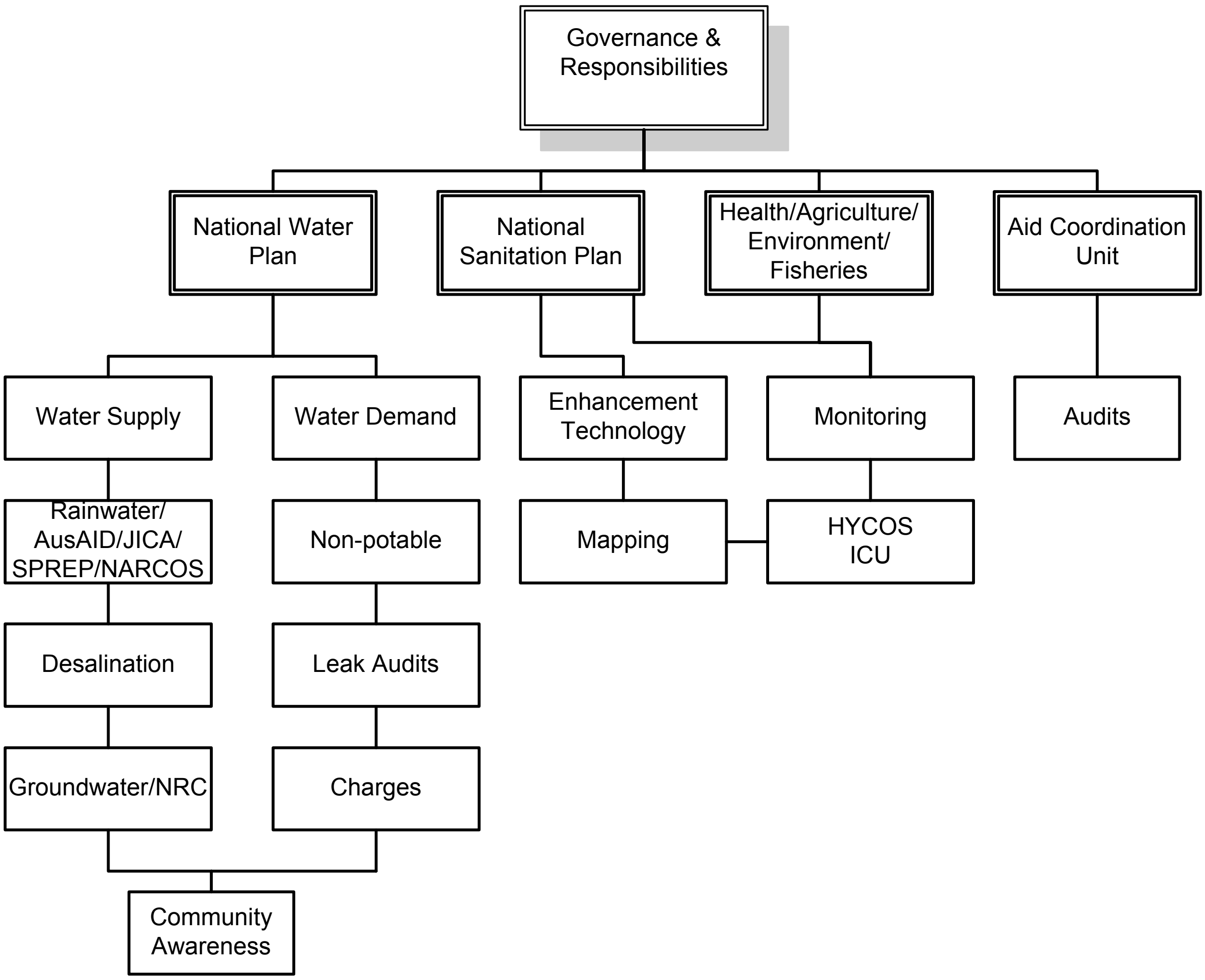
6. Capacity Development Needs for Removing the Barriers

Nauru, like most Pacific island nations, does not at present have the capacity to plan or implement sustainable integrated water resources management. There is a core of trained and well educated people in government agencies, but there is no budget or support staff to carry out the work. For example, the hospital laboratory does not have reagents and Utilities do not have water delivery trucks. Thus the IWRM must be built in Nauru from the foundations:

1. The first step is to clarify the responsibilities of various agencies and departments and to define the ownership and means of development of the groundwater resource BEFORE IT IS DEVELOPED.
2. The second step is to update the National Water Plan and National Sanitation Plan and expand them into an integrated action plan.
3. The third step is to implement the various actions on water supply and demand management as defined in the Hot Spot Workshop.
4. The fourth step is to implement the various actions on sanitation as defined in the Hot Spot Workshop.
5. The fifth step is to implement the various monitoring programmes on water quality, water supply and groundwater quality.
6. To integrate the monitoring results with the agricultural development, pollution control and environmental management sectors.
7. The final step is to initiate the annual reviews (under Health Aid Management Unit) to review progress; identify gaps and refine the action plans.

7. Introducing an Integrated Approach towards Barrier Removal

The key elements of the integrated approach have been discussed earlier in this report. Suggested integrated management arrangement for Nauru is shown in the diagram below.



Governance and allocation of responsibilities is the highest level – the National Water Plan and National Sanitation Plan need to be statutory instruments and responsibilities for various components allocated to various agencies and funded appropriately. The Aid Coordination Unit will have the responsibility of ensuring aid donors are matched to the appropriate statutory agencies and responsibilities.

The various components of water supply management and water demand management need to be resourced and funded to an appropriate level.

The National Sanitation Plan is anticipated to involve continued use of on-site systems, with enhanced treatment technology gradually being introduced in the future.

Monitoring is a key element – both to maintain public health and to keep track of the factors influencing water demand and supply. This aspect will be even more important when groundwater becomes a component of the drought water supply.

The water and sanitation activities must coordinate with the related health, agriculture, environment and fisheries interests, to achieve an integrated management system. This is anticipated to be the work of the National Water and Sanitation Coordination Committee, rather than a separate water department.

The aid coordination unit of CiR will return the responsibility of matching aid donors, to the various responsible departments and agencies, ensuring a coordinated approach is followed in community awareness programmes. Finally, the annual audit provides a mechanism for recording and reviewing progress, and refining plans each year.

References

Arvill, R. 1971. Man and the Environment. Chaucer Press, Great Britain.

AusAID, 2002. Review of water supply infrastructure on Nauru. Prepared by Marcus Howard, Infrastructure Adviser. October 2002 (draft).

Australian Groundwater Consultants Pty Ltd. 1972. Groundwater for Industrial and Domestic Supply. Report to Nauru Phosphate Corporation.

Baines, G. 1994. Rehabilitation and Development Feasibility Study, Environment Component Report, Part A, Environmental Aspects of Rehabilitation of Topside Nauru. Prepared for Australian International Development Assistance Bureau, September 1994.

Davey, G. I. 1966. Report on Rehabilitation of Mined Phosphate Land, Nauru. Unpublished report. CSIRO, Melbourne.

Department of Economic Development, 1999. Report on Nauru's National Environment Management Strategy. Government of Nauru.

EU-SOPAC, (EDF9) 2005. Project Report No. 65. Proceedings of the First Nauru – Multi-Stakeholder Consultation. Menen Hotel, Nauru, 13th July 2005.

Falkland, T. 2002. Nauru Water Management. Visit Report 28th Oct – 1st Nov 2002 for AusAID. Ecowise Environmental

Falkland, T. 2003. Nauru Sustainable Water Supply Project. Groundwater Investigation Details for Project Design Document prepared for AusAID. Ecowise Environmental.

GHD 2002. Inspection Report, Steel Water Supply Tanks 1 to 13, Nauru Island. Prepared by Gutteridge Haskins and Davey Pty Ltd for AusAID. May 2002.

Griffiths T. 1923. Report of the Administration of Nauru during the year 1922. Government Printer, Melbourne.

Jacobson G., and Hill P.J. 1988. Hydrogeology and Groundwater Resources of Nauru Island, Central Pacific Ocean Bureau of Mineral Resources, Australia, Record 1988/12, 87pp.

Jacobson G., Hill P.J. and Ghassemi F. 1997. Geology and Hydrogeology of Nauru Island. Chapter 24. *In* Vacher H.L. and Quinn T.M. (eds.) Geology and Hydrogeology of Carbonate Islands, Developments in Sedimentology 54, Elsevier, Amsterdam, 707-742.

Nauru Bureau of Statistics and Secretariat of Pacific Commission, 2002. 2002 Nauru Census, Main Report (Part One) and Demographic Profile (Part Two) of the Republic of Nauru, 1992–2002.

Republic of Nauru, 2005. Nauru National Sustainable Development Strategy 2005 – 2025. Partnerships for Quality of Life. Government of Nauru.

Republic of Nauru, Rehabilitation and Development Feasibility Study, Overview Report: Document 1 of 7, September 1994.

Republic of Nauru, 2002. Country Briefing Paper. Republic of Nauru. For presentation at the High level Consultation Meeting (Pacific Regional Consultation Meeting on Water in Small Island Countries), Sigatoka, Fiji, 29 July – 3 August 2002.

Sinclair Knight Merz, 2005. Electricity and Water Generation Capacity Assessment. Assessment and Recommendations. Report No HA00505.500 to AusAID.

SOPAC and ADB 2003. Pacific Regional Action Plan on Sustainable Water Management. Asian Development Bank and South Pacific Applied Geoscience Commission, Suva, Fiji.

Tyrer, T.G. 1963. Nauru and Ocean Islands story. New Zealand Dairy Exporter.

Viviani, N. 1970. Nauru: Phosphate and political progress. Australian National University Press, Canberra.

Wallis, I. 2001. WHO Mission Report to Nauru on Water Supply for Nauru, 9-23 May 2001, Report to Government of Nauru, May 2001.

Wallis, I, 2001. Draft National Water Plan for Government of Nauru, prepared in cooperation with Ministry of Health. Workshop Notes Sept 2001.

Wallis, I. 2001. WHO Mission to Nauru on Water Supply for Nauru, 23 September – 1 October 2001. Report to Government of Nauru, September 2001.

WHO, 1993. Guidelines for drinking-water quality. Volume 1, Recommendations. World Health Organization, Geneva.

Annexes

Monthly Average Rainfall for Nauru

Note that yellow boxes denote estimates.

Year	Jan	Feb	Mar	April	May	June	July	August	Sept	October	Nov	Dec	Total in mms
1915	na	Na	na	na	na	92	72	8	23	0	5	32	232
1916	332	26	40	5	4	18	20	20	1	7	0	2	475
1917	10	3	5	4	10	87	57	22	129	12	11	61	411
1918	4	35	383	86	131	164	478	761	305	487	354	326	3514
1919	440	644	512	454	105	133	204	347	329	350	241	293	4052
1920	60	603	479	183	127	223	na	na	na	na	na	na	1675
1921	272	75	20	22	12	2	80	114	57	54	94	451	1253
1922	377	208	17	88	86	116	308	277	58	9	165	30	1739
1923	106	88	289	173	32	167	173	357	189	221	673	398	2866
1924	435	153	159	4	61	61	83	84	30	58	15	3	1146
1925	50	113	8	1	47	91	108	244	179	474	na	na	1315
1926	na	na	na	na	na	na	na	na	76	25	195	32	328
1927	18	7	4	41	38	98	157	105	72	12	233	396	1181
1928	549	176	26	82	12	14	77	36	125	34	139	483	1753
1929	347	394	22	22	55	74	252	248	110	99	232	528	2383
1930	466	448	561	137	82	261	281	695	688	272	335	364	4590
1931	455	185	446	120	60	183	38	171	19	94	32	173	1976
1932	860	556	438	228	103	101	210	167	80	0	2	6	2751
1933	367	115	81	169	95	162	261	94	6	57	18	0	1425
1934	32	5	34	17	38	163	129	88	18	13	13	354	904
1935	359	223	47	10	100	89	130	13	91	160	76	503	1801
1936	383	265	334	110	29	33	45	76	108	49	6	392	1830
1937	277	403	162	13	33	45	76	126	98	35	12	13	1293
1938	207	121	14	1	2	25	37	17	3	0	41	67	535
1939	37	34	33	9	70	124	182	281	209	52	330	448	1809
1940	288	374	383	519	308	305	357	263	316	409	450	na	3972
1941	na	na	388	449	248	349	338	211	383	na	na	na	2366
1942	*	*	*	*	*	*	*	*	*	*	*	*	0
1943	*	*	*	*	*	*	*	*	*	*	*	*	0
1944	*	*	*	*	*	*	*	*	*	*	*	*	0
1945	*	*	*	*	*	*	*	*	*	*	40	169	209

Year	Jan	Feb	Mar	April	May	June	July	August	Sept	October	Nov	Dec	Total in mms
1946	225	258	333	366	309	346	397	195	219	459	395	228	3730
1947	369	292	9	54	24	195	129	71	13	11	186	334	1687
1948	258	387	644	481	428	300	143	111	9	37	265	305	3368
1949	588	113	390	169	44	41	59	58	25	50	30	30	1597
1950	2	36	2	6	7	13	17	51	20	10	25	91	280
1951	322	20	153	285	385	313	175	365	106	283	180	519	3106
1952	258	134	117	117	106	101	186	203	155	35	28	364	1804
1953	410	623	386	416	450	154	239	427	130	411	188	528	4362
1954	368	157	221	157	26	22	20	71	82	2	1	16	1143
1955	486	23	95	46	44	33	19	28	78	2	10	41	905
1956	104	121	78	64	53	7	20	44	16	40	82	138	767
1957	157	415	275	176	222	259	273	210	242	357	414	417	3417
1958	257	558	264	469	198	213	316	123	63	44	142	154	2801
1959	385	230	193	99	65	94	28	21	11	31	162	441	1760
1960	576	245	89	190	153	7	173	47	81	98	140	357	2156
1961	238	219	400	269	140	142	148	247	58	50	178	59	2148
1962	22	28	32	68	63	53	104	104	80	2	344	58	958
1963	34	13	26	89	68	100	52	149	272	365	132	452	1752
1964	306	568	126	3	7	4	24	75	18	1	7	282	1421
1965	400	395	134	316	104	192	345	387	325	385	356	325	3664
1966	332	441	269	302	158	114	215	40	10	106	22	133	2142
1967	64	60	14	406	47	17	81	44	49	11	16	525	1334
1968	455	374	17	51	4	14	141	15	19	6	51	146	1293
1969	0	374	548	333	100	54	32	35	0	77	87	373	2013
1970	260	641	380	474	72	105	23	26	3	8	22	0	2014
1971	13	4	1	115	54	108	72	0	18	28	28	160	601
1972	359	175	25	172	293	300	343	287	526	220	183	482	3365
1973	335	432	150	45	24	166	12	12	15	4	1	15	1211
1974	0	1	10	118	125	58	73	129	3	6	70	355	948
1975	781	215	199	70	75	114	96	58	72	3	2	17	1702
1976	5	201	523	320	198	213	258	285	425	275	179	408	3290
1977	369	311	421	310	152	53	316	127	369	191	456	450	3525
1978	163	0	454	377	24	28	28	27	32	16	64	29	1242
1979	205	403	316	21	160	227	119	95	46	303	420	526	2841

Year	Jan	Feb	Mar	April	May	June	July	August	Sept	October	Nov	Dec	Total in mms
1980	258	444	554	301	304	300	235	198	281	493	310	188	3866
1981	277	277	471	535	50	243	49	71	19	91	134	470	2687
1982	445	168	554	311	134	179	403	300	132	354	175	223	3378
1983	175	16	4	80	174	233	407	81	36	7	1	196	1410
1984	41	4	1	31	39	55	6	22	9	166	101	196	671
1985	234	100	174	17	64	53	92	90	18	7	179	248	1276
1986	437	139	3	93	139	190	201	126	203	303	495	476	2805
1987	176	510	290	340	371	430	294	441	139	155	155	484	3785
1988	110	332	78	49	58	75	50	13	41	0	3	7	816
1989	4	6	3	35	72	94	134	77	28	21	152	253	879
1990	464	314	349	289	312	102	174	183	200	138	246	338	3109
1991	419	255	439	258	215	209	178	246	355	346	528	374	3822
1992	190	253	191	437	527	303	189	369	148	125	228	746	3706
1993	212	323	299	367	444	353	312	280	248	473	111	522	3944
1994	218	87	152	89	85	208	50	50	50	50	100	100	1239
1995	371	292	180	254	93	138	16	12	24	14	23	0	1417
1996	0	0	0	0	23	24	12	3	20	66	4	150	302
1997	273	107	229	427	393	191	661	119	132	206	108	439	3285
1998	85	85	4	33	38	51	20	62	1	10	9	59	457
1999	11	1	13	61	7	46	89	103	7	9	9	5	361
2000	1	5	16	22	44	103	114	60	88	10	33	76	572
2001	77	108	35	63	146	64	274	363	128	110	151	554	2073
2002	593	348	476	382	247	275	414	228	217	50	50	50	3330
2003	282.3						239.6	190	20.4	0	163.8	138.4	1034.5
2004	425.6	139	293.8	67.2	0	0	0		50	50	21	151.8	1198.4
2005	186.1	210.2	267.4	165.8	34.6	36	79.4	151.7	108.5	50	50	62.8	1402.5
2006	6.4	27.7		37.1	26.6			292.6	133.6	319.5	261.4	442.5	1547.4
2007	312.1	427.4	26.5	128.6									894.6