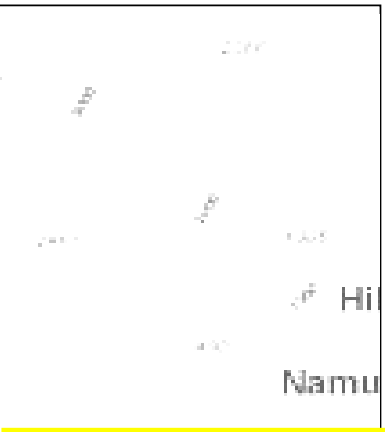

NIUE DRINKING WATER SAFETY PLAN



DRAFT 3.0
April 2009

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The Government of Niue

This document was compiled by the Division of Water Supply for more effective management of Niue's water supply.

The Department of Public Works is responsible for the implementation and oversight of this plan.

This plan is due for revision in November 2009.

Australian Government
AusAID

This document is an output of a regional programme funded by AusAID, for effective management of drinking water supplies in Pacific Island Countries.

SOPAC

World Health Organization

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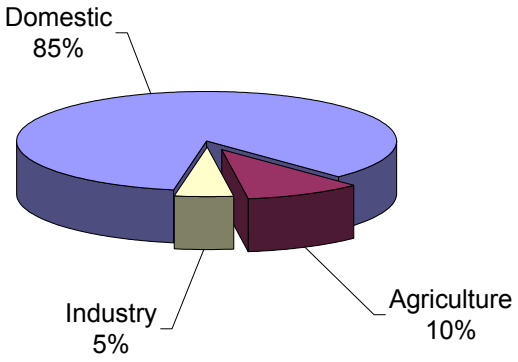
SECTION 1 INTRODUCTION

1.1 Niue Drinking Water Supply

There is no surface water on the island of Niue. The water resource consists mainly of a groundwater lens with rainwater catchment providing a small supplementary supply in rural communities.

Niue receives relatively high rainfall which permeates through the predominantly limestone soil profile to recharge the groundwater lens. This lens provides most of the freshwater used for domestic and irrigation purposes. The current demand for freshwater by sector is summarized in Figure 1.

Figure 1: Niue's Freshwater demand by sector



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The entire upper terrace of the island lies underneath a freshwater lens (200sq km less 60sq km strip of lower terrace) that is pumped to surface for drinking water, where middle of the island is known thickness off 44mtrs of freshwater (Carpenter 2005)

The aquifer strata, though, is highly permeable and the potential for contamination from surficial sources is very high. Historical data (from DoH) on E coli monitoring on all production and irrigation wells suggests that the lens has been free of any microbiological contamination to date.

The water fro the Niue groundwater lens is deemed safe and of very high quality and is thus pumped directly to consumers without any form of treatment. The costs for maintaining the drinking water supply is currently met by the Niue Government. The Niue drinking water supply is currently uncharged and it is not likely that this will change any time in the near future.

Each village has a well (bore) with a submersible pump and a reservoir to provide sufficient head to gravity feed the village reticulation network. Some systems have a surface pressure pump to boost the pressure so that water is supplied to elevated areas. There are a total of 17 production bores across the island.

Comment [M1]: Check this information

Recently, SOPAC has provided assistant under their Water Demand Management (WDM) Programme whereby monitoring of the demand and system loss manage is established.

Water resource management is of great concern for the Government of Niue and their participation in the Integrated Water Resource Management (IWRM) Programme should strengthen the political will, policy base, legislative frameworks and collaboration among agencies towards a more holistic and effective management of Niue's limited water resource.

1.2 Water quality surveillance and monitoring

The environmental health division of the Department of Health had been conducting surveillance of drinking water quality on a quarterly basis, however, the data remain unverified.

Recently, the capacity of the Environmental Health division of DoH was strengthened through training and provision of new monitoring equipment by the SOPAC/WHO Water Quality Monitoring (WQM) Programme, which aims to provide greater credibility and reliability of the DoH monitoring data.

1.3 The need for a Drinking Water Safety Plan

The Government of Niue is committed to providing continuously safe drinking water to communities in Niue and visitors (tourists) alike.

Although current management of the Niue drinking water supply seems adequate, the Government of Niue is committed to establishing a more proactive management and operation of the drinking water supply through an approach that is built strongly around risk identification and management.

1.3.1 The Drinking Water Safety Plan approach

The Drinking Water Safety Plan (DWSP) is a new approach in the Pacific, although it has been adopted successfully by drinking water supplies in developed countries including New Zealand, Australia, US and the UK over the past few years.

SOPAC and the World Health Organization (with funding from AusAID) are assisting Pacific Island Countries develop and implement DWSPs for a more effective management and operation of drinking water supplies.

The development of this plan is a result of the positive collaboration between the Niue Government and SOPAC / WHO towards an improved drinking water supply for Niue communities.

1.4 Development of the DWSP

The Niue Drinking Water Safety Plan was developed primarily by staff of the Water Division, with technical support from SOPAC and WHO. Other stakeholders and potential partner agencies including the Department of Health, Department of Environment, Department of Agriculture, Forestry and Fisheries, the Premier's Office and honourable Ministers were consulted (and/or briefed) during the development of the DWSP.

In developing this DWSP, past reports and studies were carefully scrutinized to identify issues and risks within the Niue Drinking Water Supply and recommendations from these reports have (to some extent) incorporated into this DWSP.

A comprehensive system assessment provides the basis for the risk identification and management processes that were used to develop the DWSP.

1.5 Using the Plan

It is envisaged that the Niue DWSP will be integrated in the day-to-day management, administration and operation of the Niue drinking water supply. Furthermore, it is envisaged that the Niue DWSP will be utilized as a guiding document by decision makers and policy developers when making high level decisions on policy and/or allocating funding and other resources to improve the drinking water supply.

The best means of demonstrating the effectiveness of this Plan is to show that improvements made to the system (whether infrastructural, human resource development, changes in management and/or operation of the system). This can be achieved by implementing a stringent monitoring programme to

monitor not only the quality aspects of drinking water but quantity as well and more importantly the performance of the system components.

It is envisaged that the Monitoring Schedule (Section 6) and the Improvement Schedule (Section 7) will be implemented by the Water Division.

SECTION 2 ORGANIZATIONAL DETAILS

2.1 Supply Name

Niue Drinking Water Supply

2.2 Supply Owner

Water Division (a division of the Niue Public Works Department)

2.3 Person(s) responsible

Mr. Deve Talagi, Director, Public Works Department
Mr. Andre Siohane, Manager, Water Division
Mr. Clinton Chapman, Advisor, Water Division

2.4 Source

Niue groundwater (various locations)

2.5 Treatment

None (except for hardness treatment at the Hospital only)

2.6 Distribution zone(s)

- Alofi township North
- Alofi township South (including Fualahi, Hospital, Kaimiti)
- Vaiea
- Hakupu
- Liku
- Lakepa
- Matalau
- Toi
- Vaipapahi

- Hikutavake
- Namukulu
- Tuapa
- Makefu
- Tamakautonga
- Avatele

2.7 Level of Service

To provide safe, adequate and reliable drinking water supply at appropriate pressure for the people of Niue at no cost (apart from connections).

Quality

To provide drinking water that is safe, wholesome, poses no significant threat to public health and generally conforms to the standard of quality described in the World Health Organization Guidelines for Drinking Water Quality.

Quantity

To provide at least 350 L of drinking water per person per day.

Comment [M2]: Change if needed to reflect reasonable average domestic water use.

2.8 Use and Users

Comment [M3]: Review this section if required to reflect the true definitions for use and users.

The Niue drinking water supply is intended primarily for domestic use, and all sectors across the island such as, government premises, use at commercial premises, private sectors, agriculture ,ect (except sale in any form). The Niue drinking water supply may be used for fire-fighting purposes or as declared by the Premier in a National Emergency situation.

Niue drinking water supply is not intended for use as irrigation on commercial farms. Separate irrigation bores established for this particular purpose by the Department of Agriculture must be used.

2.9 Population served

The population of Niue (Commonwealth data, 2005) was 1,625 (2005) with a population density of 6 people per sq km. 35%of the population lives in urban areas. The birth rate in 2005 was around 15 per 1,000 people with a life expectancy of around 63 years.

Both UNICEF and WHO data (Joint Monitoring Programme Report, 2005) indicates that 100% of Niue's population has access to improved drinking water and improved sanitation.

SECTION 3 NIUE DRINKING WATER SUPPLY DESCRIPTION

3.1 Catchment & Source

3.1.1 Geography and Geology

Niue Is an uplifted high carbonate (or simple a raised limestone) island with a land area of approximately 259 sq. km lying at 19°S, 169 W in the central Southwest Pacific. It has a maximum thickness of limestone 68m above sea level with a series of wave-cut terraces and platforms associated with periods of uplift. The island consists of more than 500m of limestone below sea level (Terry and Nunn 2003)5 underlain by caldera-shaped volcanic structure6 (Schofield 1959).

Chasms exist around the coast, most notably at Vailoa, Matapa, Togo, Vaikona, with smaller structures and 'pools' at Limu and elsewhere. Most of these appear to be sub parallel to the general coastline and are presumably associated with faulting (Schofield, 1959) which has subsequently undergone extensive dissolution. Most are observed to have freshwater or brackish springs.

3.1.2 Hydrogeology

Surface water

There are no surface water bodies in Niue. Some isolated freshwater springs (and resulting pools) can be found close to chasms and caves found along the coastline of the island.

Groundwater

The main source of freshwater in Niue is groundwater in the form of a freshwater lens of approximately 200 sq. Km (the area of Niue island (259 sq. km) less a 1 km strip around the coastline (50-60 sq. km)), located some 34 – 55 m below ground level.

The great expanse and thickness of the limestone on Niue island (compared to most atolls islands) harbours a large aquifer volume (Carpenter et al, 2007), despite its limited storage capacity.

The recharge zone is believed to be the entire surface area of the island less a 1km band around the circumference of the island. Recharge is quite rapid (Carpenter et al, 2007) through the limestone profile. It is assumed that over the entire freshwater lens area (currently estimated as the area of the island) the recharge potential is around 132 million m^3/yr.

3.1.3 Soils

Soils on the island are poorly developed, and rainfall is expected to infiltrate rapidly through the extensive secondary porosity (dissolution features) within the limestone rock. There are no surface water features on the island at all. There are however a number of caves, both perched and below/at sea level containing freshwater around Niue.

The coral atoll origins of Niue have made soil conditions marginal for intensive agriculture and long term monoculture. Much of the land is covered with fern growth, which again indicates the poor structure and nutrient contents of the soil and rainfall is expected to infiltrate rapidly through the extensive secondary porosity within the limestone rock. Thus up to 40% of land is unsuitable for agriculture while those areas under cultivation are only at subsistence level.

3.1.4 Climate

Niue lies on the edge of the southern tropical cyclone belt and in the zone of the southeast trade winds, and is subject to strong gale force winds during the hot season. There are two distinct seasons: the hot/wet season from December to March and the cool/dry season from April to November.

The average annual rainfall is approximately 2,180 mm, but it can vary from 810 to 3,300 mm. Bulk of the rainfall is concentrated in the hot season delivered in torrential downpours, and account for 68% of the total annual rainfall. At this time both temperature and humidity are high, with average temperatures of 27°C. The cool season is characterised by warm sunny days and cool nights, with temperatures averaging 24°C.

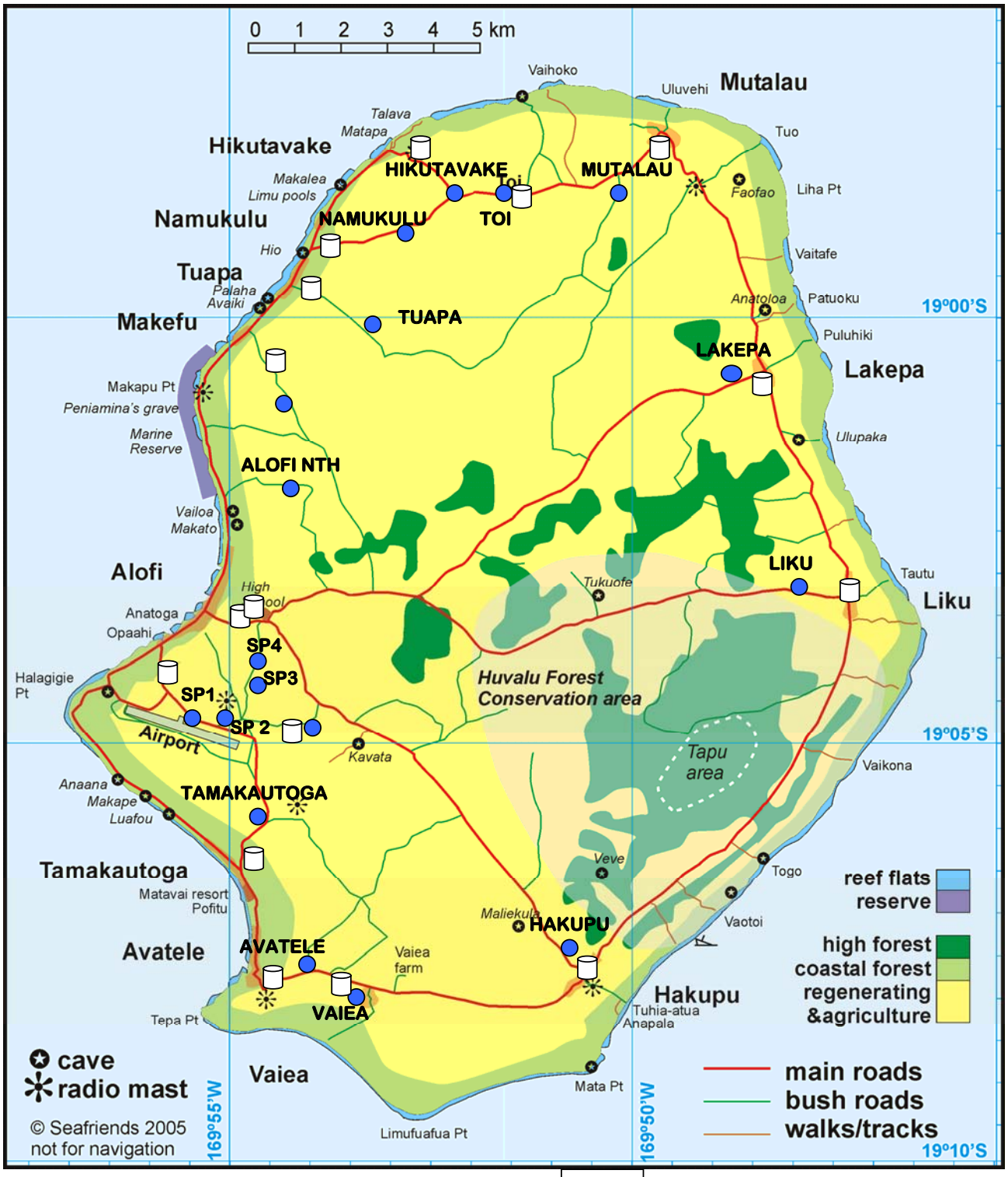
Annual average temperature does not vary greatly throughout the year due to the influence of the sea on a small low-lying island. The annual rain pattern is erratic, with very dry or very wet months possible at any time of the year.

3.1.5 Land-use & Vegetation

There are seven major types of vegetation found in Niue. These include fern and cropland and littoral shrub land, littoral forest, coastal forest, matured forest and secondary forest.

Vegetation distribution is described in Figure 2.

Figure 2: Location of production bores/ Water Tanks



Key:

AVATELE - location of production bore

-Location of Water tanks

3.2 Intake & Treatment

3.2.1 Intakes

The drinking water supply in Niue is mainly groundwater abstraction via protected wells or bores with submersible pumps. Intakes consist of 60-80m deep and relatively secure bores, with submersible pumps.

Intakes are located at Alofi North, Alofi South, Vaiea, Hakupu, Liku, Lakepa, Matalau, Toi, Vaipapahi, Hikutavake, Namukulu, Tuapa, Makefu, Tamakautonga and Avatele.

Table 1. Productions Bore in Niue

Bore	Pump Model and Operation	Supplies Tank	Output m^3/day	Nom. Max Output m^3/day	Comments
SP1	3~phase, SP8-A18 Manual	Alofi South (Tapeu tank)	33	86	Sp1 is small pump, less flow than Sp-2 who has good flow, both connect to one main pipe to tank
SP2	3~phase SP8-A18 Manual	Alofi South (Tapeu tank)	172	172	
SP3	3~phase SP8-A18 Manual	Paliati (Alofi North, Upper and Lower Terraces Tank)	172	172	High yield pump doe to 3~phase power supply, require meters on bore for measure actual
SP4	3~phase SP8-A18 Manual	Paliati (Alofi North, Upper and Lower Terraces Tank))	172	172	
SP5	3~phase SP8-A18 Manual Sealed	Kaimiti and Alofi South Tanks-	172	172	High yield pump doe to 3~phase power supply, pump yet to fully operates
Sp-Tamakautoga	1~phase SP8-A15 Auto	Tamakautoga	73	120	Friction loss from pipeline cause less flow into tanks, 1.1 km from bore to pump
Sp-Avatele	1~phase SP8-A15 Auto	Avatele	90	120	Friction loss from pipeline cause less flow into tanks, 1.2 km pipeline from bore to tank
Sp-Vaiea	1~phase SP8-A15 Auto	Vaiea	100	120	Very productive due to shorter distance between pump and tank, less head and friction loss
Sp-Makefu	Solar operation currently not working	Makefu (not currently in use)	No data	120	Need fit electrical power supply, no technical capacity in island for solar maintenance
Sp-Tuapa	1~phase SP8-A15 Auto	Tuapa	89	120	Friction loss from pipeline cause less flow into tanks1.3 km pipeline from bore to tank
Sp-Namukulu	1~phase SP8-A15 Manual	Vaipapahi and Namukulu	87	120	Friction loss from pipeline cause less flow into tanks1.2 km pipeline from bore to tank
Sp-Hikutavake	1~phase SP8-A15 Auto	Hikutavake	90	120	Friction loss from pipeline cause less flow into tanks1.2 km pipeline from bore to tank
Sp-Toi	1~phase SP8-A15 Auto	Toi	110	120	Tank closer to the pump, less head and friction loss very effective
Sp-Lakepa	1~phase SP8-A15 Auto	Lakepa	86	120	Friction loss from pipeline cause less flow into tanks1.2 km pipeline from bore to tank pumping at high head
Sp-Liku	1~phase SP8-A15 Auto	Liku	89	120	Friction loss from pipeline cause less flow into tanks1.2 km pipeline from bore to tank pumping at high head
Sp-Hakupu	1~phase SP8-A15 Auto	Hakupu	83	120	Friction loss from pipeline cause less flow into tanks1.8 km pipeline from bore to tank, pumping at high head
Sp-Mutalau	1~phase SP8-A15 Auto	Mutalau	83	120	Friction loss from pipeline cause less flow into tanks1.3 km pipeline from bore to tank, pump at high head

3.2.2 Water Supply Systems

There are two main types of systems:

- Pressure pumps – to pump the water to elevated consumers/ households
- Gravity systems – using gravity for reticulation

Pump Systems:

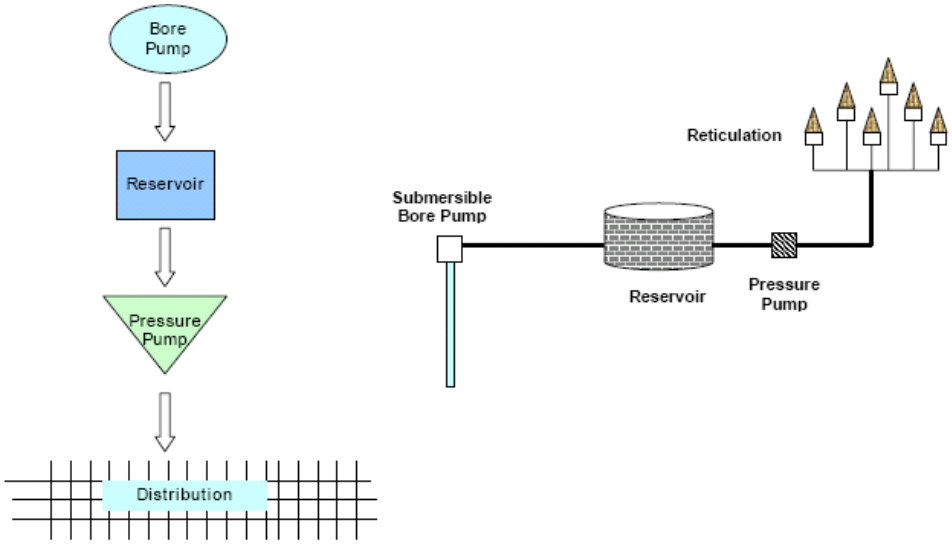


Figure 3: Pump systems

Alofi South (including Fualahi, Hospital, Kaimiti), Vaiea, Hakupu, Liku, Lakepa, Mutalau, Toi, Vaipapahi all have pressure pump systems.

Gravity systems:

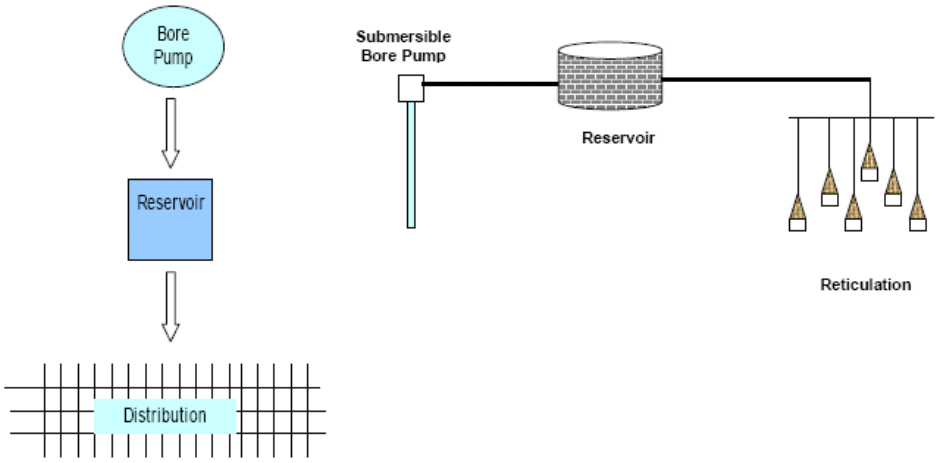


Figure 4: Gravity systems

Hikutavake, Namukulu, Tuapa, Makefu, Alofi North, Alofi South, Avatele and Tamakautonga all have gravity systems.

3.2.3 Submersible Pumps

There are two main types of bore (submersible) pumps used by the Water Division. These are SP8A-15 and SP8A-18 models.

SP8A-15/18

The SP range is capable of handling flows up to 470 m3/h heads up to 810 m. A total system combines a stainless-s SP submersible pump, an MS/MMS motor made specifica submersible pump applications in mind, and an MP 204 m protection unit for added reliability.

SP systems are used worldwide wherever efficient water handling is called for. The main application areas are irriga farmland and groundwater extraction for drinking water.

Protection

The SP8A-15/18 models come with inbuilt protection for external factors such as temperature changes, voltage changes, overload/underload, phase changes, and power failures or disruptions. The motor, however, is quite vulnerable and needs to be protected.

[Information from manufacturers website]

3.2.4 Treatment

The Niue drinking water supply is un-treated except for a small hardness treatment plant at the Niue Hospital.

3.2.5 Monitoring Bores

Monitoring bores have been established to monitor the changes in quality and more specifically, quantity of the Niue aquifer.

3.3 Storage

3.3.1 Storage Tanks

For each bore system, water is pumped into an adjacent storage tank.

There are 16 storage tanks which currently form part of the public water supply system. Details of the condition of these tanks and their capacity are given in the following table. An estimate of the population served is also included based on information collected by Niue Statistics in September 2004.

Table 2: Storage tank summary

Comment [M4]: Check data and record tank condition in "notes" column

Tank/District	Notes	Capacity m3	Pop. Served	No. days supply @350l/p/d	Area Supply
Alofi South	(Marvi-plate coated)Badly Leakage on walls and base, rust roofing Iron	450	609	3.1	Residential, govt building, airport, fire rescue, fish school
Paliati (Alofi Nth Lower Terrace)	Rusted roofing iron,	230	427	1.5	Residential, Schools, Govt Buildings, Main Port, Cor Centre, Niue Power, -Link with Alofi South Tank,
Paliati (Alofi Nth Upper Terrace)	New Tank installed 2007	195	205	2.7	Residential, Niue High School, USP Centre, Govt B Link with Paliatai Lower terrace tank
Tamakautonga	Leaking on walls, and base	80	157	1.5	Matavai Resort with two swimming , Niue Dive, res community hall, link with Avatele Tank
Avatele	New Tank installed 2007	120	164	2.1	Supply Avatele Residential I x swimming pool, beac business, community hall
Vaiea	Leaking walls and base, roofing rust	50	59	2.5	Residential, private business, Noni Farm,
Makefu	Damage roofing, leaking walls	90	0	0	Currently Not in operation
Tuapa	Minor Leaking on base	195	196	2.3	Supply Tuapa, Namukulu, Makefu villages and stanby-Al
Namukulu	Overhang roofing type, not attaché to the tank, leaking walls	50	22	6.5	stan-by Tuapa and Namukulu village, 20bed roon swimming pool, 3 residential,
Vaipapahi farm	Old concrete tank, badly leaking walls due to Tongan earthquake in 2006	50	12	11.9	Supply the Govt Research farm, plus 6 residence to higher ground
Hikutavake	Reroofing 2001, tank is in good condition	80	56	4.1	Supply Hikutavake residence at lower terrace, p business plus new relocating residence in higher
Toi	Re-roofing 2001, tank in good condition	80	31	7.2	Supply Toi residence, community centre,
Lakepa	Re-roofing 2001, top rim, bolts a rusted from sea spray-require replacement	80	72	3.2	Supply Lakepa residence and community cen
Liku	Re-roofing 2001, top rim, bolts a rusted from sea spray-require replacement	80	62	3.7	Supply Liku residence, community centre
Hakupu	Re-roofing 2001, tank in good condition	120	162	3.4	Supply Hkupu residence and community cent
Mutulau	Re-roofing 2001, tank in good condition	120	81	4.2	Supply Mautalu residences, community centi
Kaimiti	New Tank 2005	195	100	5.6	Support new hospital, new relocating residence building, link with Hospital tank, Alofi South T

(Source Water Division –Feb 09)

All sites currently have in excess of 24 hours storage as recommended in the minimum design guidelines, based on the design demand of 350 l/p/d.

3.4 Distribution

3.4.1 Pressure Pumps

There are six (6) pressure pump systems supplying water to villages which could not be gravity-fed. These are equipped with Llowara 1.1 kW single phase stainless steel pumps with the exception of Alofi South which is served by a Salmson Springson 405 – M/D provided as part of the cyclone relief. The pumps have an approximate average life of 4 years.

3.4.2 Pressure Vessels

Each pressure pump has an associated Davy mild steel pressure vessel used to dampen out pressure fluctuations in the supply system. In normal operation the vessels operate between 175 and 210 kPa controlled by Danfos pressure switches connected back to the pumps. Each vessel is fitted with a 1000 kPa pressure gauge.

The pumps can produce a maximum pressure of 550 kPa so in the event of a pressure switch failure this is the maximum pressure the vessel would be exposed to. The vessels are mostly thought to date from 1987, although some may be older.

When these vessels fail they need to be replaced and budget should continue to be allocated for replacement as necessary.

3.4.3 Mains Pipe-work

Mains pipe-work consists mainly of solvent welded uPVC pipes of various sizes (lengths, diameters etc).

3.4.4 Leak Detection

A proactive programme of leak detection involving water division staff going house to house to repair leaking taps and toilet cisterns was very active when in 1997-1999. This proved to be very effective. Effort has been re-directed elsewhere in recent times, particularly with reconstruction work after cyclone Heta.

The Water Supply Division has reinstated this programme over the last six months, but the programme has been limited by a lack of resources (i.e. transport, staff, and tools).

3.4.5 Service Lines and Domestic Pipe-work

Domestic pipe-work is generally connected to the mains line via a network of service lines.

There are two main problems with older service line connections. They are often not connected to the main line but to the pipe servicing a neighbouring house and are usually not fitted with an isolating valve. This can lead to local pressure problems as well as the lack of isolation valves putting the system at risk of contamination from back flow.

3.5 Water Demand Management

The current demand of 350 L/person/day is quite high for the small population of Niue. Consumer education is very important and given the very high average demand it is clear that there an urgent need for education and awareness in this area.

Comment [M5]: Insert current value for demand here

The WDM programme has recommended investigating subsidy schemes and consumer education for purchase and installation of devices to conserve water or restrict water use.

3.6 Water Quality

Water is delivered to consumers untreated however there are no known community health problems arising from the water supply. Department of Health routinely monitor well water quality for Total Coliform and E.coli and monitoring records show no significant contamination (apart from rare positive samples which could be attributed to sampling error rather than well contamination).

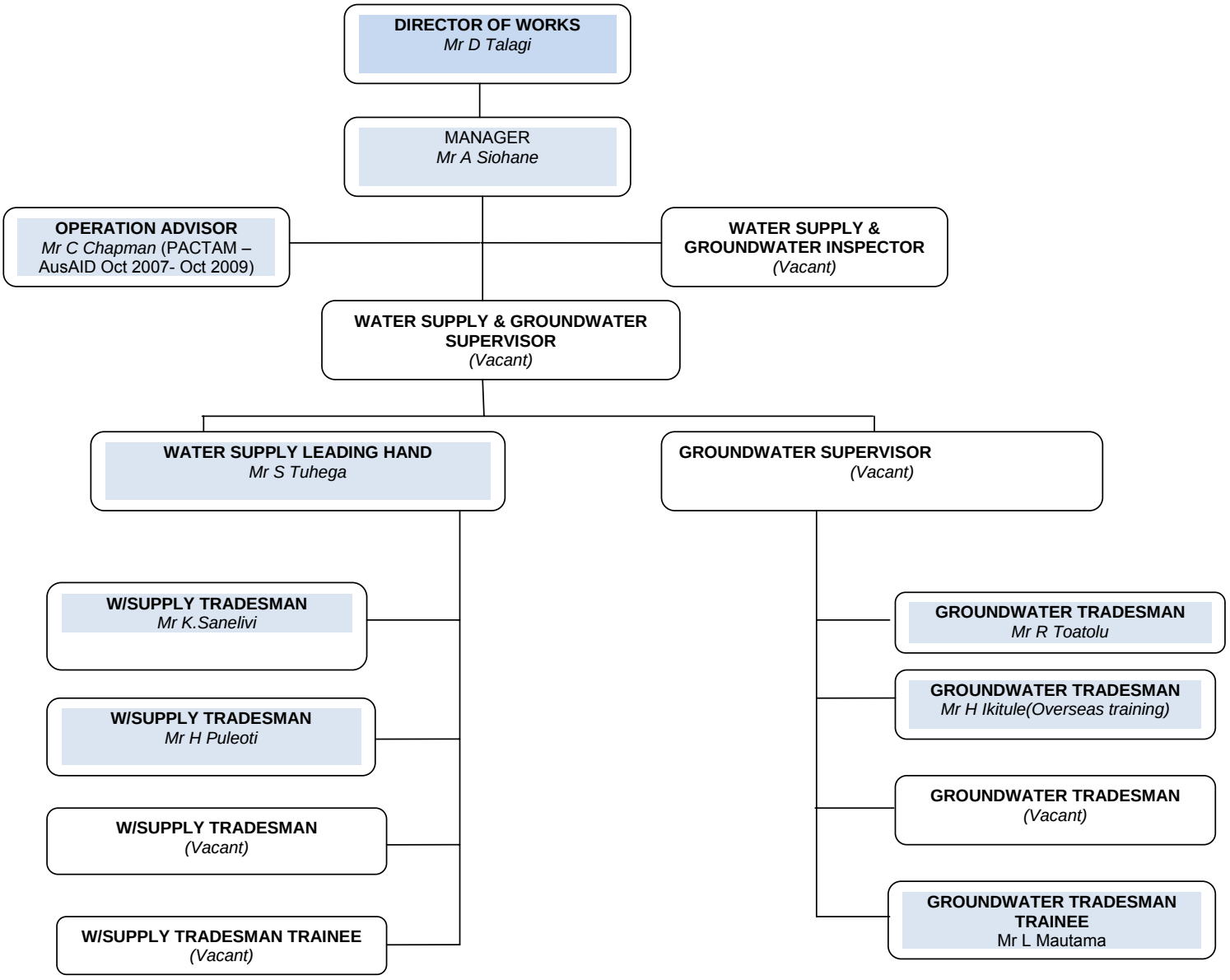
A study conducted by the Louisiana State University in 2000 further showed that there was no significant chemical contamination.

The water division does recommend that people boil their water before drinking.

3.7 Staff and Human Resources

The water supply division currently employs 6 permanent staff. The Water Division is committed to developing the capacity of their staff to perform specialized and highly skilled procedures involved in the day-to-day operation of the Niue drinking water supply.

Figure 2 outlines the current staffing of the Water Division.



(PWD- Human Resource Plan 2009-2013)

SECTION 4 RISK ASSESSMENT

4.1 Background

Risk assessment is the process of identifying, evaluating and prioritizing risks. The objective of this process is to identify all risks associated with the drinking water supply whether existing or could exist in future. This exercise provides the basis for Drinking Water Safety Planning in the following section.

4.2 Methodology

- Each component of the drinking water supply was scrutinized to identify critical points where drinking water safety could be compromised if appropriate control measures were not in place.
- A comprehensive list of existing and potential hazards (including the hazardous event or cause) was compiled (described in Tables 2-6).
- Each risk was evaluated based on LIKELIHOOD of the event occurring and CONSEQUENCE if the event occurred.
- Based on the risk score, each risk was assigned a priority level (e.g. Low, Medium, High or Urgent)

4.3 Summary of risks

4.3.1 Catchment

The catchment for the Niue drinking supply covers essentially the entire island surface, however, the outer 1km band is of special significance as this region has most residential, industrial and agricultural activities located. This region also houses the current rubbish dump and Asbestos dump site.

Seepage of residential sewage from septic tanks

This is viewed as a risk of microbiological contamination of the Niue groundwater lens although ongoing tests by DoH indicate no contamination. Presently, the population of Niue is shown to be decreasing, however, if the population increased in future, seepage from septic tanks could present a major contamination risk for the Niue groundwater.

DoH is required to monitor septic tanks on a regular basis, however, whether there is a current inspection programme for septic tanks by the DoH is not clear. There is currently no standard or guidelines for septic tank design.

The increase in land surface activities may compromise the quality of the water lens. A study carried out by SOPAC on coastal water quality in 2003, was initiated due to fish poisoning outbreaks and fish deaths. The study confirmed a high nitrate and phosphate concentration believed to be caused by inadequate wastewater treatment primarily from septic tanks draining into the groundwater regime. The survey highlights the vulnerability of Niue's water resources to any land surface activities and the close link between land and catchments activities and coastal zone impacts.

Seepage from piggeries

Seepage of waste from improperly designed/constructed piggeries is another potential contamination risk although monitoring by DoH indicates no contamination of groundwater. If there was an increase in piggeries in Niue, the risk could be elevated. Increased rainfall events may also aggravate the risk.

Agricultural runoff

Agricultural activity on Niue are currently quite limited and restricted to certain areas only. The application of fertilizers and pesticides is currently not being monitored. There is no register or records of amount of agricultural chemicals brought into Niue. Although a study by Louisiana State University in 2000 did not suggest contamination by pesticide or other agricultural products. Test also undertaken by Department of Agriculture fisheries, & forestry in 2003 under Pop's regional project shows no signed of pollution and also confirmed by Department of Health/Works during the 2005 groundwater Investigation test for major irons determine any form of contamination by pesticide or other agricultural products.

Industrial discharge

Industrial activity in Niue is limited to a Fish canning plant and isolated auto repair garages. Thus the potential for contamination by industrial waste or discharge is not considered a problem, however, the risk exists.

Seepage from rubbish dumpsites

Dumping of hazardous wastes such as disused electronic products, batteries etc poses a contamination risk from heavy metals such as mercury, arsenic, cadmium etc.

Burying of disuses car frames is also a potential source of chemical contamination.

4.3.2 Source

The Niue drinking water source i.e. the Niue groundwater lens is considered relatively well protected [Carpenter et al, 2007] from surficial pollution. The quantity is also considered to be fairly well maintained through annual recharge from rainfall.

The quality of water sourced from the Niue groundwater lens has been proven (DoH monitoring) to be free of E.coli indicating a source relatively free of microbiological contamination.
The increase in land surface activities may compromise the quality of the water lens. A study carried out by SOPAC on coastal water quality in 2003, was initiated due to

Increase in agricultural use for irrigation, cleaning of piggeries, cash cropping of vanilla and Noni will impact on water quality and quantity.

4.3.3 Pumps

Pumps (both submersible and surface) could be affected without proper maintenance programme in place. Factors such as power disruptions, voltage changes, temperature, phase changes etc could damage the pump or affect its operation.

Some spare pumps/parts are stored by the Water Division, however there needs to be an active programme of maintaining backup pumps and spare parts.

4.3.4 Treatment

The lack of treatment of the Niue drinking water supply makes it vulnerable to contamination during storage and distribution. Of particular concern are the storage tanks and pipe-works supplying water to consumers. On-site filters at each house are being considered.

The systems rely heavily on electricity and any power outage will result in system shutdown.

4.3.5 Reservoirs (Tanks)

The tank conditions are mostly satisfactory, however some tanks are in need of repair. Cracks and leaks in tank structure or fittings is a source of potential contamination.

4.3.6 Pipeworks

The condition of pipeworks is unknown. Cracks or leaks in pipeworks or fittings/connections pose a risk of microbiological contamination.

Bio-films and biological growths in pipeworks is another potential risk.

Pipe damage by plant roots could affect the distribution network and expose the drinking water to microbiological contamination.

4.3.7 Backflows

Backflows from industrial or other high risk connections is a serious threat to drinking water safety. There are no backflow prevention devices within the reticulation network.

4.3.8 Illegal Connections

Illegal connections are known to exist within the distribution zones, however there is no active programme of monitoring or disconnecting illegal connections.

4.3.9 Natural disasters

Since there is a limited supply of freshwater on the island, climatic conditions such as a drought could adversely affect the availability of drinking water in Niue.

Natural disasters such as cyclones, earthquakes, storm surges could damage the drinking water supply infrastructure and affect the distribution of drinking water to consumers. During cyclone HETA some reservoirs were contaminated by saltwater.

Table 3: Catchment, Source & Intake

RISK	RISK EVENT/ CAUSE	LIKELIHOOD	CONSEQUENCE	PRIORITY
Microbial contamination	Seepage from sewage & wastewater	4	4	High
Microbial contamination	Seepage from improperly disposed piggery waste	4	4	High
Microbial contamination (roof water)	Contamination from animals, birds, dust, leaves, and debris	4	4	High
Chemicals	From agricultural activities e.g. fertilizer, pesticides	3	3	Medium
Chemicals (roof water)	From agricultural activities e.g. fertilizer, pesticides (spray drift)	3	3	Medium
Nutrients	From agricultural activities i.e. fertilizer and/or organic waste disposal e.g. composting fish waste	3	3	Medium
Saltwater intrusion	Due to over extraction, climatic impacts e.g. cyclones, drought	3	3	Medium
Organics	Due to Burn-offs (land clearing)	3	3	Medium
Turbidity	From Logging	3	2	Medium
Chemicals	Contamination from surficial solid waste disposal (dumpsites)	3	3	Medium
Oil, fuel etc	Storm water runoff from roads, runway (airport)	4	4	High
Organics	Feral animals (dead animals in caves, quarries, makasea pits)	3	3	Medium
Chemicals	Cross pollutants from roadside dumps	3	3	Medium

RISK	RISK EVENT/ CAUSE	LIKELIHOOD	CONSEQUENCE	PRIORITY
Automotive Chemicals e.g. cadmium, iron, oil etc	Batteries and scrap metals (rusted car bodies, roofing iron)	3	3	Medium
Turbidity	Due to interruptions in power supply or system stoppage for maintenance works	4	4	High
Chemicals-Power Generator Waste oil	Spillage during maintenance /leaking storage drums	3	4	High
Niue Power, Air Port Fuel Storage	Spillage during maintenance/ natural disaster	3	4	High

Table 4: Source and Intake – Bore Pump

RISK	RISK EVENT/ CAUSE	LIKELIHOOD	CONSEQUENCE	PRIORITY
Pump failure	Due to Power outage	4	4	High
Pump failure	Due to Pump Breakdown or electrical fault (e.g. switchboard)	4	3	High
Drop in water level, flow	Due to pump breakdowns	4	4	High
Microbial contamination	Contamination of bore sites	4	4	High
Equipment fault	damage due to sabotage, vandalism	3	3	Medium
Contamination	Due to rust on bore heads, galvanised column pipes	3	3	Medium
Microbial contamination	Due to ingress into bore (from top) of insects, rodents etc	3	3	Medium
Organics	Due to Leaf litter	3	3	Medium
Chemical contamination	Contamination during repairs	3	3	Medium
Chemical contamination	Contamination during maintenance	3	3	Medium
Chemical contamination	Contamination during sampling and monitoring (from contaminated probes)	2	2	Low

Table 5: Storage & Distribution – Pressure Pump

RISK	RISK EVENT/ CAUSE	LIKELIHOOD	CONSEQUENCE	PRIORITY
Pump failure	Due to Power outage	4	3	High
Pump failure	Due to Pump Breakdown or electrical fault (e.g. switchboard)	4	3	High
Equipment fault	From damage due to sabotage, vandalism	2	3	Medium
Contamination	Due to rust on pressure cylinder	4	2	Medium
Chemical contamination	Contamination during repairs	3	3	Medium
Chemical contamination	Contamination during maintenance	3	3	Medium

Table 6: Storage & Distribution – Reservoirs

RISK	RISK EVENT/ CAUSE	LIKELIHOOD	CONSEQUENCE	PRIORITY
Microbial contamination	From cracks, leaks	4	3	High
Microbial contamination	From rusted / damaged roofing, covers	4	3	High
Microbial contamination	From ingress at reservoirs of birds, rodents and insects	4	3	High
Microbial contamination	From overhanging vegetation, leaf litter	4	3	High
Microbial contamination	From vandalism (kids swimming in reservoirs)	5	5	High
Salt-water contamination	Saltwater intrusion during/after cyclones	4	4	High
Microbial contamination	Vandalism, sabotage	2	3	Medium
Microbial contamination	Covers (manhole, barmaid valves) not secured (covers not put back after removal during checks, maintenance)	3	3	Medium
Poor turnover of storage	Due to Pump failure	3	3	Medium
Loss of water due to leaks	Structural damage by creepers and tree roots	5	3	High

Table 7: Storage & Distribution – Hospital Water Softener

RISK	RISK EVENT/ CAUSE	LIKELIHOOD	CONSEQUENCE	PRIORITY
Microbial contamination	build-up of germs in resin bed	4	4	High

Table 8: Storage & Distribution – Pipe Works

RISK	RISK EVENT/ CAUSE	LIKELIHOOD	CONSEQUENCE	PRIORITY
Microbial Contamination	Main and service line breaks, leaks	5	4	High
Water loss	Main and service line breaks, leaks	5	4	High
Microbial Contamination	Cross contamination from backflow	5	4	High
Microbial Contamination	Contamination during repairs, maintenance	3	3	Medium
No water at system extremities	Low flow rates	4	3	High
Damage to Pipeworks/households water appliances	High Pressure	4	3	High
Damage to Pipeworks	High flow rates and flow reversals (pressure differential)	4	3	High
Poor turnover at system extremities	Due to low pressure/flow at end of the line	4	3	High
Microbial Contamination	Cross contamination from connections to rainwater systems	4	4	High
Damage to Pipeworks	Vandalisms, sabotage (intentional damage)	2	3	Medium
Microbial Contamination	From backflows due to unauthorised, illegal connections	4	4	High
No Water	High Demand at low points i.e. sea tracks	4	4	High

Table 9: General Items

RISK	RISK EVENT/ CAUSE	LIKELIHOOD	CONSEQUENCE	PRIORITY
Communication	Results of DoH testing necessary for PWD.	4	4	High
Data loss	Computer failure	4	4	High
Data not collect	Transportation failure	4	3	Medium
Water quality testing not done	No proper laboratory, untrained staff, lack of funding resources.	4	4	High

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SECTION 5 DRINKING WATER SAFETY PLAN

The Drinking Water Safety Plan is a matrix of risks (and/or hazards) associated with the Niue drinking water supply, the ways in which these risks can be monitored to ensure they do not pose a threat to the safety of drinking water supplied to consumers and ways in which these risks could be controlled either through existing controls or by making improvements.

5.1 DWSP Tables

A separate DWSP table has been developed for each of the different components (described in Figure 5) of the Niue drinking water supply. Each DWSP table describes the Hazard, the events that cause the hazard to exist in the system, the risk (priority) posed by the hazard (based on an assessment of its likelihood and consequence), description of existing controls (if any), proposed improvements if no existing controls, monitoring details to ensure hazard is consistently under control and corrective actions (actions to be taken if and when a hazard becomes a threat).

Collectively, these tables provide the framework required for more effective management of the supply.

5.2 Hazard

The hazard component of the DWSP describes the category of hazard that exists within the system. Hazards can be those that pose a threat to quality and safety of drinking water or quantity (availability of water). The hazards described in this plan are mostly based on public health risks i.e. the effect on public health.

5.3 Hazardous Events

This component of the DWSP describes the events that may cause each of the hazard to become a threat to safety of drinking water. There can be multiple events to cause a common hazard to exist, however, each event is treated separately when identifying control measures or monitoring specifications.

5.4 Priority

The priority component describes the level of concern associated with the respective hazard (or the level of risk posed by the hazard). These are based on an assessment of the likelihood and consequence of the hazard existing in the system.

5.5 Control Measures

The “Hazard under control?” component describes any existing control measures that are already within the system to manage the respective risk(s).

5.6 Improvements

The Improvements component describes the improvements that are required if the respective risk is not under control through existing control measures.

5.7 Monitoring

The monitoring component proposes a monitoring regime to consistently ensure that drinking water safety is not compromised at any time, and if the safety of drinking is compromised, this is picked up relatively quickly for remedial action to be initiated as soon as possible. The monitoring component identifies:

5.7.1 What to monitor?

This column lists the parameters that should be tested, inspected or checked.

5.7.2 What is the Critical Limit?

This column describes the level a which safety of drinking water is compromised and indicates that remedial action to address the risk must be initiated immediately.

5.7.3 Who should monitor?

This column identifies the person or agency that is responsible for conducting the monitoring tests, inspections and/or checks.

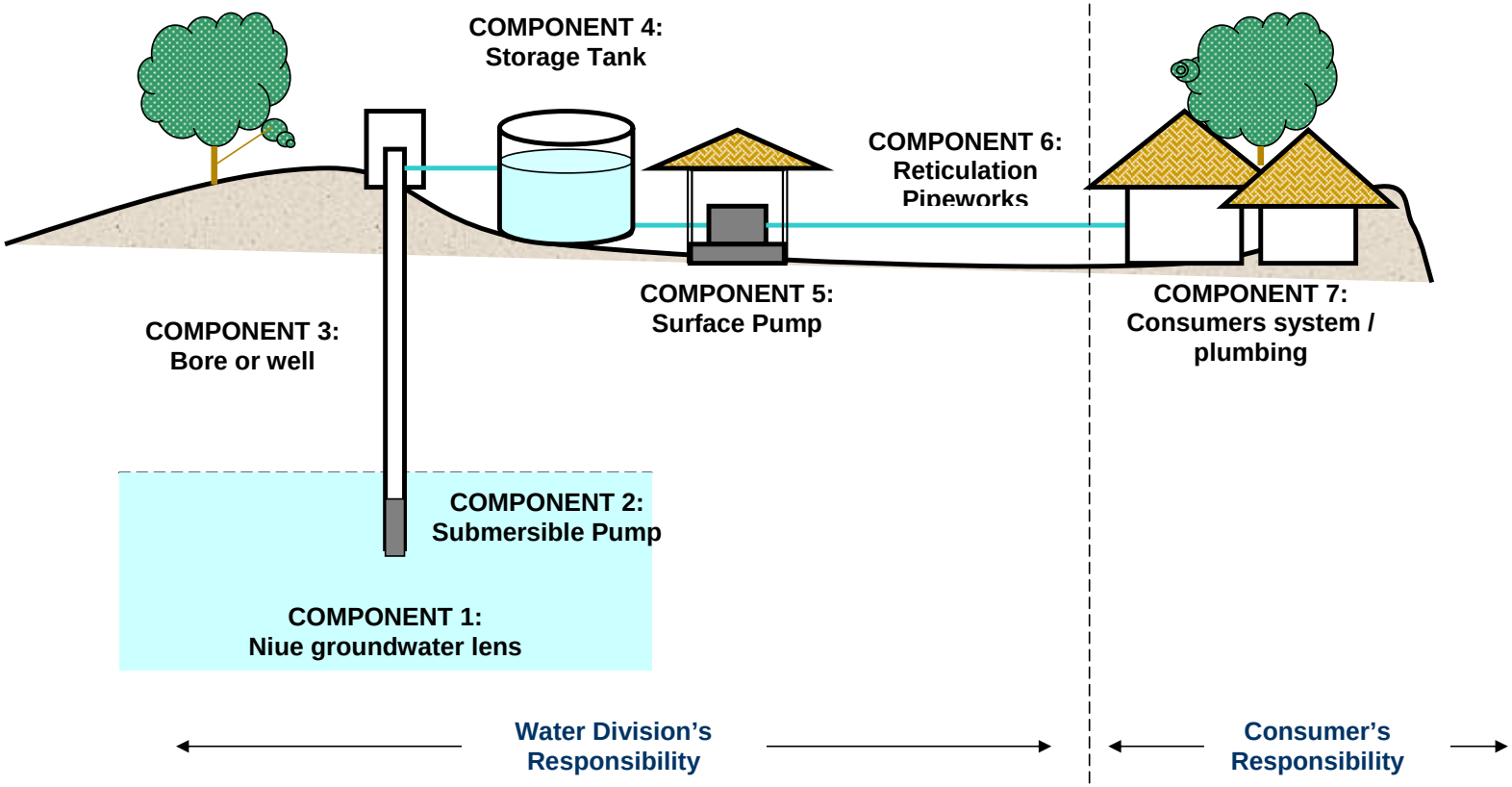
5.7.4 How often?

This column indicates how often the test, inspection or checks must be undertaken. Usually the frequency is based on the associated level of risk.

5.8 Corrective or remedial action

This component describes the corrective (remedial) action(s) that must be undertaken when monitoring indicates a risk is present.

Figure 5: Typical water supply system in Niue



NIUE DRINKING WATER SUPPLY

1.0 CATCHMENT & SOURCE

1.1 COMPONENT 1 – GROUNDWATER LENS

HAZARD	HAZARDOUS EVENT	PRIORITY	HAZARD UNDER CONTROL?	IF NOT, WHAT IMPROVEMENTS ARE NEEDED?	HOW DO WE KNOW WATER IS SAFE?				WHAT TO DO WHEN CRITICAL LIMIT BREACHED?
					WHAT TO TEST	CRITICAL LIMIT	WHO?	WHEN?	
MICROBIOLOGICAL CONTAMINATION	SEEPAGE FROM SEPTIC TANKS	HIGH	No	Review septic tank design standards in Niue building code; inspection of septic tanks by DOENV officials, level drop test	E.COLI	>1 CFU/100ML	DOEnv	WEEKLY	Consider treatment options e.g. chlorination
	SEEPAGE OF PIGGERY WASTE	MEDIUM	No	Farmer education and awareness on appropriate waste disposal practises	E.COLI	>1 CFU/100ML	DOH	WEEKLY	Consider treatment options e.g. chlorination
ASBESTOS IN WATER	SEEPAGE OF ASBESTOS FROM ASBESTOS DUMP SITE	MEDIUM	No	Transport asbestos off-island	ASBESTOS	Asbestos Programme Not Implemented	PWD	ANNUALLY	Inform consumers of possible contamination
HIGH NITRATES IN WATER	SEEPAGE FROM SEPTIC TANKS	HIGH	No	Septic tank design standards; inspection of septic tanks by DOH officials	NO_3	<10mg/L	PWD	MONTHLY	Consider treatment options e.g. chlorination
	SEEPAGE OF PIGGERY WASTE	MEDIUM	No	Farmer education and awareness on appropriate waste disposal practises	NO_3	<10mg/L	PWD	MONTHLY	Consider treatment options e.g. chlorination
HEAVY METALS IN WATER	SEEPAGE FROM RUBBISH DUMP SITES	HIGH		Discourage uncontrolled dumping of rubbish e.g. through awareness programmes and fines	HEAVY / TRACE METALS	WHO Drinking Water Guidelines	PWD	3 YEARLY	Consider other water sources or treatment options (if appropriate)
	INDUSTRIAL DISCHARGE	MEDIUM		Discourage industrial discharge e.g. through awareness programmes or fines	HEAVY / TRACE METALS	WHO Drinking Water Guidelines	PWD/DOENV	3 YEARLY	Consider other water sources or treatment options (if appropriate)

HAZARD	HAZARDOUS EVENT	PRIORITY	HAZARD UNDER CONTROL?	IF NOT, WHAT IMPROVEMENTS ARE NEEDED?	HOW DO WE KNOW WATER IS SAFE?				WHAT TO DO WHEN CRITICAL LIMIT BREACHED?
					WHAT TO TEST	CRITICAL LIMIT	WHO?	WHEN?	
	USED BATTERIES DUMPED IN ROADSIDE DUMPS	MEDIUM	DOH collect and ship batteries off-island	Consumer awareness to discourage dumping and encourage collection of batteries	HEAVY / TRACE METALS	WHO Drinking Water Guidelines	PWD/DOENV	3 YEARLY	Consider other water sources or treatment options (if appropriate)
PESTICIDES IN WATER	AGRICULTURAL RUNOFF	HIGH	No	Agricultural chemicals register; monitor sales and application of pesticides	PESTICIDES	-	PWD/DOENV/ DAFF	3 YEARLY	Consider other water sources or treatment options (if appropriate)
SHRINKING OF THE F/W LENS	OVER-EXTRACTION (e.g. from irrigation wells)	HIGH	Partially (Max population identified)	Record s of volume of water extracted through various applications including water supply, irrigation and private wells.	EXTRACTION RATE	Extraction rate > sustainable yield	PWD/DAFF	DAILY	Issue water restriction notices and monitor water extraction and use. Water conservation promotion
	DROUGHT	HIGH	Partially	Explore storage options; consider other sources e.g. rainwater catchment	RAINFALL	-	MET	DAILY	Issue water restriction notices and monitor water use Water conservation promotion
	SALTWATER INTRUSION	HIGH	Partially	Consider other sources e.g. rainwater catchment	Conductivity EC	< 1000 uS/cm >1 CFU/100 ML	PWD	MONTHLY	Explore other water sources e.g. rainwater catchment Water conservation promotion

1.0 CATCHMENT & SOURCE

1.2 COMPONENT 2 – ROOF WATER

HAZARD	HAZARDOUS EVENT	PRIORITY	HAZARD UNDER CONTROL?	IF NOT, WHAT IMPROVEMENTS ARE NEEDED?	HOW DO WE KNOW WATER IS SAFE?				WHAT TO DO WHEN CRITICAL LIMIT BREACHED?
					WHAT TO TEST	CRITICAL LIMIT	WHO?	WHEN?	
MICROBIOLOGICAL CONTAMINATION	CONTAMINATION FROM BIRDS AND ANIMALS	HIGH	No	Maintenance of Roofs, Gutterings, Pipes, Downpipes	E.COLI	>1 CFU/100ML	DOH	WEEKLY	Consider treatment options e.g. chlorination
	CONTAMINATION FROM DUST, LEAVES AND DEBRIS	HIGH	No	Maintenance of Roofs, Gutterings, Pipes, Downpipes	E.COLI	>1 CFU/100ML	DOH	WEEKLY	Consider treatment options e.g. chlorination
CHEMICAL CONTAMINATION	CONTAMINATION FROM SPRAY DRIFT	MEDIUM	No	Maintenance of Roofs, Gutterings, Pipes, Downpipes	COMPLAINTS	-	PWD	-	Disconnect down-pipe; Wash roof; Replace water in tank (if bad)

2.0 INTAKE

2.1 COMPONENT 3 – BORES/WELLS

HAZARD	HAZARDOUS EVENT	PRIORITY	HAZARD UNDER CONTROL?	IF NOT, WHAT IMPROVEMENTS ARE NEEDED?	HOW DO WE KNOW WATER IS SAFE?				WHAT TO DO WHEN CRITICAL LIMIT BREACHED?
					WHAT TO TEST	CRITICAL LIMIT	WHO?	WHEN?	
MICROBIOLOGICAL CONTAMINATION	CONTAMINATED WATER BREACHES WELL HEAD AND ENTERS WELL	MEDIUM	Secure Well Heads	-	E.COLI	>1 CFU/100ML	DOH	WEEKLY	Disinfect wells
	UN-SANITARY PRACTISE DURING REPAIRS ON WELL HEADS OR OTHER COMPONENTS IN WELL	MEDIUM	Yes	Review procedures and practises for repair works on wells	E.COLI	>1 CFU/100ML	DOH	WEEKLY	Disinfect wells

2.0 INTAKE

2.2 COMPONENT 4 – SUBMERSCIBLE PUMP

HAZARD	HAZARDOUS EVENT	PRIORITY	HAZARD UNDER CONTROL?	IF NOT, WHAT IMPROVEMENTS ARE NEEDED?	HOW DO WE KNOW WATER IS SAFE?				WHAT TO DO WHEN CRITICAL LIMIT BREACHED?
					WHAT TO TEST	CRITICAL LIMIT	WHO?	WHEN?	
SUBMERSCIBLE PUMP FAILURE	POWER OUTAGE	HIGH	Generator available in some villages	Back-up power for all intakes	POWER	NO POWER	PWD	DAILY	Issue water restriction notice until power back online Water conservation promotion
	PUMP BREAKDOWN	HIGH	Preventative maintenance programmes in place	Ensure backup pump stored on-site; spare parts stored on-site	PUMP OPERATION	PUMP NOT WORKING	PWD	DAILY	Issue water restriction notice until pump repaired and installed Water conservation promotion
	SABOTAGE	LOW	Protected and secured bores	Warning signage	SIGNS OF VANDALISM	PUMP NOT WORKING	PWD	DAILY	Issue water restriction notice until pump repaired and installed Water conservation promotion
	SWITCHBOARD FAILURE	HIGH	No	Warning light external of bore Spare switchboard for installation	SWITCHBOARD	PUMP NOT WORKING	PWD	DAILY	Repair or replace switchboard
MICROBIOLOGICAL CONTAMINATION	UNSANITARY PRACTISE DURING PUMP REPAIRS AND/OR INSTALLATION	HIGH	Yes	Staff education and awareness; SOPs Development of Operations and Maintenance Manuals	E.COLI	>1 CFU/100ML	PWD	DAILY	Disinfect well

3.0 STORAGE AND TREATMENT

3.1 COMPONENT 5 – TANKS

HAZARD	HAZARDOUS EVENT	PRIORITY	HAZARD UNDER CONTROL?	IF NOT, WHAT IMPROVEMENTS ARE NEEDED?	HOW DO WE KNOW WATER IS SAFE?				WHAT TO DO WHEN CRITICAL LIMIT BREACHED?
					WHAT TO TEST	CRITICAL LIMIT	WHO?	WHEN?	
	VERMINS CONTAMINATE WATER INSIDE TANKS	HIGH	No	Prevent access of vermin inside tanks e.g. by filling in unnecessary openings / holes, and repairing cracks	E.COLI	>1 CFU/100ML	DOH	WEEKLY	Clean and Disinfect Tanks
MICROBIOLOGICAL CONTAMINATION	UN-SANITARY PRACTISE DURING REPAIRS ETC ON TANKS	MEDIUM	Yes	Review procedures and practises for repair works on tanks	E.COLI	>1 CFU/100ML	DOH	WEEKLY	Clean and Disinfect Tanks
	CONTAMINATION DUE TO CHILDREN SWIMMING INSIDE TANKS	HIGH	No	Secure tank openings e.g. with a padlock	VISUALLY CHECK TANKS	SIGNS OF UNAUTHORIZED ACCESS	PWD	DAILY	Clean and Disinfect Tanks
	INTENTIONAL CONTAMINATION i.e. sabotage	MEDIUM	No	Secure tank openings e.g. with a padlock, warning signage	VISUALLY CHECK TANKS	SIGNS OF UNAUTHORIZED ACCESS	PWD	DAILY	Discontinue using the tank, clean, repair, disinfect and then put back online. If tank not suitable for continuing operation, replace with new tank. Issue public notice on water restriction for the zone(s) affected.
	WATER LEAKAGE DUE TO DAMAGED TANKS OR FITTINGS	HIGH	Partially	Preventative Maintenance on tanks	WATER LEVEL IN TANKS	WATER LEVEL < MINIMUM ACCEPTABLE LEVEL	PWD	DAILY	Repair leaks or replace tanks
NO WATER	TANK DAMAGE DUE TO NATURAL DISASTERS	MEDIUM	No	Ensure tanks are sufficiently protected	TANK INTEGRITY	TANK DAMAGED TO POINT OF DIS-USE	PWD	DAILY	Repair or replace tanks

3.0 STORAGE AND TREATMENT (HOSPITAL WATER SOFTENER)

3.2 COMPONENT 6 – WATER SOFTENER

HAZARD	HAZARDOUS EVENT	PRIORITY	HAZARD UNDER CONTROL?	IF NOT, WHAT IMPROVEMENTS ARE NEEDED?	HOW DO WE KNOW WATER IS SAFE?				WHAT TO DO WHEN CRITICAL LIMIT BREACHED?
					WHAT TO TEST	CRITICAL LIMIT	WHO?	WHEN?	
MICROBIOLOGICAL CONTAMINATION	RISK OF ILLNESS DUE TO BUILD-UP OF GERMS IN RESIN BED	HIGH	No	Maintenance Programme	E.COLI	>1 CFU/100ML	DOH	WEEKLY	Clean media and regenerate and back flush Disinfect water after the softener

3.0 STORAGE AND TREATMENT (NO TREATMENT SYSTEM)

3.2 COMPONENT N/A – NO TREATMENT SYSTEMS

HAZARD	HAZARDOUS EVENT	PRIORITY	HAZARD UNDER CONTROL?	IF NOT, WHAT IMPROVEMENTS ARE NEEDED?	HOW DO WE KNOW WATER IS SAFE?				WHAT TO DO WHEN CRITICAL LIMIT BREACHED?
					WHAT TO TEST	CRITICAL LIMIT	WHO?	WHEN?	
MICROBIOLOGICAL CONTAMINATION	RISK OF ILLNESS DUE TO LACK OF TREATMENT OF ROOF AND BORE WATER	HIGH	No	Install filtration and disinfection systems per improvement schedule	E.COLI	>1 CFU/100ML	DOH	WEEKLY	Clean and Disinfect System

4.0 DISTRIBUTION

4.1 COMPONENT 7 – SURFACE (PRESSURE) PUMP

HAZARD	HAZARDOUS EVENT	PRIORITY	HAZARD UNDER CONTROL?	IF NOT, WHAT IMPROVEMENTS ARE NEEDED?	HOW DO WE KNOW WATER IS SAFE?				WHAT TO DO WHEN CRITICAL LIMIT BREACHED?
					WHAT TO TEST	CRITICAL LIMIT	WHO?	WHEN?	
PRESSURE PUMP FAILURE	POWER OUTAGE	HIGH	Generator available in some villages	Back-up power for all intakes	POWER	NO POWER	PWD	DAILY	Issue water restriction notice until power back online Water conservation promotion
	PUMP BREAKDOWN	HIGH	Preventative maintenance programmes in place	Ensure backup pump stored on-site; spare parts stored on-site	PUMP OPERATION	PUMP NOT WORKING	PWD	DAILY	Issue water restriction notice until pump repaired and installed Water conservation promotion
	SABOTAGE	LOW	Protected and secured bores	Warning signage	SIGNS OF VANDALISM	PUMP NOT WORKING	PWD	DAILY	Issue water restriction notice until pump repaired and installed Water conservation promotion
	SWITCHBOARD FAILURE	HIGH	No	Warning light external of pumphouse Spare switchboard for installation	SWITCHBOARD	PUMP NOT WORKING	PWD	DAILY	Repair or replace switchboard
MICROBIOLOGICAL CONTAMINATION	UNSANITARY PRACTISE DURING PUMP REPAIRS AND/OR INSTALLATION	HIGH	Yes	Staff education and awareness; SOPs Development of Operations and Maintenance Manuals	E.COLI	>1 CFU/100ML	PWD	DAILY	Disinfect well

4.0 DISTRIBUTION

4.1 COMPONENT 8 – PIPEWORKS

HAZARD	HAZARDOUS EVENT	PRIORITY	HAZARD UNDER CONTROL?	IF NOT, WHAT IMPROVEMENTS ARE NEEDED?	HOW DO WE KNOW WATER IS SAFE?				WHAT TO DO WHEN CRITICAL LIMIT BREACHED?
					WHAT TO TEST	CRITICAL LIMIT	WHO?	WHEN?	
MICROBIOLOGICAL CONTAMINATION	CONTAMINATION DUE TO CRACKS AND LEAKS	HIGH	Leak detection programme e.g. WDM PROJECT	Repair or replace pipes	E.COLI	<1 CFU/100ML	DOH	WEEKLY	Repair or replace pipeworks
	CONTAMINATION FROM BACKFLOWS AND CROSS-CONNECTIONS	HIGH	No	Backflow preventers at high risk areas	E.COLI	<1 CFU/100ML	DOH	WEEKLY	Investigate source of contamination and fix
	UNSANITARY PROCEDURES DURING REPAIR OR REPLACEMENT	HIGH	Yes	Training	E.COLI	<1 CFU/100ML	DOH	WEEKLY	Disinfect pipeworks
	BIOLGICAL GROWTH IN PIPWORKS	HIGH	No	Secure water storage Distribution survey (leaks and backflow) Determine low point of system Install isolation valves Install scour valves	E.COLI	<1 CFU/100ML	DOH	WEEKLY	PIG pipeworks and flush the system
	PRESSURE VARIANCE	HIGH	No	Pressure meters, install pressure reducing valves	PRESSURE	<15m or <150 KPa	PWD	DAILY	Boost pressure, check for leakage, investigate problem
WATER DISRUPTIONS	LOW FLOW	HIGH	Flow meters installed	Back-up power for all intakes	FLOW	Complaints Received	PWD	DAILY	Boost flow, check for leakage, investigate problem Water conservation promotion
	HIGH DEMAND AT LOW POINTS	HIGH	No	Install breaktanks	FLOW	Complaints Received	PWD	Daily	

SECTION 6 MONITORING SCHEDULE

The Drinking Water Safety Plan (Section 4) identifies critical parameters (quality and quantity) that must be monitored to ensure consistently safe and good quality water is supplied to consumers. These parameters are summarised below:

6.1 Visual Inspection Catchment

Water Quality Parameter	Target Limit	Where?	Who?	When?	Action
Septic Tank Inspection	Meets Requirements	Across Catchment	DoEnv	Annually	Regulatory Action
Piggery Inspection	Meets Requirements	Piggery Sites	DoEnv	Annually	Regulatory Action
Rubbish Disposal Sites	No seepage No complaints No Environmental Issues	Rubbish Dump Sites	DoEnv	Annually	Regulatory Action
Industrial Sites (e.g. Service Stations, Airport)	No Discharge No complaints No Environmental Issues	Industrial Sites	DoEnv	Annually	Regulatory Action
Fertilisers and Pesticides	No complaints No Environmental Issues	Check of Chemicals coming in at Border	DoEnv Customs	Annually	Regulatory Action

6.2 Water Quantity Check Catchment

Water Quanity Parameter	Target Limit	Where?	Who?	When?	Action
Rainfall	Seasonal Norm	Across Catchment	DoEnv	Annually	Regulatory Action
Extraction Volume	Historical Norm	Bore Sites	PWD	Monthly	Leakage Survey Water Restriction

6.3 Water Quality Checks

Water Quality Parameter	Target Limit	Where?	Who?	When?	Action
E Coli	<1.0 CFU/100ml	Bores, Storage Reservoirs	DoH	Monthly	Provide results to PWD Boil water advisory Disinfect Tanks
Turbidity	<5 NTU	Bores	DoH	Monthly	Boil water advisory Use Alternative Supply
Electrical Conductivity	< 1000 uS/cm	Bores	PWD	Monthly	Close bore for period of time
Nitrate	<10 mg/L	Bores	DoH	Quarterly	
POPs	Promotion programme implemented	Bores	PWD	Every two years	

6.4 Water Quantity Checks

Water Quantity Parameter	Target Limit	Where?	Who?	When?	Action
Water Level	Tanks running low	Bores, Storage Reservoirs	PWD	Monthly	Check system for cause and repair
Water Flow	Complaints received Datalogger information	Pipe works	PWD	Monthly	Check system for cause and repair
Pressure	Complaints received <15m or <150 kPa	Pipe works	PWD	Monthly	Check system for cause and repair
Water Demand	Complaints received Datalogger information	Overall	PWD	Annually	Check system for cause and repair Restrict water use

6.5 Visual Inspections – Production Bores

What to inspect?	Target Limit	Where?	Who?	When?	Action
Bore cover	Bore cover closed and secure	Bore Cover	DoH	Monthly	Close & secure cover
Bore pump condition	Pump in working condition	Bore pump	PWD	Monthly	Maintenance / repair
Signs of vandalism, trespass	No signs of vandalism, trespass	Bore area	PWD	Monthly	Public warning, prosecution
Signs of vermin	No signs of vermin inside bore cover	Inside bore cover	PWD	Monthly	Clean and dis-infect bore
Leaf litter	No signs of leaf litter inside bore cover	Inside bore cover	DoH	Monthly	Clean and dis-infect bore
Signs of spillage, contamination during/after repair works	No spillage	Bore area	PWD	After repairs	Clean up

6.6 Visual Inspections – Storage Reservoirs

What to inspect?	Target Limit	Where?	Who?	When?	Action
Tank cover	Tank cover closed and secure	Tank Cover	DoH	Monthly	Close & secure cover
Tank Structural Integrity	Tank structure sound and in good condition	Tank structure	PWD	Monthly	Maintenance / repair
Signs of vandalism, trespass	No signs of vandalism, trespass	Tank and surrounding area	PWD	Monthly	Public Warning, prosecution
Signs of vermin	No signs of vermin outside / inside tank	Outside and inside tank	PWD	Monthly	Clean and dis-infect tank
Leaf litter	No signs of leaf litter outside / inside tank	Outside and inside tank	DoH	Monthly	Clean and dis-infect tank
Signs of spillage, contamination during/after repair works	No spillage	Tanks and surrounding area	PWD	After repairs	Clean up

6.7 Visual Inspections – Pressure Pump

What to inspect?	Target Limit	Where?	Who?	When?	Action
Pump house	House closed and secured	Pressure Pump	PWD	Monthly	Check pump cover
Pump condition	Pump in working condition	Pressure Pump	PWD	Monthly	Check pump condition
Signs of contamination, contamination during/after repair works	Standard Operating Procedure Met	Area of Repair	PWD	After Repair	Disinfect Pressure Pump
Signs of vandalism, trespass	No damage or Inference with Water Supply	Across System	PWD	Weekly	Repair Secure System (signage and fencing)

6.8 Visual Inspections – Pipe Works

What to inspect?	Target Limit	Where?	Who?	When?	Action
Flow rate	Continuous Acceptable Flow Rate	Pipe Works	PWD	Monthly	Check pumps, leaks
Pressure	Continuous Acceptable Pressure	Pipe Works	PWD	Monthly	Check pumps, leaks
Leaks on pipe works	Reduction in Current Water Loss	Pipe Works	PWD	Monthly	Check leaks Repair or replace
Signs of contamination, contamination during/after repair works	Standard Operating Procedure Met	Area of Repair	PWD	After Repair	Clean up, flush system
Monitoring of rainwater tank connections	No contamination	Pipe works on repair	PWD	After repairs	Clean up, flush system
Signs of vandalism, trespass	No damage or Inference with Water Supply	Across System	PWD	Weekly	Repair Secure System (signage and fencing)
Check for Illegal connections	Distribution Survey Completed	Distribution System	PWD	Annually	Advise User of Action Needed

SECTION 7 IMPROVEMENT SCHEDULE

The Improvement Schedule (Table 7 below) describes the improvements identified through the Drinking Water Safety Planning process (Section 4) and which are needed to control risks within the Niue water supply that are currently not under control.

The Improvement Schedule assigns responsibility to a person who will be responsible for implementing the respective improvement(s).

The Improvement Schedule also details the resources that are likely to be needed and gives and indication of how these resources will be sourced e.g. departmental budget, grants, aid funding etc.

A timeframe has also been assigned to indicate when the respective improvements are expected to be fully implemented. The timeframes have been estimated to reflect the practicalities and realities of implementing each improvement based on cost, time, resources needed and the likely effect on improving drinking water quality.

Table 10: Improvement Schedule

Improvement / Corrective Action needed	Priority	Responsibility	Resources Needed	Time Frame	Sta
Purchase spare pressure vessel in event of failure	1	PWD	Purchase 2 x spare vessel in stock	April 2009	
Replace Galvanising rising mains and flanges (programmed)	1	PWD	500 mtrs of 50mm dia galvanised pipe	June 2009	
Check accuracy of flow meters and replace as required	1	PWD	20 x bulk meter for reticulation system	April 2009	
Replace undersized or badly leaking tanks (refer Table I). • Alofi South (Leaking Badly) • Paliati (Alofi Nth) (Clean and seal) • Tamakautoga (requires new seals and bolts) • Avatele (leaking) • Makefu (requires new roof, tank	1	PWD	New rubber seals, bolts and roofing iron, New 195Kl-150Kl water tanks source from Overseas for Tamakautonga, Vaiapaphi and Namukulu	April 2009	

Improvement / Corrective Action needed	Priority	Responsibility	Resources Needed	Time Frame	Sta
liner, and rubber seals) • Numukulu • Vaipapahi Farm (poor condition)					
Complete the maps of the current network – update if new distribution pipes are installed	2	PWD	Pressure pipe locator	April 2009	
Backflow Prevention - Develop minimum design criteria for new connections	1	PWD	Pressure reducing valves, air releasing valves	August 2009	
Monitoring of septic tanks	1	DoEnv	GPS, Computer database	April 2009	
Sterilization of equipment e.g. dip test equipment by bleach prior to immersion into bore	2	PWD, DoH	Capacity building and	November 2008	
Back-up power supply (Solar?)	1	PWD	Solar cell units & wind generators	October 2009	
Warning signage	3	PWD	Weather board/timber post	March 2009	
Padlocks on pump sheds	3	PWD	Multi key padlocks-for all pump sheds	March 2009	
Investigate alternative disposal of piggery waste	2	DoEnv	Compost Bins	April 2009	
Education/awareness for farmers	2	DoEnv	Camera/Computers/signage	July 2009	
Police patrols to monitor trespassers and vandals	3	PWD, Niue Police	Fuel	November 2008	
Education, awareness for technicians doing maintenance, repairs, sampling	1	PWD, DoH	Camera/ computers/printing paper	November 2008	
SOP for tank maintenance, checks	1	PWD	Office consumables, notice plague	March 2009	
Strict guidelines for design and construction of rainwater systems	1	PWD	First Flush Diverters Vermin (Mosquito) Proof system	July 2009	
Education and awareness against illegal connections	1	PWD	National workshop with local communities /staff	July 2009	

Comment [tm6]: These individual entries were taken from Tu-tokaga pg 10 (first version Drinking Water Safety Plan). Can be updated for individual supply.

Improvement / Corrective Action needed	Priority	Responsibility	Resources Needed	Time Frame	Sta
Create and maintain an Inventory of Fertilizers & pesticides imported into Niue	1	DoEnv, Customs	Computer Database, Map Info software proper software	July 2009	
Need to profile all bores	1	PWD	Transportation	June 2009	
Education / Awareness on water conservation	1	PWD/DoEdu	Education materials, printing	February 2009	
Monitoring Vehicles	1 1	DoEnv PWD	4WD UTE 4WD 6 Seats Van	Feb 2010 Feb 2010	
Forestry resource control to minimise slash and burn	2	DoEnv	Weather board for Public sign	April 2009	
Ensure that dumpsites are located within 1km of the coastline (safe zone)[1]	2	DoEnv/Crown Law	Consultant for Policies	November 2008	
Build up bore sites so that runoff does not enter bore	1	PWD	Concrete, pipes	July 2009	
Education and awareness to discourage roadside dumps	2	DoEnv	Public Awareness Materials, local TV, schools	July 2009	
Ensure a proper dumping site for dumping hazardous waste such as batteries	2	DoEnv	Waste Transfer Station for Recycle and Re-use	November 2009	
Install isolation section valves	1	PWD	Purchase 100 off isolation valves	August 2009	
Install scour valves at low points	1	PWD	Require 500 for the whole island	August 2009	
Abandoned houses to be disconnected	1	PWD	Pvc fittings, water valves	July 2009	
Regular Preventative maintenance	1	PWD		November 2008	
Warning signage	3	PWD	Weather board/steel post/bolts/nuts	July2009	
Weather proof the bores	1	PWD	Ready mix concrete	July 2009	

[1] Carpenter et al suggests that the freshwater lens of approximately 200 sq. Km (the area of Niue island (259 sq. km) less a 1 km strip around the coastline (50-60 sq. km)), This 1km strip could be considered as a "safe zone" as any surficial seepage will not affect the groundwater.

Improvement / Corrective Action needed	Priority	Responsibility	Resources Needed	Time Frame	Sta
Screens to keep vermin out of the bore even when cover is open	1	PWD	Pump cover, sheets metals, angle bar, dics	July 2009	
Replace capacitors for Grundfos pumps with Jensens capacitors	1	PWD	20 require replace	April 2009	
Install lightning arrestors to protect bore pump control boxes	1	PWD	40 require for each bore and pressure pump boxes	July 2009	
Install float or pressure switches to protect all pressure pumps	1	PWD	All new tanks with pressure pumps	June 2009	
Purchase and maintain stock of spare switchboards and electrical spare parts	1	PWD	New Parts source from overseas as replacement, 2 off each spare boxes pressure pump -single & 3~phase bore pumps	April 2009	
Purchase and Install Breaktanks	1	PWD	1200ltrs concrete water tanks	July 2009	
Clear procedure for transfer of information between DoH and PWD	1	DoH, PWD	Capacity building	November 2008	
Need a good water testing laboratory to verify effectiveness of drinking water safety plans	1	DoH in collaboration with PWD	1. Basic equipment (incubator, autoclave, distil water maker) to do water quality testing 2. Lab to be air conditioned. 3. Vehicle and fuel for sampling purposes 4. Additional technician to work in lab. 5. Increase in recurrent lab budget to ensure consistent supply of reagents and consumables for lab work	1. Provided by SOPAC/WHO WQM Programme 2. As soon as possible 3. As soon as possible 4. As soon as possible 5. As soon as possible	1. Do 2-5 Y be actio

SECTION 8 REVIEW

This Drinking Water Safety Plan will be reviewed every time a change is made to the Niue drinking water supply or every two years (if no changes are made to the system within the 2 years).

The review must involve Management and Operational staff of the Public Works Department and the Water Division. Other stakeholders such as the Department of Health, DAFF and Department of Environment should be engaged in the review of this Plan.

The review should be preceded by an assessment of the system's performance in line with this Plan specifically the Monitoring Schedule (Section 5) and the implementation status of the Improvement Schedule (Section 6).

APPENDIX: WATER AND PUBLIC HEALTH

This Water Safety Plan is to assist the Public Works Department to protect the health of the people of Niue.

Microbial Agents

Microbial agents include four major groups of human pathogens: viruses, bacteria, protozoa, and helminths.

Viruses: These parasites only replicate within the cells of a host. Viral diseases include infectious hepatitis, diarrhoea, jaundice, and eventually liver damage.

Bacteria: These are microscopic single-celled organisms capable of self reproduction without sunlight. Each gram of human faeces contain 1 to 1000 million bacteria including *Escherichia coli* (*E. coli*) that is used as an indicator of pollution. Some strains of *E. coli* can cause illness. Bacterial diseases include typhoid and paratyphoid, dysentery, cholera, and gastroenteritis.

Protozoa: These are intestinal parasites. They can cause diarrhoea and dysentery (e.g. giardia).

Helminths: These are intestinal worms that can cause illness when somebody swallows the eggs that then hatch in the body. They can cause anaemia, digestive disorders, abdominal pain, and can be debilitating.

Chemicals

Chemicals can cause taste, odour, and appearance problems in water. Over a long period exposure to chemicals can cause health problems. Pesticides can leach into groundwater or contaminate surface water. They can cause acute or chronic effects in people.

Physical Problems

Turbidity, colour, objectionable tastes or odours may indicate health hazards or they may prevent people using a safe water supply.

Testing the Water

The most important tests in the Niue Water Safety Plan are the following:

- *E. coli:* This common bacteria found in human faeces is tested as an indicator of contamination. Normally the bacteria resides in human intestines without causing any ill effects, however some uncommon strains can cause severe illness. If *E. coli* is found, other bacteria that can cause illness may be present.
- Turbidity: Turbidity in water is caused by particulate matter. High levels of turbidity can stimulate bacterial growth and can be a sign of protozoa. Changes in turbidity indicate changes in the water supply.
- Salinity: This measures the infiltration of seawater into water supply.

- Electrical Conductivity: The conductivity of the water measures dissolved compounds in the water, but is most commonly used as an indicator of salinity.
- Nitrate: this is a common form of nitrogen found in water. It is an indication of fertilisers and other nutrients reaching the water supply.

Hardness

Water hardness is the measure of the capacity of water to react with soap. It is caused mainly by calcium and magnesium dissolved in the water, barium, iron, manganese, strontium, and zinc can contribute. In Niue the limestone rock will contribute to the hardness.
Hard water may cause scale deposition in the pipes, hot water cylinders, and jugs. It also causes excessive soap consumption and formation of “scum”.