RURAL WATER SUPPLY

DESIGN AND CONSTRUCTION STANDARDS FOR RURAL WATER SUPPLY IN VANUATU

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MESSAGE FROM THE DIRECTOR

Every Ni-Vanuatu citizen should have access to safe water in sufficient quantities to meet basic needs, including drinking, cooking and sanitation. The relatively abundant supply of fresh water in Vanuatu should further increase livelihoods opportunities and be fully harnessed to improve the overall economic standing of the country, both now and in the future.

As Vanuatu's population grows, demands on existing water sources will increase. These demands when combined with the increasing risk of pollution and climate-related changes could be expected to limit the future availability of potable water, constrain its productive use and impact negatively on Vanuatu's most precious resource, its pristine natural environment.

The National Water Strategy aims to address these issues by overcoming constraints that limit sustainable development of the water sector including factors related to finances, human resources, institutions and operations. In doing so, it gives effect to certain directives of the Ni-Vanuatu Government such as for Physical Planning Areas requiring detailed strategies and plans for all Government Departments.

The mission of the Department of Water Resources is to develop and manage the nation's water resources for the social and economic wellbeing of the people of Vanuatu with a vision to make sure 'sustainable and equitable access to safe water for the people of Vanuatu to support improved public health and promote social and economic development'.

The purpose of standard is to provide guidance and direction on the technical aspects of implementation of water supply systems for rural Vanuatu. There are many sponsors and providers of water supply and sanitation, and I hope that you will rally behind this standard to develop a consistent approach that is appropriate for Vanuatu. Over time, I hope to create supporting resources, including standard drawings, specifications and training notes that will complement these standards which will be freely available to all stakeholders, including community operators, builders, Provincial Government, donor partners and NGOs.

I wish to sincerely thank Piter Visser who assisted the Department with creating the first edition this document. This standard will be updated from time to time with the issue of new editions. My staff and I welcome your feedback on any improvements or suggestions that you may have.

Erickson Sammy
Director, Department of Water Resources

MESEJ BLONG DAREKTA

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INTRODUCTION

For many decades, the national government has been involved in water supply, sanitation and hygiene promotion (WASH) activities in rural Vanuatu. Pre-independence, the activities were carried out by a private French company which travelled around the islands constructing projects in a somewhat ad-hoc manner. A more structured approach came with Independence in 1980 with the formation of the Department of Rural Water Supply (RWS). Sanitation and hygiene have been the responsibility of the Department of Health (DoH), though other departments at times carried the responsibility as well. The 'Vanuatu National Water Strategy 2008–2018' signals another change: an integrated water resource management approach. The Department of Water Resources (DoWR)[1] is now responsible for water supply in both rural and urban areas.

The DoWR aims to ensure adequate safe, appropriate and environmentally sustainable water supplies to all citizens of Vanuatu to improve the health and living standards of its population. It does so by providing technical, financial and institutional support to rural communities and managing water assets and contracts in urban areas.

In rural settings, the DoWR is not the only actor with various non-governmental organizations (NGOs), church organizations, the private sector, community-based organizations (CBOs), and individuals also involved. With a variety of actors comes a variety of design and construction standards as well. Though much good work has been done, there is at times a disparity between the intended and actual outcome. In part, this is caused by the absence of proper design and construction standards.

In 2001, the then called Department of Rural Water Supply (RWS) issued the 'Vanuatu Rural Water Supply Technical Standards Manual'. The manual primarily focused on presenting the standard designs as used and developed by RWS. Though useful to a certain extent, there are several reasons for the manual to be updated:

1. The new departmental structure and responsibilities provide an ideal opportunity to update existing programs and standards;
2. Focus more on 'design standards' rather than 'standard designs';
3. Provide a workable and enforceable set of design and construction standards.
4. Incorporate expected consequences of *climate change*.

The aim of this standard is to provide the reader with the information needed to design and construct appropriate, durable and sustainable water supply infrastructure.

The standard is set up as follows:

- PART I: GENERAL INFORMATION
  Part I provides brief, relevant background information on Vanuatu (both geographical and socio-economic aspects), and the legal framework for the WASH sector.
- PART II: WATER SUPPLY
  Part II deals with the design standards for water supply infrastructure. It includes information on appropriate systems for rural Vanuatu, system selection, design standards for each type of system, and water quality standards.

Though the DoWR has standard designs, these are not included in this design standard. They can be obtained at the DoWR offices or on their website.

Where the previous edition was written for any individual or organization involved in WASH, including skilled villagers in rural areas, this design standard is primarily written for experts involved in the design and construction of rural water supply infrastructure.

Piter Visser, M.Sc.
March 2010

[1] The former Department of Geology, Mines and Water Resources has split up with the geology, minerals and geo-hazards sections having been assigned to other departments.

LIST OF ABREVIATIONS/DEFINITIONS

CAP	Community Action Plan
CBO	Community-Based Organization
CDT	Community Development Training (course)
DoH	Department of Health
DoWR	Department of Water Resources
EIA	Environmental Impact Assessment
F/C	Ferro-cement
GI	Galvanized Iron
NBC	National Building Code
NGO	Non-Government Organization
HDPE	High Density Poly-Ethylene /PE 100
l/c	liters per capita per day
PVC	Polyvinyl Chloride
PWD	Public Works Department
RWS	Rural Water Supply (Department of)
VPT	Village Plumber Training (course)
VLOM	Village Level Operation & Maintenance
WASH	Water, Sanitation and Hygiene
WCT	Water Committee Training (course)

LEGAL NOTICE

This manual is a direction under the Water Resources Management Act. Failure to comply with the standards set herein is punishable upon conviction according to the penalties set forth in the Acts of the Government of Vanuatu.

Water Resources Management Act [CAP 281]: requires the Director of Water Resources to declare water protection zones and issue waterworks / wateruse permits for the non-customary use of water resources. The Act enables the Director to set standards and penalize compliance failures. This Act empowers the Director to transfer schemes to Rural Water Committees (RWC) that meet certain standards (i.e. undertaken a drinking water safety and security plan, at least 40% women representation, registered with the Provinces). The Act establishes National and Provincial Water Resources Advisory Committees (NWRAC & PWRACs) to strengthen coordination with other sectors.

Water Supply Act [CAP 24]: empowers the Minister of Lands and Natural Resources (with the approval of the Council of Ministers) to let water supply concession contracts of public owned water assets to the private sector. The Act requires concessionaires to have drinking water safety plans audited by the Department of Water Resources and empowers the Minister in consultation with the Director from the Ministry of Health to issue drinking water quality standards and penalize compliance failures.

Public Health Act [CAP 234]: establishes the responsibility of provincial councils to ensure and municipal councils to enforce sufficient access to safe water for all. The Act requires all owners and/or occupiers of premises that design and construct water supply systems to comply with public health standards. The Act provides for water quality sampling by environmental health officers and the imposition of penalties or closure of polluted water outlets / sources. The Act also assigns the responsibility for maintaining the safety of water for drinking to the occupier of premises.

Decentralization Act [CAP 230]: empowers Provincial Councils to pass (and notify sub-committees to draft) by-laws for water supply and public health services to be gazetted into law by the Minister of Internal Affairs after a suitable complaint redressal period. The Act empowers Provincial Councils to issue licenses, contracts & set rates for water service delivery.

Environmental Conservation Act [CAP 283]: refers to all surface water (flowing or situated), groundwater (including geothermal) and estuarine / coastal seawater and therefore does not pertain to water contained in works. All projects, proposals and activities that cause or are likely to cause significant environmental, social and/or custom impacts are required to undergo an Environmental Impact Assessment (EIA).

Physical Planning Act [CAP 193]: enables any Municipal or Local Government Council to declare any area within its jurisdiction a Physical Planning Area with the preparation of a physical (zoning) plan and then gazetting by the Minister for Internal Affairs. No person shall carry on development in a Physical Planning Area without the approval of the Council.

Building Act [No. 36 of 2013]: Empowers the Minister of Infrastructure and Public Works Utilities to prescribe a Building Code for the construction of buildings in any municipality or Physical Planning area or any building owned or partly owned by the State. No person may construct a building without first obtaining a building permit from the Authority.

Utilities Regulatory Authority Act [No. 11 of 2007]: Establishes the Utilities Regulatory Authority (URA) to promote consumers long-term interest in access to safe, reliable and affordable water services. The URA approves tariffs for water services for state-owned public water enterprises and private providers under concession contracts.

Custom Land Management Act [No. 33 of 2013]: provides for the determination of custom owners and the resolution of disputes over ownership of custom land by customary institutions. **Land Reform Act [CAP 123]:** vests all state land and all public roads at the day of Independence with the Government of Vanuatu. **Land Acquisition Act [CAP 215]:** provides for the acquisition of land and easements in the public interest including systems for determining appropriate compensation, appeal and resolution. **Land Lease Act [CAP 163]:** provides for the registration of the rights and responsibilities of a lessee (Individual or body corporate) to land, water and air and the development of those resources.

Business License Act [CAP 249]: requires any "Water Works, Distribution and Supply Companies and Providers" for the "collection purification distribution, supply and sale of water to household, industrial and commercial users" to obtain a license from the Minister or Local Council. **Vanuatu Qualifications Authority Act [No. 1 of 2014]:** establishes the Vanuatu Qualifications Authority to strengthen the post-school education skills training (i.e. plumbing), regulate the issuing of qualifications and ensure the maintenance of quality standards in associated trades.

PART 1: GENERAL INFORMATION

1. VANUATU

1.1 Location & population

The Republic of Vanuatu lies between latitudes 13°S and 21°S and longitudes 165°E and 170°E. It is a Y-shaped archipelago stretching over approximately 1300km. The Vanuatu territory, including its marginal seas, covers about 700,000 km^2. Vanuatu has 83 islands of which 65 are inhabited. The total land surface area is 12,190 km^2.

The rural population of Vanuatu, which totals 75.7% of the total population, leads a subsistence lifestyle with very little cash income. Most live in coastal communities though with increasing population pressures there is movement back inland. Vanuatu ranks at position 126 of the Human Development Index (2007). The adult literacy rate (>15 yrs) is 78.1%.

Most of the population lives on 16 of the main islands. The less populated outer islands consequently enjoy less service, particularly in terms of transport. Only few communities have proper wharves, many lack proper road excess. The large distances combined with poor transport facilities make logistics very costly.

The key population data are as follows:

Table 1: Population data, rural & urban:

Area	Males	Females	Total	Households (HH)	Average HH size	Average annual population growth rate (%)	% of total
TORBA	4,296	4,159	8,455	1,585	5.3	0.9	3.5
SANMA	17,842	16,546	34,388	6,639	5.2	3.2	14.1
PENAMA	16,282	15,570	31,852	6,577	4.8	1.9	13.1
MALAMPA	19,350	18,811	38,161	7,771	4.9	1.6	15.8
SHEFA	19,438	18,531	37,969	6,911	5.5	4.4	15.6
TAFEA	16,822	16,479	33,301	5,404	6.2	1.4	13.6
Rural total	94,030	90,096	184,126	34,887	5.3	2.4	75.7
Urban total	30,707	28,471	59,178	11,142	5.3	4.1	24.3
TOTAL	**124,737**	**118.567**	**243,304**	**46,029**	**5.3**	**2.8**	**100.0**

(SOURCE: VANUATU NATIONAL STATISTICS OFFICE, 2009 census)

1.2 Geography

Vanuatu is very young in geological terms with the oldest islands (Torres group, Santo and Malekula) having formed only 22 million years ago. An estimated 20% of the land surface was formed within the last 200,000 years. The main island building force is plate tectonics. Vanuatu lies on the Pacific Plate with the subduction zone to its west. The geology is still very active with numerous earthquakes and tremors, and volcanic activity.

The second origin of island building is coral formation. Large limestone formations can be found in Vanuatu, which often provide good water bearing layers. Thick capping of soil and loosely consolidated (volcanic) deposits may result in surface waters significantly reducing in flow or even disappear during dry periods.

Vanuatu is mostly mountainous with natural forests covering its surface. Approximately half of the land surface area (6000 km^2) is estimated to be arable of which about one sixth is used at the moment. The highest mountain is on Santo, standing 1800 meters tall.

1.3 Climate

Vanuatu has a fairly uniform temperature. The slightly hotter period is from November to April. Daytime temperatures are around 30^{o}C. The cooler period is from May to October with average daytime temperatures of approximately 26^{o}C.

The hot season corresponds with the wet season as well, with March as the wettest month of the year. Average annual rainfall for Vanuatu is 2360mm, though there is considerable difference between the regions. The Banks islands get around 4000mm per year. The predominant wind direction is south-east, affecting the rainfall patterns as well. On the bigger islands, the windward sides receive almost twice as much rain than the north-western leeward sides.

Several cyclones may come about during the wet season, bringing strong wind and torrential rains. In particular roof structures must take cyclones into account.

The effects of *climate change* may not be accurately predicted at this time, though considerable work is being carried out for Vanuatu and the Pacific islands states. Changing rainfall patterns, increased radiation levels (increased temperatures), rising sea level, as well as more frequent and/or intense extreme weather events may occur. Subsequent effects such as landslides and salt water intrusion may occur more frequently or pronounced.

Rainfall data can be found in APPENDIX 1: VANUATU RAINFALL DATA.

1.4 Key community aspects

1.4.1 Village setup

Vanuatu communities are nucleated rather than dispersed. Most facilities, if any, are within a village though health posts, boarding schools and churches may be found away from a village to allow easy access to several communities. Gardens are generally located in the hinterland.

Communal water supply facilities are spread out in a community, but sanitary facilities generally are not. Though some communities still use areas for open defecation, most households have their own toilet. These toilets are on household plots within the village rather than at a designated area, as can be found in other (Melanesian) countries. The spreading of toilets throughout a village requires careful positioning of any groundwater facility.

1.4.2 Religion

Vanuatu is a predominantly Christian country. An estimated 32% is Presbyterian, 13% Anglican, 13% Catholic and 11% Seventh-Day Adventists. The remainder is a mix of Christian churches including Assemblies of God, Church of Christ, Church of the Later-Day Saints and others. The plethora of churches may affect water supply projects, as communal facilities must be accessible to all religious groups within a community.

1.4.3 Land issues

Land is the principal economic resource to indigenous Pacific Islanders, which has the highest rate of customary land ownership in the world. Very little land in Vanuatu is not claimed by custom owners. With Melanesian society based more on oral tradition rather than written, many disputes arise over who is the owner of a certain piece of land. This can certainly affect infrastructure projects which cross several land boundaries, such as for example piped water supplies. Clear agreement and consensus is required prior to commencing a project though this is not a guarantee that a project will not encounter any land issues in the future.

1.4.4 Social structures

Any negotiations with a community must take into account the social structures within a Vanuatu community. Communities are led by a (head) chief, whom with fellow chiefs and village elders decides on issues affecting the community.

Women in Vanuatu generally play a subservient role to men and are rarely involved in the decision-making process. As women are responsible for the collection of water and many household chores, involving them in the project process can be challenging, but is necessary.

Table 2: Key Health Statistics (2009)

Country	Infant (per 1000 live births)	Under 5 (per 1000 live births	Maternal (per 100,000 live births)
Australia	4.26	5.04	8.40
New Zealand	4.79	6.05	19.95
New Caledonia	6.10	9.06	0.02
Fiji	15.20	23.20	27.50
Vanuatu	**27.00**	**31.00**	**86.00**
Solomon Islands	26.00	37.00	103.00
Papua New Guinea	56.70	74.70	733.00

2. LEGISLATION

2.1 Introduction

This chapter provides information on the legislative basis for rural water supply in Vanuatu. Key aspects of the most relevant acts are presented here with. Full copies are available on the Vanuatu Government website (http://www.paclii.org/countries/vu.html). The most relevant acts are:

1. Water Resources Management Act (2002);
2. Environmental Management and Conservation Act (2002);
3. The Public Health Act (1994).
4. The Water Supply Act (1993)
5. The Building Act (2013)

2.2 Water Resources Management Act

The Water Resources Management Act commenced in March 2003. It states that the responsibility for protection, management and use of water lies with the Minister responsible for water resources.

Water in the Act means all surface water (flowing or situated), groundwater, estuarine & coastal seawater, and water contained in works. The latter therefore includes rainwater stored in tanks.

Key sections:

Section (3): subject to the Act, water may be used for any purpose.

Section (4): Customary rights and rights of occupiers are regulated as follows:

1. Every person may use water if no other customary users of the same water resource are adversely affected, and the use of that water is for customary use. Customary use means use recognized by the landowners of an area, and includes non-commercial irrigation.
2. An occupier of any land can use water on, adjacent to or under that land for domestic and stock purposes, if no other lawful users are adversely affected.
3. If any lease is made under the Land Leases Act, the lessee may use any water on, adjacent to, or under that land in accordance to subsection (1) and (2); must apply to the Director for use of other purposes.

Section (5): Existing works and uses lawfully undertaken prior to the commencement of the Act are deemed lawful under the Act.

Section (6): A person must apply to the Director for the right to use water for any purpose that does not comply with *Section 4* and *Section 5*, unless water is supplied from a work authorized under the Act. Similarly,

Section (7): a person must apply to the Director for the right to construct, maintain, or operate works not complying with *Section 4* and *Section 5*. The existence of any work does not confer any rights to that land on the part of the owner of the works; or to the work on the part of the landowner.

Section (19): A landowner or group of landowners can establish a water management committee for any water resource on or under the land for the purpose of implementing water supply conservation measures or a water management scheme. Local water management committees are required to register with the Department.

Section (32): Any person

a. contravening a regulation, order, declaration, direction or term of condition of an approval under the Act; or
b. hinders, obstructs or fails to give reasonable assistance to any officer or person empowered to carry out any function or duty under the Act; or
c. provides false or misleading information under any requirement of the Act; or
d. obstructs someone lawfully entitled to use water; or
e. without authorization, interferes or encourages others to interfere with the means of supply of water, including any works; or
f. without authorization, pollutes any water commits an offence punishable upon conviction. If convicted, the fine for individuals is a maximum of Vt 1,000,000; and/or a maximum imprisonment of 2 years. The fine for any other cases is a maximum of Vt 5,000,000.

Disputes within or between communities often leads to damage done to the water supply scheme. This is punishable under the Act (bullet point *e* in the above list).

Amendments passed in December 2016 specify the approval requirements as follows:

Water use permit (Division 2): Requires all non-custom users of water to obtain a water use permit (Section 5) by way of application on a prescribed format (Section 6) to be determined by the Director of DoWR (Section 7) within limits set by the Director (Section 8).

Water works permit (Division 3): Requires any non-custom construction, operation or maintenance of works affecting water resources to obtain a water works permit (Section 9) on a prescribed format (Section 10) to be determined by the Director of DoWR (Section 11).

The DoWR will support water works and water use permit holders in:

- the assessment, conservation, protection or management of water resources
- training on water safety and security planning processes
- bacterial and chemical water quality testing and analysis

The Act further regulates the planning, development & monitoring of national water resources; and the cross-sectoral coordination linked to water resource management. These are not discussed here.

In essence, the above implies that water is not owned by any individual but by the state/the people. Landowners on whose land exist water resources may use but not claim the water resource as his/her own. A landowner can therefore not prohibit the use of a source, though he can of course object to pipes or infrastructure to be on his/her land.

2.3 Environmental Management and Conservation Act

The Environmental Management and Conservation Act provides for the conservation, sustainable development and management of the environment of Vanuatu, and the regulation of related activities.

The act applies throughout Vanuatu, including its lands, air, and waters.

Key aspects:

Section (2):

Environment means the components of the earth and includes all or any of the following: land & water; layers of the atmosphere; all organic and inorganic matter and all living organisms; the interacting natural, cultural and human systems that include the mentioned components.

Water in the Act means all surface water (flowing or situated), groundwater including geothermal water), and estuarine & coastal seawater. Water contained in works therefore does not fall under this act.

Section (12): Subject to the Environmental Impacts Assessment (EIA) provisions in this Act are all projects, proposals and activities that cause or are likely to cause significant environmental, social and/or custom impacts. More specifically, all projects, proposal or activities that:

- affect coastal dynamics or cause coastal erosion;
- results in pollution of water resources;
- affect any protected, rare, threatened or endangered species, its habitat or nesting grounds;
- result in the contamination of the land;
- endanger public health;
- affect important custom resources;
- affect protected proposed protected areas;
- affect air quality;
- result in unsustainable use of renewable resources;
- result in the introduction of foreign organisms and species;
- result in any other activity prescribed by regulation.

Section (14): A preliminary impact assessment[2] is required to determine whether the proposal, project or development activity is likely to cause any environmental, social or custom impact and the significance of the identified impact. Based on the preliminary EIA, the Director decides whether a full EIA is required.

Section (24): Any activity undertaken subject to an EIA without prior approval or when approval has been refused is an offence punishable upon conviction to a maximum fine or Vt1, 000,000, a maximum of 2 years imprisonment or both.

Unless a water supply project is planned in a protected area, an EIA will not be necessary for most rural water supply projects.

2.4 Public Health Act

The 1994 Public Health Act details the regulations of many aspects of public health. Those regulations concerning water supply, sanitation and hygiene are summarized here:

Section (1): A nuisance is anything that injures or is likely to injure health. A local authority officer or environmental health officer will serve an abatement notice on the author of the nuisance. Failure to comply with the abatement notice, a complaint will be made before the court, which will decide on a suitable fine upon conviction.

Section (31): All collections of water, waste, rubbish, etc. in or around any dwelling that permit or facilitate the transmission of disease carrying factors are labeled as nuisances and dealt with accordingly.

[2] *Preliminary EIA forms can be found here: www.mol.gov.vu/env_app_forms.html.*

Section (33): Any water holding receptacle (tank, barrel, bucket, etc.) must be covered with a lid or screen to prevent mosquitoes from entering. Failure to do so is punishable upon conviction by a maximum fine of Vt50, 000, 12 month imprisonment or both.

Section (35): Cesspools, cesspits, septic tanks, or soakaways must be properly screened by the owner or occupier of the premises to which such structures are upon or attached to.

Section (43): Every local government council shall take all necessary steps to ensure that all inhabitants of the rural area under its jurisdiction have access to proper and sufficient supplies of potable water.

Section (45): An environmental health officer may enter upon any land or premises at any time of the day to collect water samples at any water source or supply.

Section (46): A local authority, based on the findings of an environmental health officer, may order the temporary or permanent closure or cutting off of any water source or supply if the water is found detrimental of the public health, or restrict its use.

Section (47): Any receptacle for collecting or storing water for human domestic use must be kept clean and protected from contamination.

Section (50): Every local government council shall take all necessary steps to ensure that all inhabitants of a rural area have access to proper and adequate sanitation systems.

Section (53): All hotels, restaurants or similar places must have and maintain a proper sanitation system with sufficient number of toilets for those visiting the premises. Failure to comply may result in the closure of the premises *(Section (55)*).

Section (54): An environmental health officer may enter any premises at any reasonable time for the purpose of ensuring the sanitation system is proper and adequate for the occupant of the premises.

Section (56): All sanitation systems must be kept clean by the occupier of the premises to the satisfaction of the environmental health officer, so as not to become a nuisance.

Section (57): Any person causing or permitting to cause a sanitation system to become a nuisance or dangerous to health, by willfully destroying or damaging the sanitation system or its (water supply) components is guilty to an offence and liable upon conviction to a fine not exceeding Vt 50,000, 12 month imprisonment or both.

Section (58): In every urban area, the municipal council provide and maintain in proper and convenient situations sufficient toilets for public use.

Section (62): Any sanitary convenience used in common by two or more premises or by other people, must be kept clean and maintained in a proper state so as to avoid becoming a nuisance. Failure to do so is an offence and liable upon conviction to a fine not exceeding Vt 50,000, 12 month imprisonment or both.

Section (63): No person shall erect or cause to be erected any toilet within 30m of any well, dam, reservoir, river, creek, stream, water course, aquifer or groundwater which is used for domestic supply. Failure to comply is an offence and liable upon conviction to a fine not exceeding Vt 1,000,000, a maximum of 5 years imprisonment or both.

Though the Act refers to owners and/or occupiers of premises with regards to the regulations, any organization designing and implementing the construction of water supply and sanitation systems must comply as well. Hence, water supply and sanitation infrastructure must be designed and constructed in such a manner so as not to become a nuisance.

2.5 Water Supply Act

The Water Supply Act (commencement 1955, revised 1993) stipulates the regulations regarding connections to public water mains as managed by the Public Works Department (PWD) or its concessionaire effectively focusing on metered, urban water supplies.

Applicant wishing to be connected to the public mains must apply to the Director of Public Works. The cost for any extension to the applicant premises will be paid by the applicant. However, the infrastructure up to the premises' boundary is the property of PWD. Liability for the (payment of) connection in the case of change of ownership of the premises, remains with the applicant until the new owner, in writing, accepts the liability for the connection.

The government is responsible for maintenance for the entire infrastructure up to and including the meter, but is not liable to any person for failure to supply water from any cause. This includes temporary interruptions of water supply for maintenance purposes.

The Minister, with the approval of the Council of Ministers, may enter into an agreement or contract with any legal entity granting that entity the sole concession for the provision, development, management and maintenance of water supply to the public within the area of concession. The 'area of concession' is identified as Port Vila Municipality and any part of the Efate Local Government Council region prescribed by the Minister by order.

Any damage caused to water mains through negligence or willful intent, obstruction or assault of an authorized officer in the exercise of any powers conferred or execution of any works for the PWD or the concessionaire, is upon conviction punishable by maximum fine of Vt30, 000, a maximum of 3 months imprisonment or both. Any person wasting or diverting water supplied by the concessionaire is punishable by a maximum fine of Vt30, 000.

Amendments to the Act in December 2016 requires concessionaires to have drinking water safety plans audited by the Department of Water Resources. The amendments also empowers the Minister in consultation with the Director from the Ministry of Health to issue drinking water quality standards and penalize compliance failures.

2.6 Building Act

The Building Act [No. 36 of 2013] empowers the Minister of Infrastructure and Public Works Utilities to prescribe a Building Code for the construction of buildings in any municipality or Physical Planning area or any building owned or partly owned by the State. This requires that no person may construct a building without first obtaining a building permit from the Authority. No building or any part of a building may be occupied or reoccupied unless the Authority has issued a fitness to occupy certificate (based on an inspection against the terms of the building permit). Any such construction must comply with the requirements of the national building code.

- Vanuatu National Building Code (2000): Specifies compliance with AS 3500 Plumbing and Drainage Code and AS 2179/80 Metal Rainwater Goods Standard (Specification, Selection & Installation). The code includes plumbing and rainwater specifications for any buildings (DF5 & DF7), public buildings (NF5 & NF7) including fire mains (NE 1.2).

PART 2: WATER SUPPLY

3. SURVEY & DESIGN

STANDARD 1: PROJECT DESIGN

Projects are designed to provide optimum level of service while keeping operation and maintenance requirements to a minimum.

3.1 Indicators

- Projects have detailed design reports, as per Government standard format, including, where appropriate, hydraulic design details;
- Projects are not overly large or technically complex;
- All designs for water supply schemes should be done by an approved engineer, e.g.:
  - Professional engineer with a qualification in civil engineering, or other relevant engineering degree;
  - Professional civil engineering consultant registered and approved to practice in Vanuatu.
  - Any individual trained to perform the duties of a water engineer, as recognized by the Government of Vanuatu.

3.2 Guidance notes:

With a lack of qualified engineers working in the rural water supply sector, many projects are not properly designed. Instead, fieldworkers or other staff guess what materials are required for water supply systems without any (hydraulic) calculations being done. As a result, many systems function poorly and often are poorly constructed as adequate design reports are not available either.

It is important therefore that qualified person do the designing of systems, in particular where hydraulic calculations are required. It is recognized that there are individuals who are capable of doing hydraulic design but do not have any formal qualifications. These individuals may still carry out design work if recognized and approved by the Vanuatu Government. Recognition of persons without qualifications is carried out by a trade test conducted by the chief/principal engineer at the Department of Works or EHD.

A key criterion for water supply projects is ease of operation and maintenance. Low-tech facilities and low operation costs are essential for the sustainability of projects. High-tech systems must be avoided in community settings as much as possible. Where a gravity-fed supply is not possible, but a pumped supply is, the designer must be convinced that the community is capable of bearing both the cost of operation and has the skills to maintain the system. The community must therefore be made aware of the consequences of pumped supplies.

A second key criterion is the size of piped water supply systems: the larger, the higher the risk of poor management and (land) disputes. Breaking up a potentially large system into several smaller ones (using different water sources) should always be investigated and be the preferred option.

'Level of service' primarily refers to the quantity of water provided per person per day, and to a lesser degree the ease of access to water. An 'optimum' level of service means as much water is provided as possible, but without sacrificing ease of operation and maintenance. For example: a combination of wells and rainwater harvesting may be preferred over a mechanically pumped water supply system.

3.3 Survey requirements

Survey reports shall at least include:

- A clear description, sketch or photo of the source, its flow rate, possible water quality issues (including presence of lime stone that may lead to growth in pipes), and description on how to develop it;
- Soil conditions and whether pipes can be buried or not;
- Locations of possible air traps;
- Length and location of suspended crossings and required type of crossing;
- Population figures for communities (it is recommended to count the number of households which is usually more accurate);
- Number of staff and student for education facilities including realistic growth figures for schools;
- number of beds and outpatients at health facilities, using normal circumstances (non- emergencies);
- number of physically disabled people and the nature of disability;
- Distance and elevation readings at regular intervals (not merely major points such as junctions, tank site, village site etc.) to obtain good topographical data; Where there is very little elevation difference, altimeters/GPS devices will not suffice;

Prior to starting the survey, a rough sketch of the proposed system must be made, including population figures, land use, alternative sources, and main topographical features (rivers, gorges etc.).

3.4 Design requirements

3.4.1 Design period

The design period for all communal water supply systems shall be not less than 15 years.

3.4.2 Population growth

All designs shall incorporate a population increase as per the relevant growth rate shown in Table 25.

Table 2: Rural growth rate per province

Area	Avg. annual population growth rate (%)	Population growth factor over 15yrs design period
TORBA	0.9	1.14
SANMA	3.2	1.56*
PENAMA	1.9	1.33
MALAMPA	1.6	1.27
SHEFA	4.4	1.56*
TAFEA	1.4	1.23

(SOURCE: National Census 2009);
* Figures for SHEFA and SANMA are high because of urban drift to the respective rural centers. The growth factor over 15 years has been adjusted to 3% annual growth.

Where projects target individual household systems (e.g. RWC projects on islands without any alternative water source) the current population is to be used, as installing facilities for households that are not there yet, is not advisable.

Population figures should be based on *average* and *realistic* situations:

- Outpatient numbers shall not be based on figures at times of a disease outbreak;
- Community figures shall not include the number of people coming back merely for the holidays, but may include some additional numbers for those returning to the village now that a water system is in place;
- Schools may expand but care must be taken with accepting (wishful) figures from school staff.

Verification should be sought from the relevant department. It is up to the discretion of the engineer what figures to use.

3.4.3 Flow measurement

Flow measurements shall:

- Always be carried out at the source. Even for rehabilitation or extension of existing projects, flow measurements are only taken at the source to avoid inaccurate data caused by leaks, blockages etc.;
- Be done a minimum of 3 times to ensure statistical relevance;
- Be carried out by a skilled person to ensure accuracy of the measurements;
- Be done using either of the following methods:
    - Collection of water in a receptacle of <u>known</u> volume (e.g.: bucket);
    - Water level increase over time in the intake box where the dimension of the intake box are know;
    - Use of a weir in small streams.
- Be taken (again) during the second half or at the end of the dry season if the flow is very small and may not meet the minimum water demand;
- Allow for the flow to stabilize for at least 5 minutes where the source has been disturbed in order to capture its flow;

3.4.4 Safe yield

Safe yield shall:

- Be used to allow for variances in a source's flow throughout the seasons;
- Be 80% of the measured flow where:
    - most, if not all of the water was captured during measurement;
    - little or no decrease in flow is reported by the local villagers;
    - no significantly adverse land use is present near the source or in the catchment area (logging, gardens, etc.);

- Be less than 80% of the measured flow, the precise value at the discrepancy of the surveyor, where flow is reported to reduce during the dry season;

- Be 0% of the measured flow where logging activities are in the immediate surroundings of the source. Effectively this prohibits the source from being used, as the source will be seriously affected both in terms of quality as quantity in the near future;

- Allow for residual flow to continue its natural course where possible. Where the yield is critically low to meet the demand, damming and using the entire flow away from its natural cause may be done after consultation with the community;

3.4.5 Design flow

The design flow is used to allow for peak hour demand, which usually occurs at the first few hours in the morning and at a few hours at the end of the afternoon/early evening.

Two common methods used in Vanuatu of calculating peak hour demand are:

1. 70% method: using the assumption of 70% of all the taps being open at the same time during the peak hours. This assumption requires fixed flow rates at the taps/showers (and these water points must be throttled using valves to achieve this);

2. MHD method: Maximum Hourly Demand, which is the Average Daily Demand (ADD, the total demand over 24 hours) multiplied by a factor. This does not require throttling of taps, as a determined flow enters a village, regardless of the number of water points.

Experience indicates that both methods are very similar in results (e.g. pipe sizes) for flows up to 3 l/s. For larger flows, the MHD reduces overall mainline pipe sizes and therefore the cost of the system.

However, the reliance on throttling the taps with the 70% method allows for greater risk of tampering with flow rates at taps. Also, increasing the number of tap stands in a project (as the population growths) requires careful setting and adjusting the flow rate of the newly installed taps.

Design flow shall:

1. Be calculated using the MHD method;

2. MHD = 3 x ADD;

3. Minimum flow in a branch line should not be less than 0.1 l/s to avoid too small velocities (in the case of a branch line going to a very small group of houses (1 or 2 taps @ 20 l/c flow rate could be considered at 0.02 l/sec.));

3.4.6 Storage tanks

Storage tanks shall:

- Be used where the safe yield is lower than the peak hour flow (MHD),
- Be used where it is clearly more economical to include a storage tank (thus allowing for a smaller feeding line to the tank);
- Be as limited in numbers as possible, taking into account hydraulics and management issues;
- Have their volume calculated as follows:

Period	% total daily demand used
2 hours	30%
8 hours	40%
2 hours	30%

The shortage between supply and demand represents the required storage volume.

3.4.7 Residual head

Residual head shall:

- Never exceed 50m water head at tap stands;

- Never exceed 90m water head anywhere in the system;

- Never be below 5m water head at shower stands; where the available pressure is below 5m water head, showers may not be constructed.

- Where below 2m water head, prevent tap stands from being used. Instead small storage tanks fitted with taps must be used;

3.4.8 Software

The use of software for pipe size calculations must be done with extreme caution. The software must incorporate friction loss figures relevant to the available pipes in Vanuatu or must be verified with manual calculation using relevant friction loss table or charts.

Any designs and calculations done using software must be presented in the design report in such a manner that manual verification is possible.

4. RURAL WATER SUPPLY

STANDARD 2: WATER SUPPLY QUANTITY & QUALITY

Sufficient water is easily accessible and available at all times for drinking, food preparation, personal hygiene, cleaning and laundry, and is safe for the purpose intended.

4.1 Indicators

4.1.1 Water Quality

The Vanuatu National Drinking Water Quality Standards (NDWQS) reflect best practice in drinking water quality processes required to ensure safe water consistent with the World Health Organization's (WHO) *Guidelines for Drinking Water Quality*.

Driven by a recognition of the need for different approaches in managing urban and rural supply systems, the NDWQS deals separately with treated urban and untreated rural water supply systems. For untreated rural water supply systems, the NDWQS contains standards that relate to water catchment protection, drinking water safety plans, biological / chemical water quality standards and monitoring requirements.

4.1.2 Water Quantity

To ensure that sufficient water is available to all users, the following basic water quantities are to be supplied:

Table 3: Water Demand Quantities

Category	Quantity	Description
Community	5 l/p/d	Minimum for rainwater harvesting projects. Due to the very high (relative) costs for RWC projects, minimum water demand is set at 5 l/p/d. Concurrent to WHO standard for minimum drinking quantity.
	20 l/p/d	Absolute minimum for piped water supplies. If a source cannot provide this minimum, it should be supplemented with rainwater storage.
	50 l/p/d	WHO minimum for rural communities. Can still be used if 100 l/p/d cannot be supplied by the source.
	100 l/p/d	**The standard for rural communities.**
Health facility	50 l/bed/d	When rainwater is the only water source available;
	100 l/bed/d	For combined rainwater and other water sources (where the other source is not able to provide 250 l/bed/d;
	250 l/bed/d	For large enough water sources used in a piped water system;
	10 l/patient	Out-patients
School	5 l/p/d	For schools with pit toilets
	30 l/p/d	For schools with pour-flush toilets (using a bucket)
	55 l/p/d	For schools with flush toilets
Boarding school	50 l/p/d	Boarding school with pit toilets
	85 l/p/d	Boarding school with pour flush toilets (50+35 for flushing)
	130 l/p/d	Boarding school with showers and flush toilets

4.1.3 Access

To ensure easy access to water points, the following applies:

- Service a preferred maximum of 20 users per public tap stand;
- Be at a preferred maximum distance of 100m of the users, but no more than 200m;
- Water points are at suitable height for the users to encourage them to use water as often as required.

4.2 Guidance notes

Definition:
Water supply is defined here as any facility that provides a source of water. The various types of water supply in rural Vanuatu are[3]:

- *Direct Gravity Fed (DGF)*: a facility where an uphill source is dammed or tapped into and the water is

[3] *Desalination as a solution to water shortages in certain areas, particularly those relying on rainwater or groundwater, is not used or recommended. The high cost (initial investment and energy requirement) and maintenance requirement is deemed unobtainable in rural Vanuatu at this time. Regular maintenance of water supplies is already often lacking.*

transported using gravity to the users; the preferred option in most cases.

- *Indirect Gravity Fed (IGF):* a facility where a pump is used to pump water to an overhead storage tank from which the water gravity feeds to the users; the least preferred option.

- *Hand pumps (HP):* a facility where water is manually pumped up from a borehole, a hand-dug well, an underground storage tank or other. Most hand pumps in Vanuatu are used on boreholes;

- *Rainwater harvesting (RWC):* a facility where rainwater is collected and stored in a tank. In Vanuatu, only roofs are used as catchment areas.

Most water supplies are gravity fed systems (50%). These systems use public tap stands - household connections are seldom found. Rainwater harvesting is the second most common water supply; hand pumps the least common.

IGF systems are not very common in Vanuatu, as the funds and skills required for operation and maintenance (O&M) are often beyond the capacity of a community. Pumped water supplies are recommended only for public institutions (schools, hospitals etc.), which usually have personnel and funds available for maintenance.

Direct Gravity Fed systems are therefore the preferred supply type, being cost effective, relatively easy to maintain, and providing the highest level of service (as expressed in liters supplied per person per day). Table 3 compares the various systems:

Table 4: System comparison

	Avg. cost/system	Avg. # of users	Avg. cost per user	Avg. cost/liter supplied
DGF	5,737,062	543	10,566	211
IGF	12,696,981	1540	8,225	165
RWC	3,911,052	376	10,402	2,080
HP	4,183,000	450	9,296	186

Accurate data on coverage are not available. The below table are estimates of current coverage, based on old records, census data and other sources:

Table 5: Coverage rural water supplies

	% households with supply	Total # HHs provided	Estimate % of infrastructure requiring repair
Household connection	0	0	0
Tap stand	50	17,444	30
RWC	24	8,373	13
HP	5	1,744	14
Total	**79**	**27,561**	**57**

Water demand

With the new strategy, the water demand design standard for villagers has been increased from 50 l/p/d to 100 l/p/d. This allows for increased domestic use, as well as water use for small-scale commercial activities (e.g.: guesthouses).

With this edition of the standards manual, new categories are introduced as well: health facilities and schools. Though they were included in water supply projects before, separate minimum design standards were not available (the previous design standard of 50 l/p/d was used across the board).

The design standard of 100l/p/d must be used at all time except where a water source cannot deliver the required quantity. In that case, the WHO standard of 50 l/p/d may still be applied.

The amount of 20 l/p/d represents the minimum quantity of water at which people experience a minimum level of comfort with regards to water availability (based on empirical findings around the world. This standard should only be used when water availability is severely restricted.

Health facilities with inpatients require a considerable amount of water. Showers and flush toilets are often present to allow optimal patient hygiene and comfort.

Schools require specific demand standards as well, as the concentration of people places high demands on the water and sanitation facilities. The demand standards vary based on the type of sanitation infrastructure present.

Climate change

Effects of climate change will be particularly noticed in changes in the water cycle. Increasingly unpredictable rainfall will lead to less predictable water flows and recharge, and more droughts and floods.

As with sanitation, the potential resilience of water supply technologies can be classified as high, medium or low. Highly resilient technologies should function under most expected climate change conditions, medium resilient under a significant number of climate conditions, and low under a restricted number of conditions.

The most common type used in Vanuatu, piped water supplies, are inherently highly vulnerable to climate change effects due to its size and complexity. Piped supplies are exposed to multiple threats, starting at the source, through treatment systems (if applied) and the distribution network. The network may cross many different environments with significant hazards, and may have numerous joint vulnerable to leakages. Proper design, construction, leakage detection, and choice of materials contribute to the reduction of the vulnerability.

Protected springs (with the exception of artesian springs) have a low-medium resilience to climate change effects, as they cannot be relocated and have limited adaptability in design. Water quality may be adversely affected by increased rainfall, or flow may be reduced in drying environments.

Boreholes are highly resilient to most climate change impacts but are less resilient to saline intrusion from rising sea levels. Drying environment may make boreholes less viable (deepening is not always possible or economically viable), especially where motorized pumping is used.

Hand-dug wells are highly vulnerable to reducing quantity of water and contamination following rainfall (ingress of water along the upper parts of the lining). Securing year-round supply is in many cases already problematic.

Rainwater harvesting rarely provide enough water throughout the year already and increased but less frequent rain or reduced rainfall makes the technology very vulnerable. Often systems are difficult to relocate and have limited adaptability in design.

Boreholes then are the only technology with high resilience to climate change effects. However, they are not universally applicable in Vanuatu and are relatively expensive to construct. Motorized pumping is usually outside the management capacity of the recipient community, leaving hand pumps as the more appropriate solution. Hand pump programs in Vanuatu have seen only limited success.

To mitigate the effects of climate change, it is recommended to provide a backup water supply next to the primary one. For example, another spring may be protected for use when the primary spring fails. Communal rainwater harvesting may be added to for example a piped water supply or hand-dug well project.

As Vanuatu continues to prepare for climate change, the above approach should be applied in those areas identified as highly prone to climate related hazards.

4.2 General design parameters

4.3 Piped water supply system components

4.3.1 Intake

The intake structure shall:

- Have the intake pipe secured in reinforced concrete, reinforced concrete blocks, stones, masonry or rock piles;
- Be suitably covered where possible (e.g. at a spring), either with concrete or roofing iron; when a concrete cover is used, suitable access and ventilation must be provided for;
- Use galvanized iron pipes and fittings;
- Be fitted with a control/gate valve;
- Have screened inlet piping;
- Be fitted with a washout placed at floor level, not smaller than 80mm diameter, and of suitable length to avoid erosion near the intake;
- Include provisions to prevent access to the intake structure by animals (fencing of minimum 5m around the source);
- Include surface runoff diversion where possible;
- Include flood prevention measures where possible;
- The outlet pipe a minimum of 15cm above the floor of the intake structure;
- Where possible, have the inlet pipe 3 pipe diameters below the water surface;
- Have the crest of the dam, or the overflow, below the height of the natural water level to avoid backflow;
- Provide for sufficient overflow capacity.
- Include a sedimentation and/or filtration facility for water sources with high sediment loads;

4.3.2 Pipes

All pipes shall:

- Be made of high density polyethylene (HDPE), where pipes can be buried;
- be for HDPE pipes of AS/NZS 4130-1997 or SDR 17 or equivalent ISO standard;
- be for GI pipes of AS 1074-1989, AS/NZS 4792-2006 or equivalent ISO standard;
- Be buried at least 300mm from the top of the pipe where possible, in trenches devoid of sharp objects, stones or large quantities of organic material. The trench should allow sufficient space on either side of the pipe;
- Be made of galvanized iron (GI) where pipes cannot be buried underground, are used for tank inlets, outlets or intake box fittings, or are placed on the side or in a river/creek/ stream bed;
- *Not* be made of polyvinyl chloride (uPVC), with exceptions of uPVC pipes used for tap stand

supports, Downpipes, intake washouts and tank overflows;

- Include washout valves at low points in the pipeline, protected by a cover;

- Consider the potential of air trapped inside;

- High-pressure fittings must be used at all times, of the same quality standards as the pipes. A union shall be used for every three lengths of GI pipe or less, before t-offs, valves or other types of fittings or where the pipeline changes direction. Universal couplings or Gibault joints may also be used.

- Include a GI union for every GI pipe joint where the water source contains a lot of lime stone. GI pipes should be designed one size larger to allow for possible lime stone growth inside the pipe;

- Have all major branch lines fitted with an isolation valve;

- Include gate valves on tap branch lines if excessive pressure is an issue;

- Incorporate valves of AS 2638.1-2002 or ISO 9001-2000 standard.

4.3.3 Water holding receptacles

All water holding receptacles shall:

- Be made of plastic, fiber-glass, metal (with or without liner), reinforced masonry, or ferro-cement; the latter being the preferred option[4];

- Have a strong and secure cover with a manhole to allow access (this does not always apply to prefab tanks however);

- Be of functional and water tight design;

- Include a system to extract the water without contaminating it;

- have appropriate connections for inlet and outlet fittings;

- Have all openings vermin proof;

- use GI fittings for the inlet and outlet;

- Have float valves for all tanks in a gravity fed system;

- Be fitted with an overflow of sufficient size (not possible for many prefabricated tanks however), 2x the size of the inlet, allowing excess water to drain away from the immediate tank surroundings (>3m); PVC pipes may be used for the overflow;

- Be placed on a reinforced concrete base slab of sufficient thickness, on a tank stand or other sufficient measure to prevent roots from damaging the tank;

- Incorporate the effects of seismic activity into the design, construction, placement and/or anchoring where applicable

- *Not* have any fittings protruding through the base slab;

Tanks may be constructed above or underground according to user preference.

4.3.4 Tap stands

(Public) tap stands shall:

- Be constructed at locations accessible to all community members;

- Service a maximum of 20 people per public tap stand;

- Incorporate a reinforced slab of sufficient size;

- Be sited in consultation with the users;

- Include appropriate drainage facilities to prevent mosquitoes from breeding In the vicinity of the tap stand; where water is drained away from the water point, the length of the drainage channel is at least 3m and has a minimum slope of 5%;

- Be fitted with a high-pressure ball valve tap to ensure durability;

- Be constructed using GI pipes of sufficient diameter (3/4” minimum) to withstand daily use, and include concrete or masonry support of the stand pipe;

4.3.5 Suspended & road crossings

Suspended crossings shall:

- Be made of GI pipes with the poly pipes running through, if the crossing is less than 12m wide (i.e. 2 lengths of GI pipe);

- Be of sufficient height to allow for high water levels, debris, and traffic to pass safely underneath;

[4] *Ferro-cement tanks are relatively the cheapest, durable and easy to repair but require good skills to properly construct. Plastic and fiberglass are relatively expensive but are easy to install. Fiberglass tanks can be fairly easily repaired, plastic tanks not really. Metal tanks are expensive, require medium amount of skills to install, and are prone to rusting.*

- Use a suspended steel cable of sufficient thickness under which the pipe line is hanging;
- Include sufficient anchoring on either end of the creek;

Road crossings shall:

- Be made of GI pipes, connected with sockets, with the pipe line running through, or utilize existing culverts which do not carry too much load or get blocked by the water pipe;
- Be buried at a minimum of 1 meter depth;
- Extend past the trafficable area on either edge of the road to avoid damage from traffic running off the road;

4.3.6 Pump house

A pump house shall:

- Have a reinforced concrete base slab of sufficient thickness and with a very smooth upper surface to avoid accumulation of spilled fuels;
- Be weather tight;
- Not be prone to flooding;
- Include locks on all access ways;
- Be of sufficient size to allow both pump and fuel/oil to be placed inside, the fuel separated from the pump by a concrete or masonry wall;
- Be sufficiently ventilated to prevent hazardous gas built-up in the pump house;
- Include measures to prevent fuel, oil and/or other hazardous liquids from spilling into the environment, the size equivalent to the volume of fuel used;
- Be located away from any water source, to prevent accidental spillage polluting the source;
- Be of sufficient internal size to allow easy O&M of the pump (enough space around the pump);
- Be constructed at an easily accessible location to allow safe transport of fuel/oil etc. to the site;
- Site selection should include a risk assessment and basic EIA, including noise pollution;

4.3.7 Sedimentation tanks

Sedimentation tanks shall:

- Be constructed for all stream sources and spring water sources which are visibly dirty or cloudy;
- Have a length to width ratio of at least 4;
- Have a minimum depth of 75cm;
- Have a minimum retention time of 20 minutes for systems with storage tanks;
- Have a minimum retention time of 60 minutes for systems without a storage tank;
- Have a maximum water velocity through the tank of 0,5 cm/s;
- Have an inlet fitted halfway the depth of the water, regulated with a valve, and distribute the flow as evenly as possible (perforated pipe or baffle to stop turbulence);
- Have an outlet designed to collect the surface layer of the water only (e.g.: by using a collection gutter);
- Be fitted with a washout (minimum 50mm);

4.4 Hand-dug wells and boreholes

Hand-dug wells and boreholes shall:

- Not be constructed or used for human consumption if within a radius of 30m of a waste site, sanitation facility or graveyard;
- Where used for human consumption, have the water tested for salinity, turbidity and biological contamination;
- Be fitted with adequate measures to drain excess water at least 3m away from the well/borehole, with the drainage channel having a minimum slope of 5%;
- Be raised 600mm or more above the surrounding ground to avoid surface runoff entering the well;
- Be fitted with a lid to avoid contamination;
- Have a minimum diameter of 600mm (hand-dug wells) to allow access;
- Use uPVC or metal casing (boreholes);
- Use durable, non-corrodible well lining for hand-dug wells; where concrete liners are stacked, they must be sealed

- Use, if any, Village Level Operation and Maintenance (VLOM) type hand pumps[5];

- Cater for no more than 50 people per facility;

- Be within 200m distance from any household using the facility;

- Be fitted with adequate measures to prevent pollution of the aquifer through surface infiltration along the side of the (borehole) casing (using a clay/concrete plug or seal);

- Where fitted with a hand pump, have the area fenced off and a simple roofing structure constructed (this may use bush material);

- For communal facilities, be constructed at locations accessible to all community members;

4.5 Rainwater Harvesting

Standards derived from the National Building Code (NBC) are indicated as such.

Rainwater harvesting facilities shall:

- Be of sufficient size to cater for a regular dry season, based on the minimum water demand of 5 l/p/d;

- For communal facilities, be constructed at locations accessible to all community members;

- Include a soak-away to prevent stagnant open water;

- Include a screened inlet & overflow pipe to prevent mosquitoes from entering the storage tank;

- Include a first flush (or *foul* flush) fixture;

- Include a system to extract the water without contaminating it (tap or pump);

- Include sufficiently sized roof drainage fixtures to withstand peak rainfall intensities: 5-year return intensity for temporary structures, 20-year return intensity for permanent structures (*NBC*);

- Include a 25mm freeboard for eaves gutters and 35mm freeboard for internal box gutters to prevent overflow into buildings (*NBC*);

- A fall of 1 in 50 for eaves gutters (*NBC*);

- Have a maximum bracket spacing of 500mm;

- Include downpipes of sufficient size: 50% of the cross-section of the gutter, or 650mm^2/10m^2 roof area for eaves gutters and 930mm^2/10m^2 roof area for internal box gutters (*NBC*);

- Include roof catchments constructed to withstand cyclones and earthquakes;

- Include roofing made of durable and efficient materials;

- Exclude roofing containing toxic materials (such as asbestos, lead-based paint etc.);

- Have a minimum of 600mm spacing under the tap for buckets;

- Include measure to prevent animals reaching the faucet;

- Have the tanks situated to minimize Downpipe length;

- Have no parts of the Downpipe buried or include fittings with sharp angles;

- Have the water extraction point near the tank and no more than 2 taps per tank.

Storage requirement for individual households can be calculated using the data in APPENDIX 1: VANUATU RAINFALL DATA.

To easily assess the storage requirement for communal tanks, Vanuatu has been divided in 2 categories, dry and wet. Using 5 l/p/d, a single 5000 gallon F/C tank with 50m^2 roof surface area[6] can cater for a maximum of 40 people in 'wet' areas. In 'dry' areas it can cater for a maximum of 20 people. Refer to APPENDIX 2: DRY AND WET AREAS IN VANUATU.

Some areas in Vanuatu rely mainly on rainwater harvesting (for example Aniwa). It is recommended that for such areas, rainwater facilities cater for households rather than communities. Planning for a 15 year design period may be difficult as it is impractical to construct tanks where there are no households yet. The design period standard may in this case be suspended.

[5] *Durable, sustainable, and appropriate hand pumps which can be maintained by village members requiring little special skills or equipment.*

[6] *DoWR's standard RWC unit.*

4.6 Other

4.6.1 Concrete

Concrete is one of the main construction materials in water supply and sanitation. Vanuatu experiences frequent earth tremors and occasionally strong earthquakes, which consequently places a high demand on the quality and design of concrete works.

Appropriate concrete reinforcement in particular is essential. Correct mixtures and procedures can be found in most text books.

Concrete structures shall:

- Use Portland cement;
- Use steel reinforcement;
- Not use any other reinforcement material (fiber, pre-mixed reinforced cement, rope, twines, nylon, wood or other);
- For floor slabs, have a total steel surface area of at least 0.225% of the total cross-sectional area;
- For roof slabs, have a total steel surface area of at least 0.3% of the total cross-sectional area;
- For beams, load-bearing walls and load-bearing suspended slabs, have a total steel surface area of at least 0.5% of the total cross-sectional area;
- Use the following mixtures:

Type of sand	Dry mix	Water proof mix
Black sand	1½:2:4	2½:3:6
White sand	1:2:4	2:3:6

- Ensure proper curing practices;

APPENDICES

APPENDIX 1: VANUATU RAINFALL DATA

Table 6: Sola (Banks) monthly rainfall data (35yrs)

Month	Monthly rainfall (mm)
Jan	394.7
Feb	332.1
March	397.1
April	457.3
May	381
June	334.2
July	248.9
August	243.6
Sept	240.7
Oct	322.7
Nov	392.5
Dec	369.8

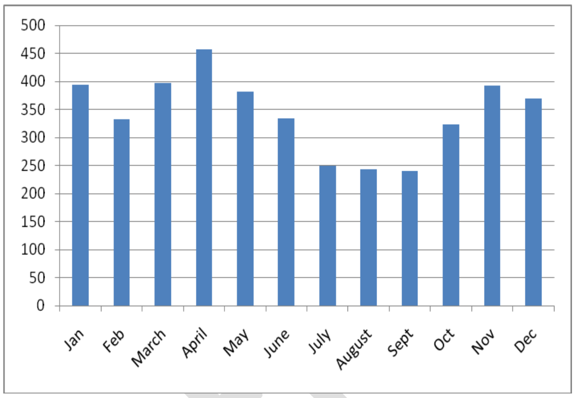


Figure 1: Sola rainfall data

Table 7: Pekoa (Santo) rainfall data (32yrs)

Month	Monthly rainfall (mm)
Jan	297.8
Feb	306.9
March	266.3
April	271.3
May	186.6
June	197.7
July	108.5
August	106.9
Sept	103
Oct	156.9
Nov	191.8
Dec	205.1

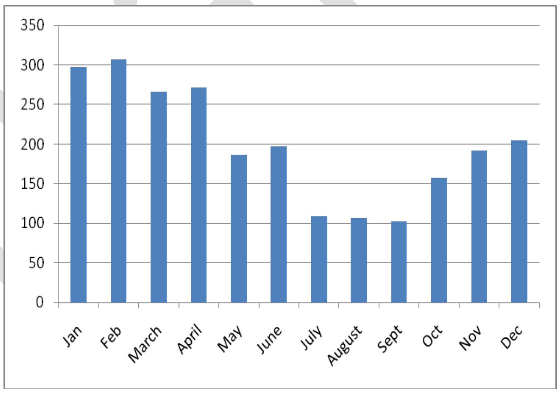


Figure 2: Pekoa (Santo) rainfall data

Table 8: Lamap (Malekula) rainfall data (47yrs)

Month	Monthly rainfall (mm)
Jan	253.8
Feb	245.8
March	277.4
April	219.2
May	160.2
June	141.7
July	118.1
August	83.7
Sept	86.5
Oct	142.2
Nov	129.5
Dec	144

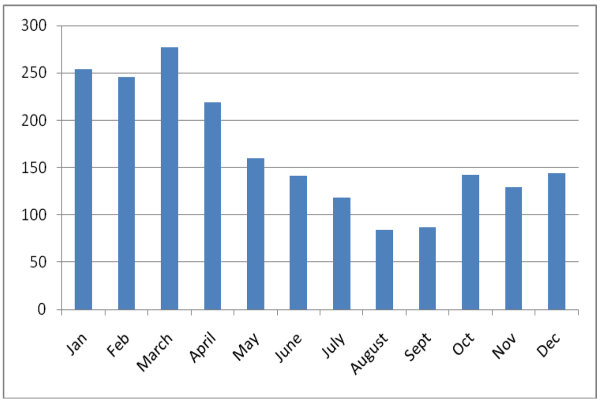


Figure 3: Lamap (Malekula) rainfall data

Table 9: Bauerfeld (Efate) monthly rainfall (36 yrs average)

Month	Monthly rainfall (mm)
Jan	291.3
Feb	324.5
March	320.7
April	231.7
May	185.4
June	182
July	82.8
August	84.7
Sept	88.3
Oct	113.1
Nov	148
Dec	169.6

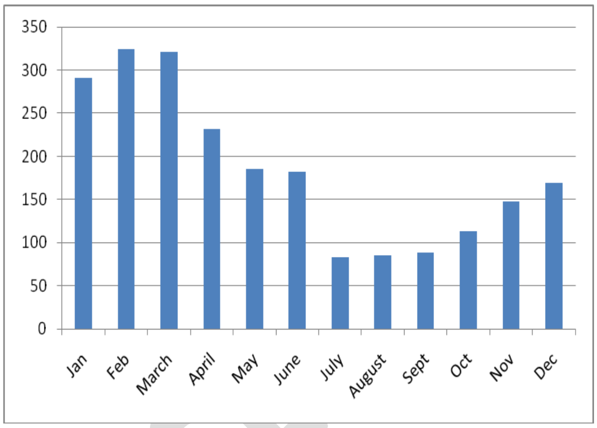


Figure 4: Bauerfeld (Efate) monthly rainfall

Table 10: Burtonfield (Tanna) monthly rainfall data (30 yrs average)

Month	Monthly rainfall (mm)
Jan	176.2
Feb	213.1
March	220.7
April	100.2
May	81.1
June	96.5
July	60.5
August	53.1
Sept	63.4
Oct	52.1
Nov	71.3
Dec	89.5

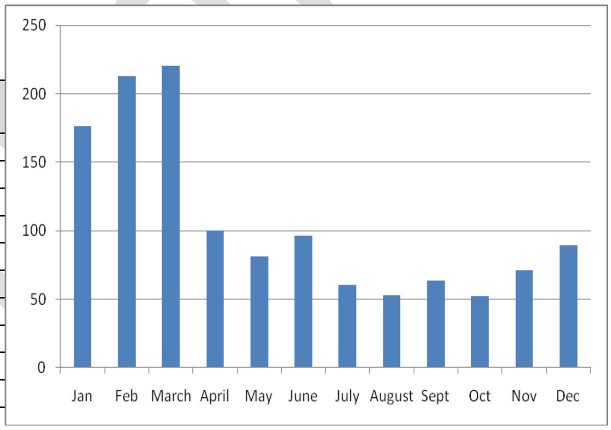


Figure 5: Burtonfield (Tanna) monthly rainfall data

Table 11: Aneitium monthly rainfall data (30yrs)

Month	Monthly rainfall (mm)
Jan	284.7
Feb	310.8
March	380.8
April	219.3
May	167.7
June	173.5
July	124.7
August	108.8
Sept	111.4
Oct	108.1
Nov	134.8
Dec	188

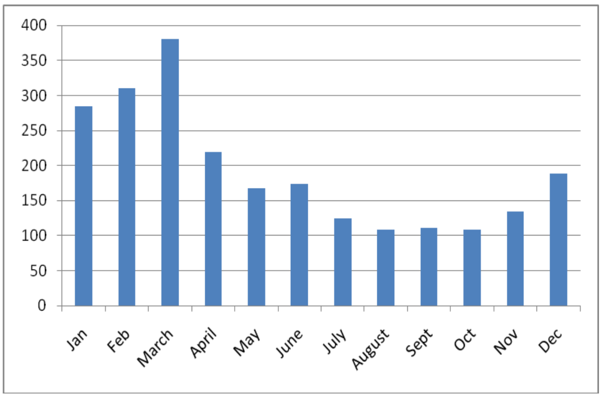


Figure 6: Aneitium monthly rainfall

APPENDIX 2: DRY AND WET AREAS IN VANUATU

To easily assess the storage requirement for communal tanks, Vanuatu has been divided in 2 categories: dry and wet. Using 5 l/p/d, a single 5000 gallon F/C tank with 50m² roof surface area can cater for a maximum of 40 people in 'wet' areas. In 'dry' areas it can cater for a maximum of 20 people. Using the maps below, target communities are in either area (when in doubt, designate them to be in a 'dry' area).

The dark areas on the maps are 'wet', the white areas on the maps are 'dry'.

TORBA PROVINCE:

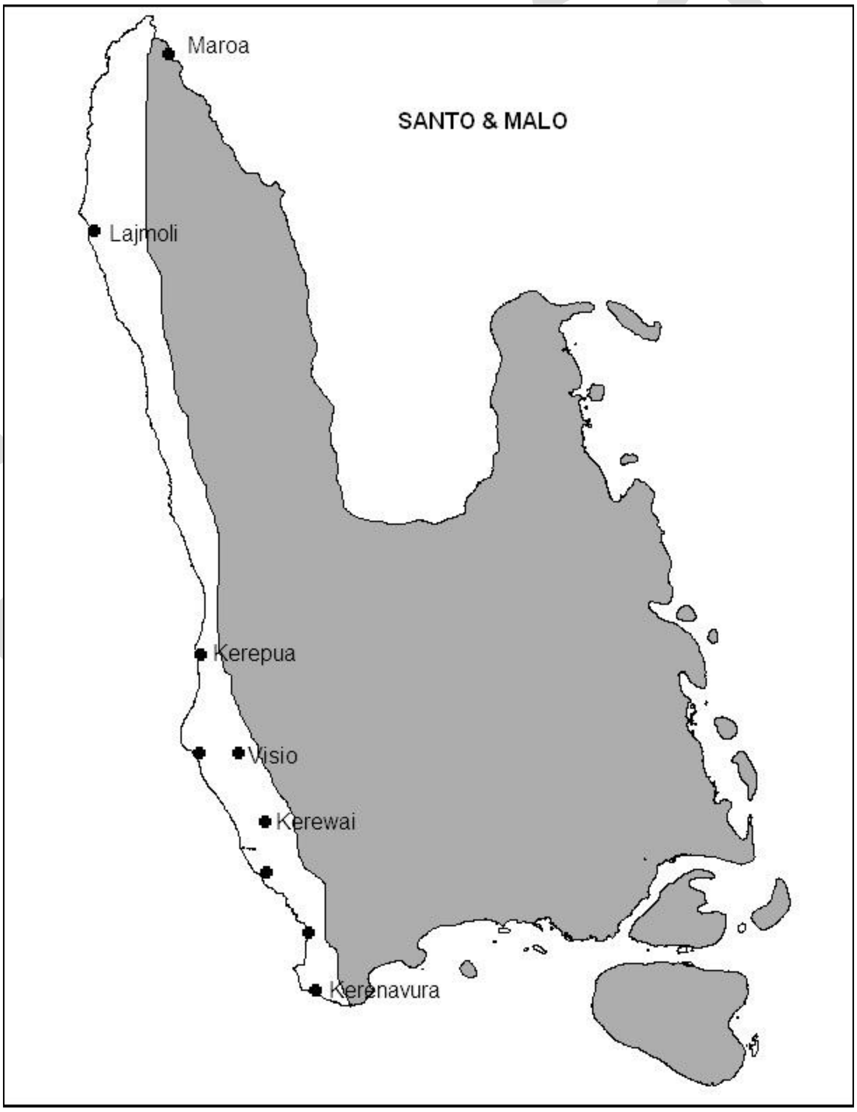
All islands of the Torres and Banks group are wet areas.

PENAMA PROVINCE:

Pentecost, Ambae and Maewo are all wet areas.

SANMA PROVINCE:

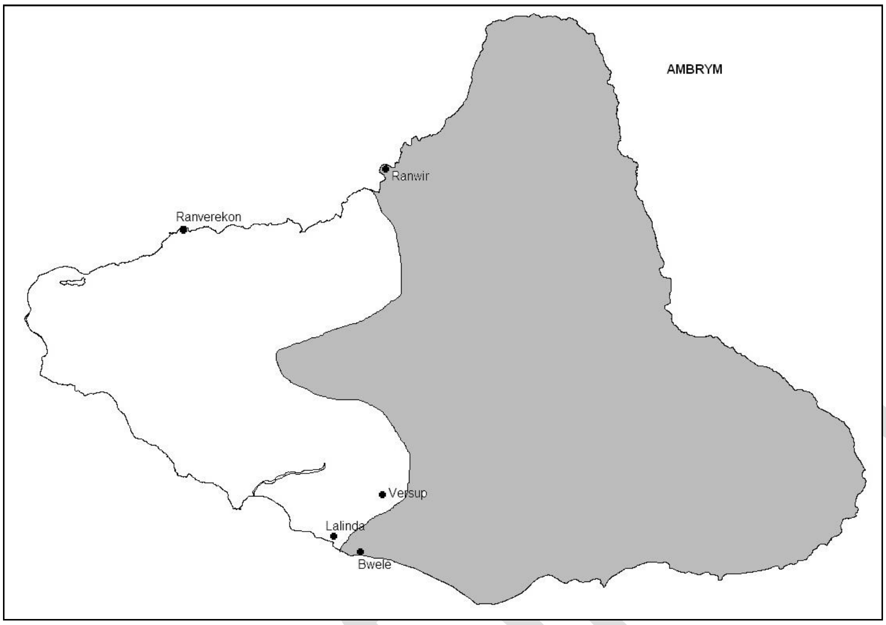
Malo Island is considered wet. The west coast of Santo is dry, the rest wet:



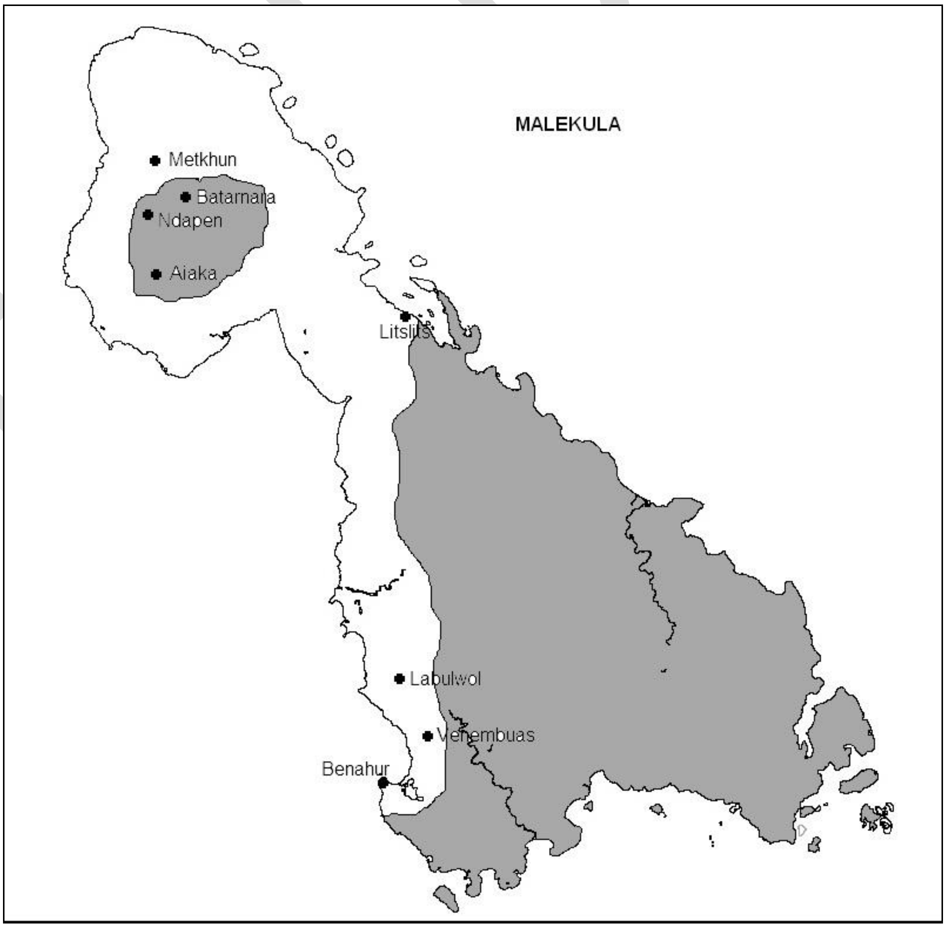
MALAMPA PROVINCE:

Paama Island is a wet area;

The western part of Ambrym is dry:



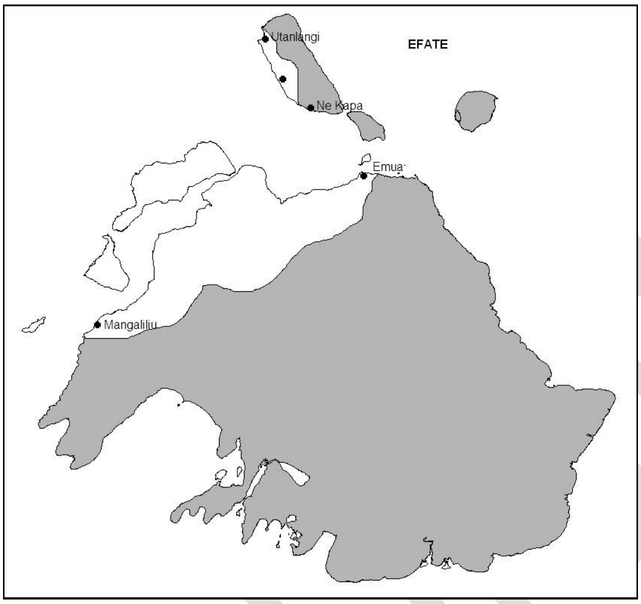
Malekula has large dry areas on the west side of the island, with a wet enclave in the north-west:



SHEFA PROVINCE:

The Sheperd Islands are “wet” areas;

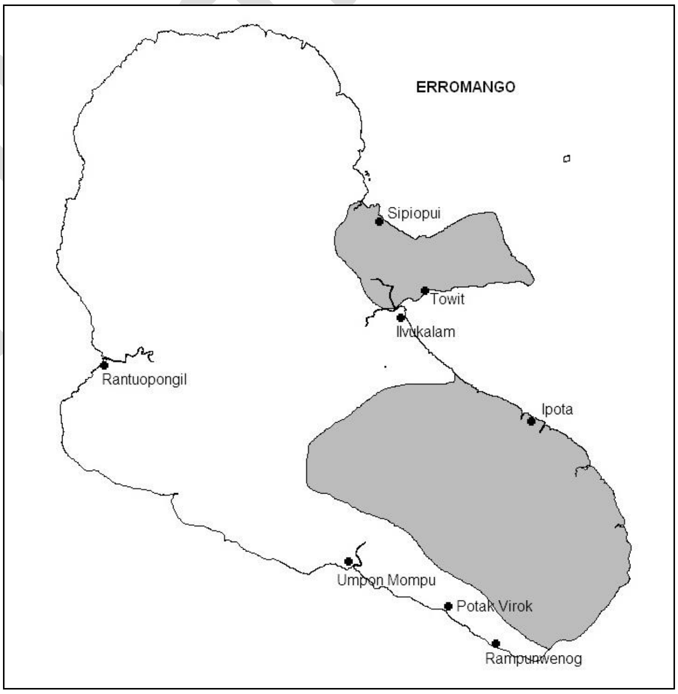
Efate has a <u>dry</u> north-west, as is the western part of Nguna Island, and the islands of Moso and Lelepa:



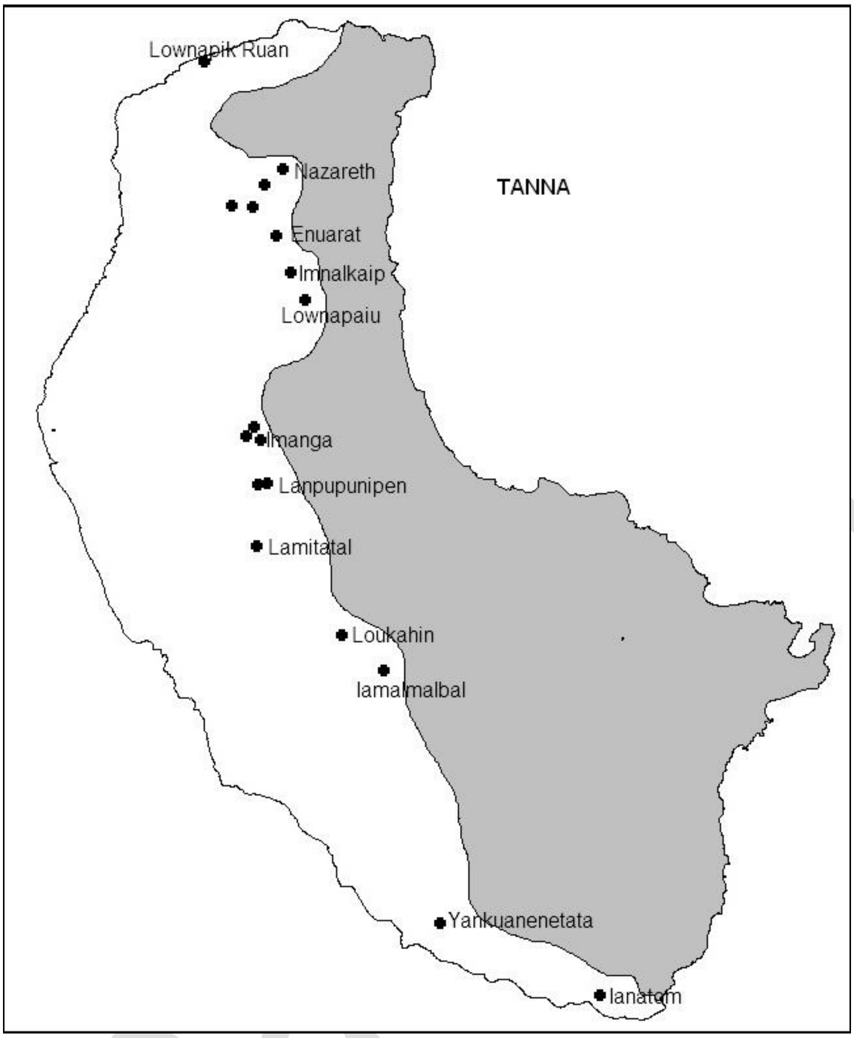
TAFEA PROVINCE:

The islands of Aniwa and Futuna are <u>wet</u>. It should be noted however that Aniwa is a small, relatively flat island with no surface water. It relies on a thin fresh groundwater layer and rainwater. *Rainwater projects should consider providing rainwater tanks at household level, rather than communal tanks.*

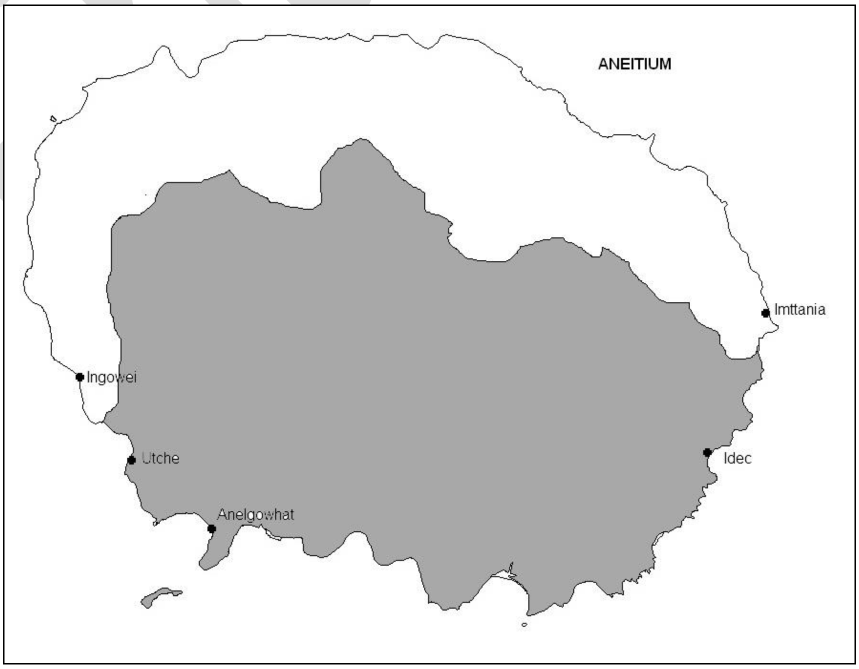
Erromango is largely <u>dry</u>, with some <u>wet</u> areas in the east and south-east:



Tanna has a dry western area:



Aneitium has a dry northern part of the island:



APPENDIX 3: TOOL SETS

The below table contains recommended minimum tool sets for different projects. A full tool set for contractors is also included.

Table 12: Tool sets

#	Tool	Supervisor /contractor	Piped supply	Hand Pump/ pumped supply	Rainwater harvesting
1	Hand saw, 22”	1	1		1
2	Hack saw, 12” + blades	1	1	1	
3	Claw hammer, 16oz.	1	1	1	1
4	Shifting spanner (300mm)	1	1	1	1
5	Level (600mm)	1			1
6	Tape measure (3m)	1	1	1	1
7	Pipe wrench, ½”	1			
8	Pipe wrench, 1”	1			
9	Pipe wrench, 1½”	1	1		
10	Pipe wrench, 2”	1			
11	Pipe wrench, 3”	1	1		
12	Pipe wrench, 4”	1			
13	Open spanner set	1		1	
14	Screw driver, Flat head, set	1	1		
15	Screw driver, star, set	1	1		
16	Trowel	2	2	1	1
17	Wooden floater	1	1	1	1
18	Steel floater	1	1	1	1
19	Pliers, side cutter, 180mm	1	1		1
20	Pliers, end cutter, 300mm	1	1		1
21	Bolt cutter, 900mm	1	1		
22	Brush (for white wash)	1	1		1
23	Line level	1			1
24	Profile string (20m)	1			1
25	Carpenters pencil	1			1
26	Cold chisel	1	1		1
27	Combination square	1			1
28	Tin snip	1			1
29	Tool box (lockable) w/lock	1	1	1	1
30	Hex key set	1			
31	Mattock	1			
32	Reseating tool	1	1		1