

Mission Report

**Prepared for the World Health Organization and the Cook
Islands Government**

Drinking Water Laboratory Capacity Review

Cook Islands

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GLOSSARY OF TERMS & ABBREVIATIONS

AusAID	Australian Agency for International Development
MFEM	Ministry of Finance & Economic Management
MOIP	Ministry of Infrastructure & Planning
MoH	Ministry of Health
MMR	Ministry of Marine Resources
NES	National Environment Service
NGO	Non Governmental Organisations
WHO	World Health Organization
SOPAC	Secretariat of the Pacific Community
TC	Total Coliforms
FC	Faecal Coliforms
NIWA	National institute for Water and Atmosphere
NZ	New Zealand
HPO	Health Protection Officer
NO _x	Nitrate and Nitrite
SO ₄	Sulphate

PO ₄	Phosphate
ISO	International Standard Organisation
COD	Chemical Oxygen Demand
BOD	Biological Oxygen demand
EU	European Union
TSS	Total Suspended Solids
pH	Degree of acidity
DO	Dissolved Oxygen
NH ₄	Ammonia
TN	Total Nitrogen
TP	Total Phosphorous
FTE	Full time equivalent
R&M	Repair and maintenance
QA	Quality Assurance

MISSION BACKGROUND

Laboratory capacity in the Cook Islands is currently insufficient for testing and analysis of drinking water. Three government departments currently undertake drinking water sampling, Ministry of Health – MoH (Hospital laboratory), Ministry of Infrastructure & Planning – MOIP (own lab with equipment but no reagents or staff) and to a lesser extent Ministry of Marine Reserves – MMR (mainly sea water but do bore water).

Currently the hospital lab is funded by central government but the other 2 are supported by aid and donor funds, this is not sustainable. It is reported that there is little extra capacity for the hospital lab to undertake further water analysis. Data gaps are starting to appear where raw and networked water samples are not being taken and analysed. Robust surveillance data is essential for monitoring the performance of the water supply and also to enable appropriate treatment technologies to be installed as part of the overall Rarotonga water supply upgrade.

The World Health Organisation has been funded by AusAID to provide technical assistance and support to Pacific countries, including the Cook Islands to improve water testing and water safety plan capacity. As a result WHO contracted Nico Van Loon from the Cawthron Institute in Nelson New Zealand to undertake the laboratory capacity review.

Nico is an experienced lab manager with more than 25 years' experience in managing commercial and research laboratories in Europe and New Zealand, and in recent years has been providing advice to several other Pacific laboratory initiatives (Samoa, Philippines, Fiji).

MISSION OBJECTIVES

A review of the current analytical capacity is undertaken in the three laboratories. This aims to minimise duplication of analysis and equipment, and to maximise analytical capability (some samples are sent overseas for analysis). The overall objective is to ensure that lab services in the Cook Islands are sustainable and not reliant on donor and aid funding.

Description of activities carried out

A physical review of the laboratory facilities and analytical capability, including staffing (experience, availability). Consultation with an economist from MFEM will provide comments on the costs of each organisation undertaking its own analysis, and the cost of each test.

Method(s) to carry out the activity

In country review of laboratories and discussions with key staff. In country review will be undertaken with the MFEM economist.

Description of the tasks/process involved in carrying out the activity

- Liaise with overseeing agency (Ministry of Finance & Economic Management -MFEM) and work with their economist.
- Physical review of the laboratory facilities and analytical capability at Hospital lab
- Physical review of the laboratory facilities and analytical capability at MMR lab
- Physical review of the laboratory facilities and analytical capability at MOIP lab
- Discussions with key staff at those organisations and other relevant organisations as to what testing is required to be done and when
- Production of a report

ACTIVITIES

In preparation of the activities, a number of reports were reviewed:

- Report on mission aim at assisting the Department of Waterworks (now MOIP) to set up the laboratory, T. Hasan (SOPAC), A. Pande (IAS-USP), 2009
- A review of Cook Islands Water Quality Monitoring Procedures, MOIP, A. Carter, T. Weier (2013)
- Stock take and review drinking water safety planning in Cook Islands, K. Khatri, (2012).

During the 4 days on the Island of Rarotonga, the following laboratories were visited:

- Hospital Laboratory (MoH)
- 'Waterworks' laboratory (MOIP)
- Marine resources laboratory (MMR)
- Hospital Laboratory review – J. Elliot

In addition the laboratory requirements for the Ministry of Agriculture were discussed with MoA staff.

Further meetings with stakeholders included an introduction and an debriefing meeting, meetings with MFEM and the chamber of commerce.

A full list of persons met is attached (I).

KEY FINDINGS / DISCUSSION

Laboratory situation – water testing

Currently the drinking water testing performed in the Cook Islands is limited to the testing for Total and Faecal Coliforms on samples taken on a quarterly basis from the following sampling points:

- Intake (source) and where the intake reaches the ring main quarterly sampling of 12 sources – $2*4*12 = 96$ samples
- Schools each term – $4 * 18 = 72$ samples
- Public drinking water access stations quarterly – $4*5 = 20$ samples

Samples are received directly from the Outer (Southern) Islands – up to 50/yr. These samples are from hotels (Pacific resort), ring mains, private homes. Non-government samples are charged at \$45. Water samples are also tested for food outlets, as part of the yearly renewal process for their license. This is also charged out at \$45 per sample (No sampling cost).

The water testing is performed by the microbiology section of the **Hospital Laboratory**. Several of the nine technicians in the hospital laboratory can perform the test. In some instances the samples are not tested as urgent medical samples take priority.

The Hospital Laboratory operates at a standard which is sufficient for the purpose of the Laboratory (level 1 hospital laboratory) with good quality systems, well trained staff, premises and instrumentation. On an annual basis the laboratory analyses ca 200 water samples for TC and FC, and ca 20,000 medical samples on which around 100,000 tests are performed.

In addition to the drinking water testing, the **laboratory of the Ministry of Marine Resources** also tests water samples, taken from streams before they enter the lagoon, as well as from the lagoons (ca 550 per year). These samples are taken as part of projects related to the lagoon water quality (Tourism, Pearl Industry) and are tested for a range of parameters (see table 1).

The laboratory performs some basic chemical and microbiological tests, and sub-contracts the more complex nutrient testing to NIWA, NZ. The MMR laboratory is small, but sufficiently equipped to perform these basic tests. Currently there are 2 experienced staff who spend approximately 80% of their time with lab related work. In addition there are two other staff who can provide support if required.

The laboratory operates a very basic quality system. Recently equipment has been purchased (Spectroquant) in order to be able to perform the nutrient tests in-house. Training for this has been organised as well (Tahiti).

MMR has contracted an experienced laboratory Manager for one year to further develop the capability and systems, starting early/mid 2014). MMR staff indicated that the lab manager was funded is through donor funds and therefore not likely to be sustained in the future.

The **laboratory at MOIP** ('Waterworks' laboratory) has not been operating for ca 2-3 years as no funding was available to appoint laboratory technicians. When it was operational, it was performing water tests on samples taken from the drinking water system (operational monitoring). The laboratory had been set up to perform basic microbiological (TC and FC) and chemical tests, including a SpectroQuant (also see table 1). At this stage there is only one MOIP employee who has the knowledge on how to perform these test.

Sampling related to the water testing is performed by two agencies: the HPO from MoH collect the samples that are tested by the Hospital Laboratory; the National Environmental Service staff collect samples for the MMR laboratory.

Testing requirements – Drinking water

From the Australian Drinking Water Standard:

Monitoring of drinking water quality should be regarded as the final check that, overall, the barriers

and preventive measures implemented to protect public health are working effectively. The purpose of drinking water quality monitoring is different from that of operational monitoring and the two types of monitoring also differ in what, where and how often water quality characteristics are measured. As it is neither physically nor economically feasible to test for all drinking water quality parameters equally, monitoring effort and resources should be carefully planned and directed at significant or key characteristics.

Key characteristics related to health include:

- *microbial indicator organisms;*
- *disinfectant residuals and any disinfection by-products;*
- *any health-related characteristic that can be reasonably expected to exceed the guideline value, even if occasionally;*
- *potential contaminants identified in analysis of the water supply system and hazard identification .*

In addition to characteristics related to health, those with significant aesthetic impact (e.g. taste, odour) may also need to be monitored. Where these frequently reach unacceptable levels, further investigation may be needed to determine whether there are problems with significance for health

The Drinking Water Standards for New Zealand and the WHO Guidelines for Drinking Water Quality Management also promote this approach.

For Rarotonga, based on test results from MMR on stream water, key parameters for drinking water quality (of interest to the MoH) would be mainly microbial indicator organisms, as the health related nutrient levels (NO_x, SO₄) seem to be quite low (stream data from MMR report). Other health related parameters like heavy metals, in particular lead (from lead pipes), and organic residues (eg herbicides, pesticides) could be sampled for on a less regular basis and sub-contracted to overseas ISO accredited laboratories, to confirm these are not an issue for Rarotonga.

Key parameters for operational monitoring for the existing system (course filtration and sedimentation), of interest to MOIP, would be microbial and total suspended solids. Should a new treatment system be installed (Te Matu Vai), some additional tests depending on the treatment selected could be required. It is likely these tests would in principle be able to be performed in Rarotonga (basic chemical tests eg Chlorine, EColi, Turbidity, pH, potential treatment reagents).

Testing requirements – Other

MOIP has indicated that future testing around wastewater treatment, as well as monitoring of septic tanks would be desirable. Typical tests involved with this are microbial indicators, Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD) and heavy metal content. These tests would be able to be performed in a basic laboratory in Rarotonga.

A couple of stakeholders have indicated an interest in food testing

- **MMR** for mercury and histamine in fish to enable export to the EU,
- **the hospital lab** for microbial testing of food products.

While the Histamine test using a Neogen test-kit would be able to be performed relative easily, without major investment in the existing MMR laboratory, the testing for mercury would be expensive to set up,

and require a relatively high skill base to maintain. It should be noted that the capability to perform the tests required for EU export is only a very small part of what is required for a country to obtain approval to export food products to the EU.

Basic food microbiological testing could be performed in Rarotonga, however the testing for pathogens would require more investment in both space, instrumentation and people.

MMR would benefit from the capability to perform marine phytoplankton analysis related to potential toxic blooms of micro-algae in the lagoons. This testing, while relatively easy to set up, requires significant training, but could easily be performed in Rarotonga (in-source when required).

The **Ministry of Agriculture laboratory** utilises a small area as laboratory for entomology as well as sample preparation for sending overseas for further animal disease identification testing. They are interested in a more dedicated laboratory space, including the use of sterilisation equipment (autoclave).

Summary of testing capacity and capability

In table 1 the current testing (capacity and capability) are summarized, as well as potential future testing:

			Tests					People capability					
			MMR		MOIP		MoH	MMR		Dorothy (back up / management)	Ngege (Back up)	MOIP	Hospital
			monthly	yearly	monthly	yearly	yearly	Teina	Tuaine			Adrian	George
Current testing	Physical	TSS	46	552	0	0	0	X				X	
		pH	46	552	0	0	0	X	X	X	X	X	
		DO	46	552	0	0	0	X		X	X	X	
		Salinity	46	552	0	0	0	X		X	X	X	
		Turbidity	0	0	0	0	0	X		X	X	X	
		Chlorophyl in vivo	12	144	0	0	0	X		X	X		
	Micro	Cholophyl extract	12	144	0	0	0	X		X	X		
		Enterococci	46	552	0	0	0		X	X	X		X
		FC	0	0	0	0	200		X	X	X	X	X
		TC	0	0	0	0	200		X	X	X	X	X
Subcontracted	Nutrients	Vibrio	6	72	0	0	0		X	X	X		X
		NO3	46	552	0	0	0					X	
		NH4	46	552	0	0	0					X	
		PO4	46	552	0	0	0					X	
		SO4	46	552	0	0	0					X	
		TN	46	552	0	0	0					X	
		TP	46	552	0	0	0					X	
Short term	Micro	Ecoli	0	0	0	0	0		X	X	X		X
		Metals											
		Aluminium	0	0	0	0	0					X	
		Iron	0	0	0	0	0					X	
		Lead	0	0	0	0	0					X	
	Other	Hardness	0	0	0	0	0					X	
		Phytoplankton	0	0	0	0	0		X?				
		Chlorine	0	0	0	0	0					X	
Wastewater	COD	0	0	0	0	0					?		
	BOD	0	0	0	0	0					?		
Long term	Food	entomology	0	0	0	0	0						
		Mercury	0	0	0	0	0						
		histamine (neogen kit)	0	0	0	0	0						
FTE							0.8	0.8	0.25	0.25	0	0.1	

Table 1: Laboratory capacity and capability, current and potential new tests. Tests in Red are subcontracted to NIWA (nutrients).

Costs to each agency to undertake tests

Due to the complex structure of the various agencies, including the funding streams, it proved extremely difficult to accurately assess the cost of the existing testing services.

It should be noted that there was (internal) charging for sampling services by NES and the MoH.

Hospital laboratory – the laboratory charges non-government customers \$45 for a TC/FC test. While the laboratory staff commented this was very low, and actual costs were much higher, the price of this test charged by commercial laboratories in NZ is around the \$30. With 200 samples analysed per year, the costs to the hospital laboratory would be in the region of \$9,000 or more.

MOIP – this laboratory is not operational so no cost estimation could be done. Should this be made operational, the cost structure would be similar to that of the MMR laboratory (see next).

MMR laboratory – MMR employs 1.8 FTE as technicians with an estimated 0.3 FTE as supervision. In the table below the total cost based on labour cost using industry benchmark data is estimated.

Cost estimate MMR laboratory		
Labour	2.2 FTE* \$35000	\$94,500
Consumables	40% of labour	\$37,800
various, R&M, QA	10% of labour	\$9,450
Total		\$141,750
Number of test done by MMR		3120
Cost per test		\$45
Cost of sub-contracting (Nutrients)		\$95,000
number tests done by NIWA		3312
Cost per test		\$29

Table 2: Estimates annual cost MMR laboratory

Note 1: The cost per tests is an average estimate, as there will be significant difference between the costs of different tests.

Note 2: MMR is currently developing the capacity to test for nutrients in-house. It is estimated this will add at least 0.5 FTE to the laboratory staff, bringing the total cost to \$141k.

Gaps in testing /analysis and options to improve sustainability

Laboratory services required in the Cooks can be summarised as follows:

- Hospital-supporting medical testing
- Drinking water quality related testing
- Drinking water production (operational) related testing
- Lagoon / marine water monitoring related testing

And in the future:

- Te Mato Vai related testing – drinking water treatment monitoring
- Wastewater (treatment) monitoring related testing
- Basic food safety related testing
- Additional lagoon / marine water monitoring related testing.

With the exception of the medical testing, all these services could be provided from one laboratory, for both microbiological and chemical tests. There is a strong overlap between the tests required by MOIP and MMR, and by careful planning of sampling regimes the workload of the laboratory staff could be more or less evenly divided over the year.

In addition, there are strong synergies with the medical testing in areas as Quality Management, use of sterilisation equipment, procurement and potentially staff expertise.

Opinion on central government funded lab

Considering the small testing volume of all stakeholders (with the exception of the medical testing), combined with the similarity of testing required, from a laboratory management perspective, there is a very strong case for a central laboratory.

Inclusion of some of the support functions of the hospital laboratory (laboratory management, quality management, autoclaves, procurement, potential staff cross training) would strengthen the case.

Combining the laboratories will create operational savings in the costs of:

- Laboratory management
- Quality systems management, incl. potential future audits
- procurement
- staffing levels (instead of two labs with 2.2 FTE's, a central lab would probably only need 3.2 FTE)

As most instrumentation could be shared (autoclaves, balances, spectrometers, incubators, media-prep equipment etc.), it would release potential future funding for instrumentation for either other projects, or for investing in automation within the laboratory, or adding new tests.

A larger laboratory would also generate a larger pool of capabilities, resources and potentially laboratory space, which could be used as a platform for future developments and/or collaborations with overseas (research) partners. For example, a central laboratory could provide the space and other

resources to host an experienced phytoplankton expert to support investigations into algal blooms in the lagoons.

It would also provide sufficient capacity and capability for any potential new tests, or an increase in tests, related to the Te Mato Vai project.

It is unlikely that any of the existing laboratory (except for the hospital laboratory) will have enough resources to gain ISO 17025 laboratory accreditation as the initial costs to achieve this, as well as the ongoing costs of maintaining is significant. A central laboratory, with more staff, will also be less prone to loss of expertise through staff turn-over.

A central laboratory will however need to ensure all requirements of end-users (customers) will be met – ‘the customer is king and always right...’.

The Cook Island private sector through the Chamber of commerce representative, expressed a strong desire to see a stable central laboratory through which ongoing issues with lagoon health and drinking water quality monitoring could be addressed.

RECOMMENDATIONS

1. From a laboratory management and operational perspective, it is strongly recommended to combine the existing laboratory capacity, (with exception of the actual medical testing, but including some of the support functions of the hospital laboratory).
2. A central laboratory will provide significant cost savings, through efficiencies, economies of scale and the elimination of duplication between separate laboratories.
3. It will also allow for a more resilient operation, with regard to staffing, capability development and efficient use of funding sources
4. It is recommended a business / scoping plan for this central laboratory is developed, based on accurate numbers for existing and future testing requirements. This would ideally include finalising an official Drinking Water Standard for the Cook Islands, including key health-related tests. This plan should include potential additional testing requirements for the upgraded water supply system (Te Mato Vai).
5. Depending on the outcome of the business plan should consider various options for funding: - fully government funded, fully privately run or a combination eg public private partnership.

ANNEX 1

Meeting list

The following people were met during the visit of the consultant:

Ministry of Health:

Elizabeth Iro, Secretary
Douglas Tou, hospital Lab manager
Theresa Tatuava – quality Manager
Tangata (Tata) Vaeau – Health Protection Unit Manager
Tereapi Nimerota – Health Protection Officer
Geoffrey Wuatai - Microbiologist

Ministry of Marine Resources:

Dorothy Solomona – Director of Pearl Division
Teariki Rongo – manager Climate Change programme
Teina Tuaiai – lab technician
Tuaine Turua – Lab technician

Ministry of Infrastructure and Planning

Adrian Teotahi – Water Works, ex- labmanager
Latu Kupa – Project Manager Te Mato Vai

Ministry of Agriculture

Tiria Rere – Chief Livestock Officer
Maja Poeschko – Entomologist PhD

Cook Islands Investment Corporation

Tamarii Tutungata - CEO
Anne Taoro – Property Manager

Ministry of Financial and Economic Management

Hilary Gorman – Development Programme Manager
James Webb – Economic Advisor
Richard Neves – Financial Secretary

Chamber of Commerce

Stephen Lyons