
AITUTAKI WATER QUALITY DATA REPORT

January ó December 2010



2011

Tuaine Turua

Teina Tuatai

Ngere George

Dorothy Solomona

Annual Report 2010

INSHORE AND AQUACULTURE DIVISION



MINISTRY OF MARINE RESOURCES

Government of the Cook Islands-

PO Box 85, Avarua, Rarotonga, Cook Islands.

Tel: +682 28722

Fax: +682 29721

E-mail: rar@mmr.gov.ck

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Water Quality Data Report

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Tuaine Turua
Teina Tuatai
Ngere George
Dorothy Solomona

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1. Introduction

Aitutaki is one of the islands in the Cook Islands that is developing rapidly and because of its pristine lagoon it attracts a considerable number of tourists. In January 2010, the island was hit by Cyclone Pat which destroyed agricultural and domestic dwellings. But this did not stop tourists from travelling to Aitutaki. Tourism is one of the main sources of income for the people on the island, therefore, it is vital that the health of the lagoon is monitored and action taken to protect the health of the lagoon, coral reef and the people that use it.

In 2004, the Ministry of Marine Resources started to monitor Aitutaki lagoon with 11 lagoon sampling sites. In 2005 Paradise Cove and Waste Management were added and in 2006 4 stream and 4 lagoon sites were introduced to the programme to the present day. Measurements made include temperature, dissolved oxygen, pH, salinity, nutrients, chlorophyll *a*, suspended solids and bacterial contamination to measure long term changes in water quality of the lagoons and streams.

Temperature varies seasonally and influences the occurrence and growth of aquatic plants, and animals. The solubility of dissolved oxygen (DO) is regulated by temperature however other factors also affect DO including water flow. In the water, DO is either absorbed directly from the atmosphere or is produced by algae via photosynthesis and is removed by respiration and decomposition of organic matter. The recommended minimum for DO saturation is not less than 75% saturation for oceanic waters, embayments, open coastal waters and estuaries and not less than 80% for streams (Department of Health, Clean Water Branch Hawaii 1994). Salinity varies little in most marine environments and saltwater is normally between 34ppt and 36ppt in areas away from freshwater influences (Smith 2004). Mosely *et al* (2004) in water quality guidelines developed for Pacific Countries suggest that pH should be between 8.0 and 8.4 in lagoon type environments. The Department of Health, Clean Water Branch Hawaii (1994) pH standard for open coastal waters is between 7.6 and 8.6 and can be as low as 7.0 in areas influenced by freshwater input.

Nutrients such as nitrate and phosphate which are naturally present in seawater are essential for the growth of phytoplankton and other algae which form the base of the food web. Elevated nutrients concentration can lead to an increase in algae and aquatic plants biomass which can have detrimental impacts on the coral reef health. The guidelines for nutrient concentrations for the protection of coral reef health are 14

µg/L for dissolved inorganic nitrogen (DIN), which is made up of nitrate and ammonia (NO₃-N + NH₄-N) and 2.6 µg/L for dissolved reactive phosphorus (DRP) (Bell 1992). The ANZECC guideline values for streams or lowland rivers that are a cause for concern in Australia tropical areas based on measured values are 10µg/L for nitrate (NO₃) and ammonia (NH₄), and 4µg/L for DRP (ANZECC 2000).

Chlorophyll *a* and total suspended measure phytoplankton biomass, inorganic and organic particulate material in the water respectively. Elevated concentrations of both have been shown to impact negatively on coral reef health above concentrations of 4-5 mg/L Bell (1992).

Increased inorganic and organic materials entering lagoons are often associated with increases in bacteria numbers and are disease causing organisms. Enterococci bacteria are used to indicate the potential presence of human pathogens in marine and freshwater environment. Guidelines have been developed by the World Health Organisation (WHO) for contact recreation using Enterococci numbers (Table 1). This guideline is also used for freshwater samples to evaluate the bacterial water quality of the streams as they flow directly into the lagoon and are likely to impact the bacterial water quality of the lagoon.

Table 1. WHO Standards for Bathing Water Quality.

Category	Indicator Counts	Microbiological Assessment
A.	m40 Enterococci / 100ml	Suitable for swimming
B.	41 to m200 Enterococci / 100ml	Suitable for swimming but requires surveillance
C.	201 to m500 Enterococci /100ml	Not suitable for swimming, requires assessment
D.	501 Enterococci / 100ml	Not suitable for swimming, public warnings

This report is a Data Report summarising the findings of the water quality sampling program in 2010 and supports the Water Quality Report Card. The Water Quality Report Card for Aitutaki 2011 is attached.

2. Methods

2.1 Sampling

All the water quality parameters were measured monthly for both lagoon and streams. In total, there are 15 marine sites and 4 stream sites for Aitutaki (Figure 1 and Table 2 & 3). Water samples from Aitutaki were stored in the dark on ice and the samples were air freighted to Rarotonga and processed within 9 hours of sample collection.

2.2 Aitutaki Marine and Stream Sampling Site Map

- Marine Sites
- Stream Sites

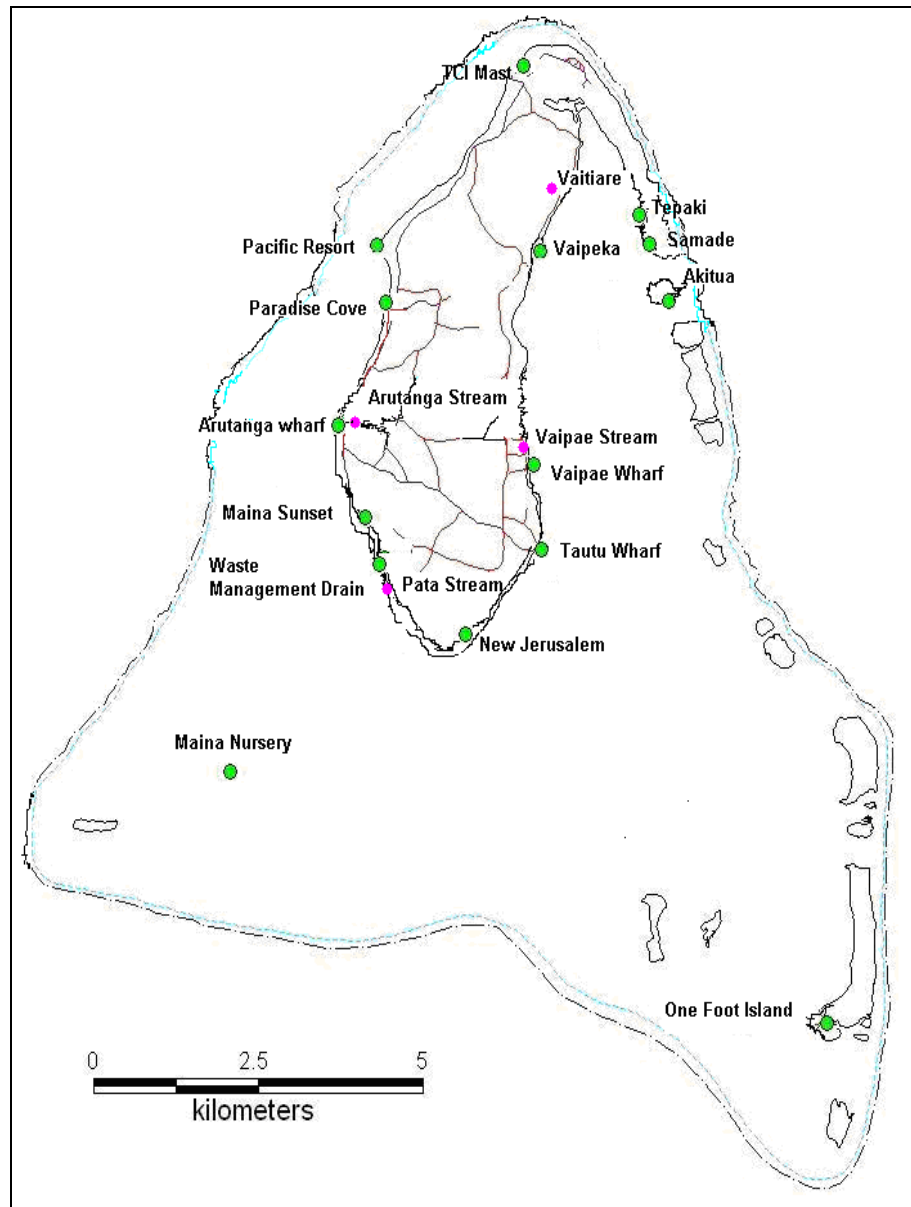


Figure 1. Aitutaki Water Quality Sampling Sites – Marine & Streams

Table 2. Aitutaki Lagoon sampling site locations.

Site Numbers	Location	Latitude	Longitude
1	Akitua	S18 51.058	W159 45.494
2	Samade	S18 50.816	W159 45.671
3	Tepaki Site	S18 50.381	W159 45.659
4	Vaipeka	S18 50.866	W159 46.431
5	Vaipae Wharf	S18 52.287	W159 46.441
6	Tautu Wharf	S18 52.925	W159 46.352
7	New Jerusalem	S18 58.607	W159 47.282
8	Waste Management	S18 53.002	W159 47.647
9	Maina Sunset	S18 52.599	W159 47.919
10	Arutanga Wharf	S18 51.825	W159 48.061
11	Pacific Resort	S18 50.806	W159 47.704
12	Paradise Cove	S18 50.174	W159 46.983
13	TCI Mast Airport	S18 49.509	W159 46.525
14	Maina Nursery	S18 54.393	W159 49.140
15	One Foot Island	S18 56.180	W159 44.178

Table 3. Aitutaki Stream sampling site locations.

Site Numbers	Location	Latitude	Longitude
1	Vaitiare	S18 50.866	W159 46.431
2	Vaipae	S18 52.268	W159 46.511
3	Pata	S18 52.908	W159 47.699
4	Arutanga	S18 51.871	W159 47.942

2.3 Physical Parameters

At each site temperature (°C), dissolved oxygen (DO), % saturation and concentration, pH, and salinity (‰) were measured using YSI 556 Probe. The individual probes were calibrated before use in the field and measurements were made at each site at the time of sampling (Hall et al., 2007). Temperature was measured using a Eutech digital thermometer at the two control sites (Maina Nursery and One Foot Island).

2.4 Nutrients

All water samples for nutrient analysis were filtered through a Whatman GF/F glass fibre filter into a 250ml acid washed plastic bottle. These samples were stored frozen until they were shipped on ice in chilly bins to NIWA for analysis. All nutrient analysis was conducted using an Astoria Pacific autoanalyser 300 series with methods from the Astoria Pacific International Methods Manual (A 6/00). NO₃-N was analysed

by the cadmium column reduction method (Astoria 305-A177), DRP by the molybdenum blue method (Astoria 305-A204) and NH₄-N by the indophenol blue method (Astoria 305-A026).

2.5 Chlorophyll *a* and Suspended Solids

Samples for chlorophyll *a* and total suspended solids analysis of known volumes were filtered on to GF/F filters and frozen immediately. The frozen filters for chlorophyll *a* were then analyzed later by acetone extraction and fluorometry (APHA 1998) in the MMR laboratory (Hall et al., 2007). Total suspended solids analysis followed Hall *et al* (2007).

2.6 Bacteria

Water samples collected for Enterococci were analysed in duplicate using Membrane Filtration method and placed on Enterococci agar. The volumes filtered differed depending on how clean the water was and on previous results. Enterococci plates were incubated at 37⁰C for 24 hours (Hall et al., 2007).

2.7 Missing Data

Lagoon

All salinity readings in the month of January at all sites were deleted because instrument calibration was not within specification. The pH readings in the months of April, June, August, October and November were also deleted because of instrument calibration not being within specification. There was no physical data recorded at Pacific Resort in January and One Foot Island in the month of July, 2009. The nitrate data for Paradise Cove was deleted due to out of range reading. There was no result for bacteria recorded at Vaiepeka in February due to missing result at one of the volume tested.

Stream

There was no water in all streams in January and in April for Vaitiare and Pata in September. All pH readings in the months of February (Arutanga), March, June and July were deleted because of instrument calibration not being within specification. There was no nutrient data for the month of May at all sites due to processing error.

3. Acknowledgments

We thank Drs Julie Hall and Els Maas for both technical advice and editorial comments, Mike Crump and his team at NIWA for their technical support, and the staff of the Ministry of Marine Resources for editorial comments. The Ministry of Marine Resources would also like to thank NZAid for all the funding support throughout the year.

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5. Appendix 1.

5.1 Water Quality data lagoon sites

Location	Site Number	Date	Temp (°C)	Salinity (ppt)	DOSat (%)	DO (mg/L)	pH	DRP (µg/L)	NH4-N (µg/L)	NO3-N (µg/L)	TSS (mg/L)	VSS (mg/L)	Enterococci (Count/100ml)
Akitua	1	25-Jan-10	26.7	36.2	90.5	5.9	8.4	3	3	4	3.5	0.5	0
Akitua	1	24-Feb-10	26.2	35.6	93.1	6.2		6	7	7	3.3	0.1	18
Akitua	1	03-Mar-10	27.0	35.0	92.5	6.1		5	5	2	2.2	2.2	5
Akitua	1	07-Apr-10	27.9	36.2	69.8	4.5	8.4	0.5	0.5	1	2.6	0.2	44
Akitua	1	13-May-10	26.7	38.9	84.7	5.5	6.9	6	8	9	2	0.4	21
Akitua	1	03-Jun-10	26.7	35.8	96.5	6.3	8.7	1	1	1	3	0.1	2
Akitua	1	13-Jul-10	26.0	36.2	108.2	7.2	9.2	4	2	2	4.2	0.9	14
Akitua	1	17-Aug-10	23.9	36.1	100.3	6.9	8.1	0.5	0.5	2	3.9	0.1	3
Akitua	1	15-Sep-10	25.3	36.2	101.0	6.8	8.1	5	2	5	1.2	1.2	2
Akitua	1	12-Oct-10	26.4	34.6	95.4	6.3	8.84	5	1	0.5	3	0.2	9
Akitua	1	09-Nov-10	27.5	34.8	95.9	6.2	8.89	2	10	3	4.5	0.0	64
Akitua	1	07-Dec-10	28.3	35.8	100.2	6.4	8.2	1	18	5	3.7	3.7	0
Samade	2	25-Jan-10	28.1	35.9	86.8	5.6	8.4	1	13	4	4.8	0.4	0
Samade	2	24-Feb-10	25.8	35.4	88.3	5.9		4	15	9	7.4	0.5	59
Samade	2	03-Mar-10	26.5	35.5	86.1	5.7		3	13	6	4.4	0.6	535
Samade	2	07-Apr-10	28.6	36.5	98.0	6.2	8.5	1	8	7	3.1	1.1	15
Samade	2	13-May-10	25.8	29.3	41.5	2.9	7.0	0.5	4	5	3.9	0.2	55
Samade	2	03-Jun-10	26.9	35.7	97.1	6.3	8.97	2	6	4	2.3	0.3	6
Samade	2	13-Jul-10	25.0	36.1	78.7	5.3	8.49	4	5	3	4.8	4.4	3
Samade	2	17-Aug-10	24.0	36.0	104.8	7.2	8.1	2	2	2	5.6	0.3	9
Samade	2	15-Sep-10	24.4	36.1	94.1	6.4	8.1	4	9	0.5	5.7	0.4	4
Samade	2	12-Oct-10	27.0	33.1	88.6	5.9	8.72	4	5	0.5	3.6	0.6	6
Samade	2	09-Nov-10	26.6	34.3	85.1	5.6	8.5	1	9	2	6	0.1	20
Samade	2	07-Dec-10	28.2	35.8	93.8	6.0	8.2	2	17	7	6.5	0.2	0
Tepaki	3	25-Jan-10	27.1	35.1	58.3	3.8	8.3	2	48	4	12.7	0.5	

Location	Site Number	Date	Temp (°C)	Salinity (ppt)	DOSat (%)	DO (mg/L)	pH	DRP (µg/L)	NH4-N (µg/L)	NO3-N (µg/L)	TSS (mg/L)	VSS (mg/L)	Enterococci (Count/100ml)
Tepaki	3	24-Feb-10	25.0	33.4	62.2	4.3		5	103	7	10.8	0.0	150
Tepaki	3	03-Mar-10	26.3	33.8	44.5	3.0		2	84	2	6.7	0.5	27
Tepaki	3	07-Apr-10	26.7	36.2	83.5	5.5	8.2	2	22	2	5.5	0.6	34
Tepaki	3	13-May-10	25.9	35.9	81.4	5.4	7.0	0.5	0.5	2	4.6	0.0	40
Tepaki	3	03-Jun-10	26.0	35.0	54.8	3.7	9.3	1	21	2	4.6	0.0	7
Tepaki	3	13-Jul-10	25.0	35.6	71.0	4.8	9.2	1	21	2	6.8	0.2	28
Tepaki	3	17-Aug-10	24.1	35.3	76.7	5.3	8.1	0.5	18	2	14.9	0.0	29
Tepaki	3	15-Sep-10	22.5	35.7	84.3	5.9	7.9	2	5	0.5	7.3	0.9	17
Tepaki	3	12-Oct-10	27.9	32.1	68.0	4.5	8.43	2	21	0.5	4.3	0.6	10
Tepaki	3	09-Nov-10	26.6	31.1	67.8	4.6	8.72	2	26	3	14.4	0.0	173
Tepaki	3	07-Dec-10	28.4	35.3	67.5	4.3	8.2	2	31	3	22	0.2	22
Vaipeka	4	25-Jan-10	26.2	36.6	97.0	6.4	8.2	0.5	19	5	6.6	1.8	17
Vaipeka	4	24-Feb-10	23.9	18.7	96.8	7.3		16	28	13	8.8	0.8	missing data
Vaipeka	4	03-Mar-10	25.8	35.8	82.5	5.5		1	0.5	4	3	1.2	5
Vaipeka	4	07-Apr-10	27.6	36.2	99.4	6.4	8.6	0.5	5	3	7.1	0.8	3
Vaipeka	4	13-May-10	27.1	39.5	94.8	6.0	7.4	3	13	6	2.4	0.1	12
Vaipeka	4	03-Jun-10	25.9	35.6	118.7	7.9	8.72	3	0.5	7	5.2	0.6	3
Vaipeka	4	13-Jul-10	24.3	36.2	113.1	7.7	8.78	3	4	3	7.9	0.4	2
Vaipeka	4	17-Aug-10	24.4	35.8	117.0	8.0	8.5	1	2	7	8.5	3.1	5
Vaipeka	4	15-Sep-10	22.4	36.6	108.3	7.6	8.0	4	0.5	14	6	0.3	120
Vaipeka	4	12-Oct-10	27.4	36.6	117.5	8.0	9.09	2	7	3	11.4	0.9	7
Vaipeka	4	09-Nov-10	24.9	15.8	94.8	7.2	8.96	2	4	3	16.2	0.5	116
Vaipeka	4	07-Dec-10	28.2	36.4	133.2	8.5	8.3	2	16	3	2.2	0.6	18
Vaipae Wharf	5	25-Jan-10	27.0	35.0	83.5	5.5	8.5	0.5	11	2	4.4	0.0	20
Vaipae Wharf	5	24-Feb-10	23.8	17.5	99.1	7.6		9	25	15	13.9	0.0	22000
Vaipae Wharf	5	03-Mar-10	26.2	35.7	99.6	6.6		0.5	7	1	7.6	0.2	16
Vaipae Wharf	5	07-Apr-10	28.0	35.9	48.8	3.1	8.5	1	13	3	3.9	0.0	0
Vaipae Wharf	5	13-May-10	24.8	31.6	91.8	6.4	7.0	0.5	9	3	5.8	0.9	7
Vaipae Wharf	5	03-Jun-10	25.9	34.7	80.1	5.4	8.69	2	1	7	6.3	0.6	24
Vaipae Wharf	5	13-Jul-10	24.4	32.9	98.3	6.8	9.6	0.5	1	1	5.9	0.0	21
Vaipae Wharf	5	17-Aug-10	23.9	35.5	95.2	6.6	8.5	2	2	0.5	6.6	0.2	8
Vaipae Wharf	5	15-Sep-10	22.8	36.4	102.4	7.2	8.1	1	0.5	1	7.9	1.8	27

Location	Site Number	Date	Temp (°C)	Salinity (ppt)	DOSat (%)	DO (mg/L)	pH	DRP (µg/L)	NH4-N (µg/L)	NO3-N (µg/L)	TSS (mg/L)	VSS (mg/L)	Enterococci (Count/100ml)
Vaipae Wharf	5	12-Oct-10	26.5	31.0	91.3	6.2	9.17	2	4	1	5.2	0.8	3
Vaipae Wharf	5	09-Nov-10	26.4	32.7	84.5	5.7	8.84	2	13	3	4.8	1.2	113
Vaipae Wharf	5	07-Dec-10	27.1	34.1	92.4	6.1	8.4	2	15	4	5.8	0.8	12
Tautu Wharf	6	25-Jan-10	27.1	36.2	86.3	5.6	8.3	1	35	3	5.7	0.1	9
Tautu Wharf	6	24-Feb-10	24.1	23.7	91.4	6.7		8	48	14	8.3	0.6	4500
Tautu Wharf	6	03-Mar-10	26.1	34.0	111.5	7.5		2	8	0.5	5	0.4	4
Tautu Wharf	6	07-Apr-10	25.8	37.4	84.3	5.6	8.4	2	23	1	8.2	3.1	32
Tautu Wharf	6	13-May-10	25.6	37.2	91.4	6.1	7.4	0.5	7	4	5.3	0.3	56
Tautu Wharf	6	03-Jun-10	25.9	35.3	102.5	6.8	9.3	3	7	10	6.3	0.9	6
Tautu Wharf	6	13-Jul-10	24.7	34.9	100.2	6.8	9.5	3	8	3	7.2	0.5	12
Tautu Wharf	6	17-Aug-10	24.4	36.0	120.3	8.2	8.5	3	0.5	4	5.3	0.6	2
Tautu Wharf	6	15-Sep-10	23.0	36.3	112.1	7.8	8.1	0.5	0.5	4	8.4	1.2	1
Tautu Wharf	6	12-Oct-10	26.7	32.3	130.3	8.7	9.17	3	6	2	4.6	0.0	6
Tautu Wharf	6	09-Nov-10	27.0	31.9	66.3	4.4	9.18	3	20	2	2.8	1.1	20
Tautu Wharf	6	07-Dec-10	27.6	34.2	89.2	5.8	8.2	2	35	4	4.6	0.0	58
New Jerusalem	7	25-Jan-10	26.6	35.5	110.3	7.3	8.6	1	5	1	4.3	0.6	0
New Jerusalem	7	24-Feb-10	25.7	34.9	77.4	5.2		35	28	5	30	0.7	11800
New Jerusalem	7	03-Mar-10	26.2	31.5	90.1	6.1		1	5	3	9.7	0.1	5
New Jerusalem	7	07-Apr-10	27.4	35.6	87.0	5.7	8.6	3	2	0.5	3.6	0.5	3
New Jerusalem	7	13-May-10	25.4	39.7	91.6	6.0	7.5	5	12	3	6.7	1.0	112
New Jerusalem	7	03-Jun-10	26.4	29.5	117.7	8.0	10.1	4	1	10	4.3	0.3	2
New Jerusalem	7	13-Jul-10	24.1	33.5	109.3	7.6	9.4	3	1	9	4.8	0.1	15
New Jerusalem	7	17-Aug-10	24.5	33.3	113.8	7.9	8.6	3	1	2	6.3	0.5	5
New Jerusalem	7	15-Sep-10	22.9	36.3	110.0	7.7	8.1	2	2	1	7.8	0.4	2
New Jerusalem	7	12-Oct-10	27.0	27.9	121.2	8.3	9.15	3	0.5	1	2.6	0.9	3
New Jerusalem	7	09-Nov-10	25.7	20.2	92.0	6.7	9.02	4	3	2	7.5	0.3	104
New Jerusalem	7	07-Dec-10	27.8	32.8	116.3	7.6	8.4	4	19	2	6.8	0.0	63
Waste Management	8	25-Jan-10	28.4	34.3	85.7	5.5	8.4	2	13	3	12.3	0.0	0
Waste Management	8	24-Feb-10	24.3	20.2	92.2	6.9		5	24	4	10	0.9	5500
Waste Management	8	03-Mar-10	26.4	34.3	102.1	6.8		2	5	4	26	0.3	9

Location	Site Number	Date	Temp (°C)	Salinity (ppt)	DOSat (%)	DO (mg/L)	pH	DRP (µg/L)	NH4-N (µg/L)	NO3-N (µg/L)	TSS (mg/L)	VSS (mg/L)	Enterococci (Count/100ml)
Waste Management	8	07-Apr-10	27.2	35.9	77.1	5.0	8.5	2	6	2	4.5	0.4	19
Waste Management	8	13-May-10	24.8	32.1	99.3	6.9	7.6	2	9	3	7.5	0.1	59
Waste Management	8	03-Jun-10	27.8	29.9	84.8	5.6	8.71	3	0.5	14	13.2	0.3	78
Waste Management	8	13-Jul-10	25.2	33.3	64.9	4.4	8.3	3	7	2	8	0.3	32
Waste Management	8	17-Aug-10	24.7	34.6	92.8	6.3	8.2	4	10	2	19.7	0.0	45
Waste Management	8	15-Sep-10	24.1	36.3	90.0	6.2	7.9	4	13	2	11.6	0.4	122
Waste Management	8	12-Oct-10	28.3	31.7	130.9	8.5	8.88	6	5	4	5	1.5	3
Waste Management	8	09-Nov-10	26.2	22.8	67.2	4.8	9.04	6	19	4	10.9	0.3	1010
Waste Management	8	07-Dec-10	29.8	30.8	85.1	5.5	8.1	4	16	3	10	0.4	23
Maina Sunset	9	25-Jan-10	27.8	35.8	60.5	3.9	8.3	2	15	2	26.4	0.3	88
Maina Sunset	9	24-Feb-10	26.2	35.4	74.1	4.9		6	42	4	9.7	2.8	82
Maina Sunset	9	03-Mar-10	26.4	33.3	109.4	7.3		0.5	33	4	7.6	0.4	10
Maina Sunset	9	07-Apr-10	26.0	32.9	95.8	6.5	8.5	0.5	32	7	13.8	0.6	13
Maina Sunset	9	13-May-10	25.6	34.6	57.3	3.9	7.5	2	11	7	4.6	0.2	43
Maina Sunset	9	03-Jun-10	27.1	35.5	74.8	4.9	10.0	3	37	9	7.2	0.5	14
Maina Sunset	9	13-Jul-10	25.3	35.9	87.8	5.9	8.2	3	8	3	8.5	0.2	8
Maina Sunset	9	17-Aug-10	24.2	36.0	75.4	5.2	8.1	3	3	1	11.2	1.3	35
Maina Sunset	9	15-Sep-10	23.3	36.6	71.0	4.9	7.9	3	6	0.5	5.6	0.5	12
Maina Sunset	9	12-Oct-10	26.9	34.5	64.5	4.2	8.9	5	10	3	7.2	0.4	21
Maina Sunset	9	09-Nov-10	27.1	32.2	74.6	5.0	8.78	3	9	3	3.8	0.8	630
Maina Sunset	9	07-Dec-10	28.6	35.6	78.6	5.0	8.2	4	21	7	6	2.0	1
Arutanga Wharf	10	25-Jan-10	28.0	36.0	68.0	4.4	8.3	1	6	2	3.6	0.3	5
Arutanga Wharf	10	24-Feb-10	25.3	33.5	89.7	6.1		6	14	7	3.8	1.2	144
Arutanga Wharf	10	03-Mar-10	27.2	30.1	91.8	6.2		2	15	8	4	0.1	17
Arutanga Wharf	10	07-Apr-10	28.2	32.9	54.5	3.5	8.3	0.5	8	6	4.7	0.3	0
Arutanga Wharf	10	13-May-10	25.8	37.3	63.7	4.2	7.8	2	7	5	3.1	0.2	13
Arutanga Wharf	10	03-Jun-10	26.7	35.7	82.2	5.4	9.9	3	5	5	3	0.4	10

Location	Site Number	Date	Temp (°C)	Salinity (ppt)	DOSat (%)	DO (mg/L)	pH	DRP (µg/L)	NH4-N (µg/L)	NO3-N (µg/L)	TSS (mg/L)	VSS (mg/L)	Enterococci (Count/100ml)	
Arutanga Wharf	10	13-Jul-10	25.3	36.0	86.8	5.8	8.4	3	4	3	4.4	0.3	31	
Arutanga Wharf	10	17-Aug-10	NO WATER COLLECTED						1	4	1	3.3	0.7	22
Arutanga Wharf	10	15-Sep-10	24.0	36.5	85.8	5.9	8.2	3	3	4	3.1	0.8	58	
Arutanga Wharf	10	12-Oct-10	26.9	34.7	99.4	6.5	8.89	3	4	3	4.5	0.4	31	
Arutanga Wharf	10	07-Dec-10	28.5	35.5	76.9	4.9	8.3	8	20	4	2.6	0.2	55	
Pacific Resort	11	25-Jan-10	27.7	36.0	93.0	6.0	8.5	4	7	6	1	1.8	4	
Pacific Resort	11	24-Feb-10	25.6	32.3	64.0	4.4		9	10	18	1.5	1.5	18	
Pacific Resort	11	03-Mar-10	27.3	32.9	72.4	4.8		4	6	13	1.2	0.2	0	
Pacific Resort	11	07-Apr-10	27.4	36.1	84.8	5.5	8.6	1	4	8	1.4	0.4	3	
Pacific Resort	11	13-May-10	25.7	39.4	69.9	4.6	7.6	3	11	13	1.2	0.0	5	
Pacific Resort	11	03-Jun-10	26.7	35.7	83.0	5.4	9.8	2	2	12	2.8	0.5	62	
Pacific Resort	11	13-Jul-10	25.9	35.9	103.4	6.9	8.5	4	7	20	1.9	6.0	0	
Pacific Resort	11	17-Aug-10	24.3	35.9	84.5	5.8	8.8	0.5	0.5	4	5.2	6.5	7	
Pacific Resort	11	15-Sep-10	24.0	36.4	106.8	7.3	8.2	3	0.5	0.5	2.4	0.8	14	
Pacific Resort	11	12-Oct-10	27.5	34.2	104.3	6.8	8.88	1	7	1	2.2	0.8	4	
Pacific Resort	11	09-Nov-10	26.6	33.4	92.1	6.1	9.05	3	12	21	1.6	0.8	17	
Pacific Resort	11	07-Dec-10	28.9	35.1	89.0	5.6	8.2	1	20	10	1.3	0.7	0	
Paradise Cove	12	25-Jan-10	27.4	35.8	66.1	4.3	8.5	5	13	6	3.3	0.9	0	
Paradise Cove	12	24-Feb-10	25.4	26.5	60.3	4.3		11	24	17	5.7	0.7	190	
Paradise Cove	12	03-Mar-10	26.8	35.1	87.8	5.8		7	11	7	3	0.1	6	
Paradise Cove	12	07-Apr-10	27.9	35.8	45.1	2.9	8.4	2	7	8	2	0.2	6	
Paradise Cove	12	13-May-10	26.9	39.6	88.8	5.7	7.7	5	22	22	2.7	0.3	8	
Paradise Cove	12	03-Jun-10	26.8	34.8	52.1	3.4	9.8	4	1	17	3.1	0.6	17	
Paradise Cove	12	13-Jul-10	25.7	35.1	79.5	5.3	9.2	5	0.5	6	2.8	0.3	2	
Paradise Cove	12	17-Aug-10	24.6	35.8	100.4	6.8	8.8	4	4	5	3.5	0.4	126	
Paradise Cove	12	15-Sep-10	24.1	35.2	74.9	5.2	8.0	2	9	9	2.2	0.5	39	
Paradise Cove	12	12-Oct-10	27.3	33.3	68.2	4.5	8.85	4	5	8	3.6	0.3	13	
Paradise Cove	12	09-Nov-10	27.2	31.7	61.6	4.1	8.8	6	10	12	3.8	0.5	162	
Paradise Cove	12	07-Dec-10	28.7	33.9	66.2	4.2	8.4	3	23	8	3	0.5	0	
TCI Mast Airport	13	25-Jan-10	26.2	36.2	89.8	5.9	8.3	4	7	4	1.8	0.2	0	
TCI Mast Airport	13	24-Feb-10	25.1	35.3	76.7	5.2		4	11	0.5	2.4	0.0	89	
TCI Mast Airport	13	03-Mar-10	27.1	34.8	78.2	5.1		5	7	4	1.7	1.4	13	

Location	Site Number	Date	Temp (°C)	Salinity (ppt)	DOSat (%)	DO (mg/L)	pH	DRP (µg/L)	NH4-N (µg/L)	NO3-N (µg/L)	TSS (mg/L)	VSS (mg/L)	Enterococci (Count/100ml)
TCI Mast Airport	13	07-Apr-10	28.1	36.2	61.4	3.9	8.5	3	6	4	2.6	0.1	2
TCI Mast Airport	13	13-May-10	26.9	36.9	66.4	4.3	7.7	2	5	5	1.6	0.1	2
TCI Mast Airport	13	03-Jun-10	25.6	35.1	59.0	4.0	9.5	5	21	11	2.5	0.2	1
TCI Mast Airport	13	13-Jul-10	25.2	36.1	85.9	5.8	8.97	3	5	3	3.5	0.8	2
TCI Mast Airport	13	17-Aug-10	24.5	35.3	85.1	5.8	8.3	2	7	2	2.4	0.3	112
TCI Mast Airport	13	15-Sep-10	24.2	36.2	95.0	6.5	7.9	4	3	0.5	1.1	1.2	1
TCI Mast Airport	13	12-Oct-10	25.5	33.9	78.8	5.3	8.5	5	15	7	1.7	0.0	0
TCI Mast Airport	13	09-Nov-10	26.1	31.8	85.9	5.8	8.79	3	11	3	0.8	1.1	3
TCI Mast Airport	13	07-Dec-10	26.5	35.4	87.5	5.8	7.8	5	25	4	1.8	0.4	5
Maina Nursery	14	25-Jan-10	27.6	36.2	77.7	5.0	8.5	1	5	3	1.1	1.1	0
Maina Nursery	14	24-Feb-10	25.8	35.6	104.5	7.0		5	7	3	1.3	0.5	990
Maina Nursery	14	03-Mar-10	26.4	35.8	92.3	6.1		7	7	13	1.1	2.8	0
Maina Nursery	14	07-Apr-10	26.4	23.9	101.7	7.2	8.6	3	3	5	0.6	3.9	0
Maina Nursery	14	13-May-10	27.0	40.7	96.8	6.1	7.8	3	5	4	0.4	7.3	7
Maina Nursery	14	03-Jun-10	23.4	36.0	88.0	6.1	10.2	6	3	16	0.6	0.3	1
Maina Nursery	14	13-Jul-10	24.9	36.4	105.3	7.1	9.3	5	2	2	0.5	14.4	0
Maina Nursery	14	17-Aug-10	Lab collected	36.1	Lab collected		8.3	4	0.5	1	0.6	3.3	8
Maina Nursery	14	15-Sep-10	24.2	36.4	100.0	6.8	8.2	4	3	0.5	0.9	1.1	0
Maina Nursery	14	12-Oct-10	24.1	35.2	94.9	6.5	6.6	4	3	4	0.6	0.6	0
Maina Nursery	14	09-Nov-10	25.9	35.3	92.5	6.2	8.92	2	4	2	0.4	0.6	26
Maina Nursery	14	07-Dec-10	26.7		100.8	8.1	8.4	4	15	3	0.4	0.5	11
One Foot Island	15	25-Jan-10	25.3	36.2	79.3	5.3	8.6	4	3	2	0.9	0.4	0
One Foot Island	15	24-Feb-10	24.9	34.3	79.6	5.4		7	8	5	0.9	0.4	18
One Foot Island	15	03-Mar-10	26.7	35.8	94.1	6.2		6	8	8	1.4	0.4	7
One Foot Island	15	07-Apr-10	23.6	36.4	85.3	5.9	8.7	3	3	2	0.5	0.7	2
One Foot Island	15	13-May-10	25.8	40.7	98.1	6.4	7.8	3	1	3	0.3	0.6	3
One Foot Island	15	03-Jun-10	23.0	35.6	77.8	5.4	10.4	8	0.5	5	0.9	0.5	0
One Foot Island	15	13-Jul-10	22.2	36.3	100.0	7.1	9.0	5	3	2	2.9	0.1	31
One Foot Island	15	17-Aug-10	Lab collected	35.9	Lab collected		8.3	5	1	2	1.5	0.7	7
One Foot Island	15	15-Sep-10	23.8	36.0	101.1	7.0	8.3	6	1	3	2.3	0.4	0
One Foot Island	15	12-Oct-10	21.8	34.8	91.9	6.6	9.1	4	6	1	1.7	0.3	3

Location	Site Number	Date	Temp (°C)	Salinity (ppt)	DOSat (%)	DO (mg/L)	pH	DRP (µg/L)	NH4-N (µg/L)	NO3-N (µg/L)	TSS (mg/L)	VSS (mg/L)	Enterococci (Count/100ml)
One Foot Island	15	09-Nov-10	25.9	34.2	93.8	6.3	8.96	2	5	7	1.6	0.5	42
One Foot Island	15	07-Dec-10	22.1	35.6	98.9	7.0	8.7	4	19	3	1.3	0.4	6

5.2 Water Quality data stream sites

Location	Site Number	Date	Temp (°C)	Salinity (ppt)	DOSat (%)	DO (mg/L)	pH	DRP (µg/L)	NH4-N (µg/L)	NO3-N (µg/L)	TSS (mg/L)	VSS (mg/L)	Enterococci (Count/100ml)
Vaitiare	1	25-Jan-2010	NO WATER	NO WATER	NO WATER	NO WATER	NO WATER	NO WATER	NO WATER	NO WATER	NO WATER	NO WATER	NO WATER
Vaitiare	1	24-Feb-2010	26.0	0.3	37.2	3.0	8.1	34	82	23	7.8	1.4	19250
Vaitiare	1	03-Mar-2010	27.2	0.2	12.6	1.0	8.6	41	104	9	7.9	4.5	1390
Vaitiare	1	07-Apr-2010	NO WATER	NO WATER	NO WATER	NO WATER	NO WATER	NO WATER	NO WATER	NO WATER	NO WATER	NO WATER	NO WATER
Vaitiare	1	13-May-2010	24.9	0.2	73.3	6.1	7.1	PROCESSING ERROR			5.6	2	500
Vaitiare	1	03-Jun-2010	25.1	0.2	7.8	0.6	7.4	89	79	5	33.1	9	100
Vaitiare	1	13-Jul-2010	24.6	0.9	17.6	1.5	9.6	48	226	2	15.4	1.7	160
Vaitiare	1	17-Aug-2010	24.0	0.3	57.7	4.9	7.4	45	143	11	9	2.6	191
Vaitiare	1	15-Sep-2010	23.6	2.4	42.7	3.6	7.2	8	328	2	17.5	5	345
Vaitiare	1	12-Oct-2010	25.7	0.2	74.9	6.1	7.0	92	8	3	5.5	1	1555
Vaitiare	1	09-Nov-2010	25.3	0.1	65.3	5.4	7.2	97	5	1	5.2	2.1	6800
Vaitiare	1	07-Dec-2010	27.9	0.2	78.6	6.2	6.8	49	33	3	6.7	0.6	620
Vaipae	2	25-Jan-2010	NO WATER	NO WATER	NO WATER	NO WATER	NO WATER	NO WATER	NO WATER	NO WATER	NO WATER	NO WATER	NO WATER
Vaipae	2	24-Feb-2010	25.9	0.0	58.0	4.7	8.2	3	24	41	10.2	1.8	6450
Vaipae	2	03-Mar-2010	27.4	0.2	70.3	5.6	8.9	0.5	11	4	8.9	2.5	1020
Vaipae	2	07-Apr-2010	27.3	0.2	79.0	6.3	6.7	1	35	95	5.2	0.9	1730
Vaipae	2	13-May-2010	26.5	0.3	73.6	5.9	6.7	PROCESSING ERROR			7.6	1.8	220
Vaipae	2	03-Jun-2010	26.7	0.2	77.7	6.2	6.4	5	18	77	3.4	0.8	245
Vaipae	2	13-Jul-2010	25.7	0.2	80.4	6.6	8.8	4	14	92	3.1	3.1	180
Vaipae	2	17-Aug-2010	25.1	0.2	90.1	7.4	7.2	1	9	64	1.8	0.2	375
Vaipae	2	15-Sep-2010	24.0	0.2	94.6	8.0	7.1	1	6	12	2.1	0.7	415
Vaipae	2	12-Oct-2010	26.7	0.2	113.1	9.0	7.3	1	4	18	2.5	0.4	465
Vaipae	2	09-Nov-2010	26.0	0.2	55.6	4.5	7.0	2	12	40	11	7.2	5850
Vaipae	2	07-Dec-2010	27.5	0.2	81.6	6.4	6.8	0.5	2	16	2.8	1.5	170
P ta	3	25-Jan-2010	NO WATER	NO WATER	NO WATER	NO WATER	NO WATER	NO WATER	NO WATER	NO WATER	NO WATER	NO WATER	NO WATER

Location	Site Number	Date	Temp (°C)	Salinity (ppt)	DOSat (%)	DO (mg/L)	pH	DRP (µg/L)	NH4-N (µg/L)	NO3-N (µg/L)	TSS (mg/L)	VSS (mg/L)	Enterococci (Count/100ml)
P ta	3	24-Feb-2010	25.4	0.3	7.5	0.6	8.7	8	20	1	2.1	1	30600
P ta	3	03-Mar-2010	26.4	0.3	2.9	0.2	9.5	4	103	4	9	3.6	1905
P ta	3	07-Apr-2010	26.9	0.2	17.0	1.4	7.0	2	35	0.5	1.5	0	2150
P ta	3	13-May-2010	24.7	0.2	32.3	2.7	7.9	PROCESSING ERROR			5.6	3.1	625
P ta	3	03-Jun-2010	24.9	0.2	6.0	0.5	7.1	7	46	1	5.7	2.2	230
P ta	3	13-Jul-2010	24.0	0.2	6.4	0.5	9.4	2	86	0.5	9.4	1.2	60
P ta	3	17-Aug-2010	22.6	0.2	3.5	0.3	7.8	1	120	3	3.5	1.5	51
P ta	3	15-Sep-2010	NO WATER	NO WATER	NO WATER	NO WATER	NO WATER	NO WATER	NO WATER	NO WATER	NO WATER	NO WATER	NO WATER
P ta	3	12-Oct-2010	24.3	0.3	12.9	1.1	7.3	0.5	129	2	21.9	8.1	170
P ta	3	09-Nov-2010	24.7	0.1	39.1	3.3	7.1	15	15	8	5.3	2.8	13250
P ta	3	07-Dec-2010	25.5	0.1	21.2	1.7	6.6	4	28	4	10	10	80
Arutanga Wharf	4	25-Jan-2010	NO WATER	NO WATER	NO WATER	NO WATER	NO WATER	NO WATER	NO WATER	NO WATER	NO WATER	NO WATER	NO WATER
Arutanga Wharf	4	24-Feb-2010	26.9	0.2	96.8	7.7	9.0	9	7	1220	2	0.2	10900
Arutanga Wharf	4	03-Mar-2010	27.2	0.2	89.7	7.1	10.0	7	6	1340	2.5	0.7	10
Arutanga Wharf	4	07-Apr-2010	27.5	0.2	85.7	6.8	7.9	8	5	817	0.3	0.3	325
Arutanga Wharf	4	13-May-2010	26.8	0.2	90.4	7.2	7.7	PROCESSING ERROR			1.1	0.3	600
Arutanga Wharf	4	03-Jun-2010	27.6	0.3	44.8	3.5	10.9	6	3	728	1.6	0.3	1125
Arutanga Wharf	4	13-Jul-2010	26.7	0.2	87.0	7.0	9.1	6	3	735	0.6	0.6	555
Arutanga Wharf	4	17-Aug-2010	26.5	0.2	98.1	7.9	7.9	7	8	751	2.3	0.2	965
Arutanga Wharf	4	15-Sep-2010	26.3	0.2	103.6	8.4	8.1	6	7	603	15	1.9	11200
Arutanga Wharf	4	12-Oct-2010	27.3	0.2	83.6	6.6	6.8	10	4	923	4.2	0.8	995
Arutanga Wharf	4	09-Nov-2010	26.1	0.2	94.8	7.7	7.8	37	3	239	89.6	12.1	31850
Arutanga Wharf	4	07-Dec-2010	27.5	0.2	87.4	6.9	7.4	5	3	521	1	0.2	5750