



## RAROTONGA WATER QUALITY REPORT OCTOBER 2025

### SUMMARY

Water samples were collected on Tuesday 7<sup>th</sup> October. Weather was fine, breezy and sunny with tides shifting from high to low during sample collection. All seventeen lagoon sites were accessible and sampled. Most lagoon sites were safe for swimming. Two out of twelve streams were flowing and sampled. Juvenile fish were observed in sampled streams. Stagnancy, no water, ebb flow and seawater influence were observed at the remaining streams, therefore could not be sampled. Enterococci bacteria, total suspended solids and dissolved oxygen results and levels are summarized in the table below.

Lagoon Site	Site ID	Enterococci (MPN/100ml)	Total Suspended Solids (mg/L)	Dissolved Oxygen (%)
Pouara Rai	RAM03	10	0.4	127
Avana Mudflats	RAM04	10	0.4	120
Paringaru	RAM05	<1	1.9	136
Tikioki Packing Shed	RAM06	<1	0.3	128
Totokoitu Station	RAM08	20	1.3	128
Papua	RAM09	10	0.3	126
Arorangi School	RAM11	10	1.3	140
Social Centre	RAM13	<1	0.3	133
Muri Buoy	RAM16	63	0.3	118
Betela Beach	RAM17	<1	0.3	135
Avatiu	RAM18	<1	2.3	142
Muri Koka	RAM19	75	2.3	123
Ngatipa	RAM20	<1	1.3	137
Matavera Outfall	RAM21	<1	2.3	127
Muri Aroko	RAM22	97	0.3	119
Tikioki	RAM23	<1	0.3	127
Papaaroa	RAM24	<1	1.3	129
Stream Site	Site ID	Enterococci (MPN/100ml)	Total Suspended Solids (mg/L)	Dissolved Oxygen (%)
Avana	RAS01	NW	NW	NW
Paringaru	RAS02	NW	NW	NW
Akapuao	RAS03	NW	NW	NW
Totokoitu	RAS04	NW	NW	NW
Betela	RAS06	1046	4.0	79
Avatiu	RAS08	NW	NW	NW
Vaiterenga	RAS10	NW	NW	NW
Areiti	RAS11	58	25.0	55
Takuvaine	RAS12	NW	NW	NW
Pouara	RAS13	NW	NW	NW
Avana Mouth	RAS14	NW	NW	NW
Papua	RAS15	NW	NW	NW



GRADING SCALE	Excellent	Very Good	Good	Poor	Very Poor	Extremely Poor
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### Lagoon:

- Most sites were safe for swimming due to very good and excellent levels with low Enterococci bacteria results at <1 MPN/100mL to 97 MPN/100mL. However, levels were poor and very poor with high results at three sites, namely Avana Mudflats (211), Paringaru (414) and Ngatipa (228). These sites were resampled and results ranged between <1 MPN/100mL and 10 MPN/100mL at excellent levels. This indicated that the areas were safe for swimming.
- Total suspended solids results were below 5.0 mg/L, ranging from 0.3 mg/L to 2.3 mg/L with very good to excellent levels at all sites indicating clearer waters and minimal threat to coral reefs.
- Dissolved oxygen levels were above the recommended threshold of 80% showing excellent levels at all sites.
- Temperature ranged from 24.4 degrees at Papua to 27 degrees at Avatiu with a mean of 25.6 degrees.
- Salinity was stable ranging from 30.7 ppt at Tikioki to 35.3 ppt at Betela Beach and Matavera Outfall with a mean of 34.6 ppt.
- pH ranged from 7.81 at Totokoitu Station to 8.11 at Matavera Outfall with a mean of 8.01.

### Stream:

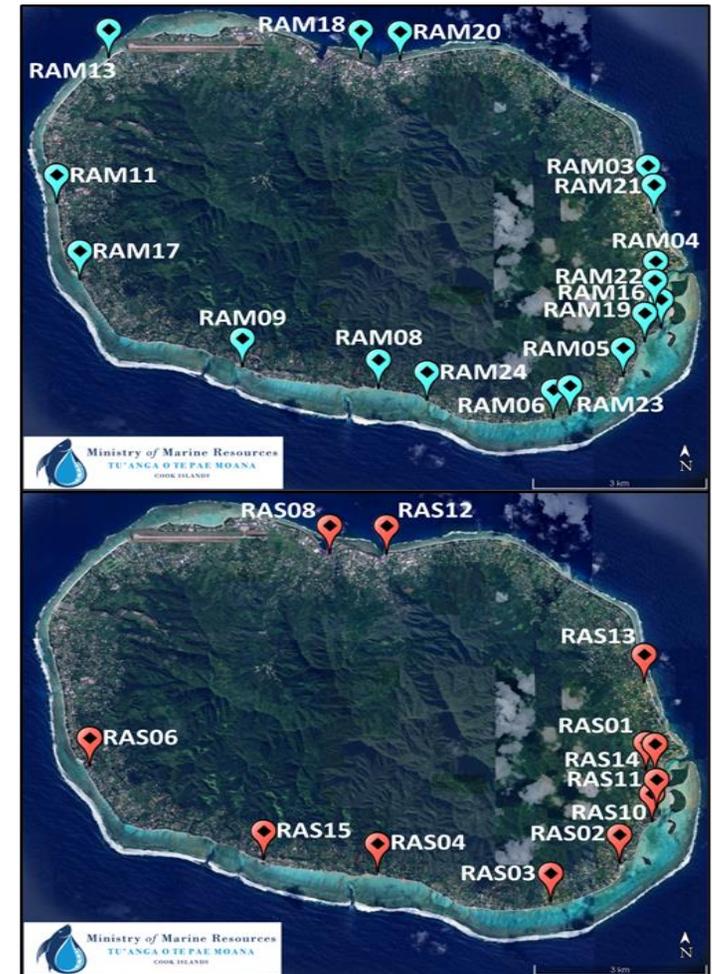
- Enterococci bacteria ranged from very good levels with 58 MPN/100mL at Areiti to extremely poor levels with 1,046 MPN/100mL at Betela.
- Levels of total suspended solids were good with 4 mg/L at Betela and extremely poor with 25 mg/L at Areiti.
- Poor and very poor levels of dissolved oxygen at 79% and 55% were recorded at Betela and Areiti, respectively.
- Temperature ranged from 23.9 degrees at Betela to 24.1 degrees at Areiti with an average of 24 degrees.
- Salinity readings were stable at Betela with 0.1 ppt and at Areiti with 0.4 ppt. Overall mean salinity was 0.3 ppt.
- pH readings ranged from 6.50 at Areiti to 6.80 at Betela with a mean of 6.65.

The monthly summary reports, rainfall data and lab study report can be found at the end of this report.

1. ENTEROCOCCI BACTERIAL COUNTS - RAROTONGA - Most Probable Number of Enterococci per 100 mL (MPN/100mL)

Lagoon Site	Site ID	May	Jun	Jul	Aug	Sep	Oct
Pouara Raui	RAM03	10	<1	<1	<1	<1	10
Avana Mudflats	RAM04	160	75	20	20	74	10
Paringaru	RAM05	10	10	75	<1	10	<1
Tikioki Packing Shed	RAM06	10	<1	134	<1	31	<1
Totokoitu Station	RAM08	<1	148	63	41	20	20
Papua	RAM09	10	10	185	<1	52	10
Arorangi School	RAM11	10	86	109	10	31	10
Social Centre	RAM13	<1	<1	<1	<1	110	<1
Muri Buoy	RAM16	10	<1	<1	<1	<1	63
Betela Beach	RAM17	<1	187	<1	10	20	<1
Avatiu	RAM18	160	<1	<1	10	<1	<1
Muri Koka	RAM19	10	20	20	10	<1	75
Ngatipa	RAM20	20	10	NO DATA	<1	NO DATA	<1
Matavera Outfall	RAM21	<1	<1		<1		<1
Muri Aroko	RAM22	20	63	NO DATA	20	NO DATA	97
Tikioki	RAM23	<1	10		<1		<1
Papaaroa	RAM24	<1	31	<1	<1	<1	<1

Stream Site	Site ID	May	Jun	Jul	Aug	Sep	Oct
Avana	RAS01	378	NW	649	NW	435	NW
Paringaru	RAS02	921	411	1203	NW	NW	NW
Akapuao	RAS03	649	NW	>2420	NW	NW	NW
Totokoitu	RAS04	NW	816	488	2420	816	NW
Betela	RAS06	980	308	1553	1986	NW	1046
Avatiu	RAS08	461	109	299	NW	NW	NW
Vaiterenga	RAS10	>2420	NW	>2420	NW	NW	NW
Areiti	RAS11	NW	28	>2420	488	328	58
Takuvaine	RAS12	NW	NW	NO DATA	NW	NO DATA	NW
Pouara	RAS13	NW	NW		NW		NW
Avana Mouth	RAS14	NW	NW	NW	NW	NW	NW
Papua	RAS15	NW	NW	NW	NW	NW	NW



GRADING SCALE			REFERENCE
Excellent	A	< 41	WHO 2021 Guidelines on Recreational Water Quality for Coastal and Fresh Waters.
Very Good	B	41 ≥ 100	
Good	C	101 ≥ 200	
Poor	D	201 ≥ 350	
Very Poor	E	351 ≥ 500	
Extremely Poor	F	> 500	

## 2. TOTAL SUSPENDED SOLIDS - RAROTONGA - Milligrams per Litre (mg/L)

Lagoon Sampling Site	Site ID	May	Jun	Jul	Aug	Sep	Oct
Pouara Raui	RAM03	3.3	0.3	1.3	2.0	2.6	0.4
Avana Mudflats	RAM04	0.5	1.5	0.6	3.0	2.0	0.4
Paringaru	RAM05	5.5	1.6	2.9	2.0	1.9	1.9
Tikioki Packing Shed	RAM06	3.0	1.6	1.3	2.0	2.2	0.3
Totokoitu Station	RAM08	5.6	4.7	33.3	4.3	16.7	1.3
Papua	RAM09	0.3	2.4	7.8	2.0	10.1	0.3
Arorangi School	RAM11	2.3	1.0	6.8	4.1	7.4	1.3
Social Centre	RAM13	1.3	3.3	1.9	2.0	3.9	0.3
Muri Buoy	RAM16	1.3	0.3	0.5	2.0	0.3	0.3
Betela Beach	RAM17	0.3	2.0	25.2	5.0	5.6	0.3
Avatiu	RAM18	5.4	1.0	17.9	3.0	0.3	2.3
Muri Koka	RAM19	2.7	1.0	0.5	4.0	1.3	2.3
Ngatipa	RAM20	2.3	1.0	NO DATA	0.3	NO DATA	1.3
Matavera Outfall	RAM21	4.3	1.0		2.0		2.3
Muri Aroko	RAM22	1.3	1.0		1.0		0.3
Tikioki	RAM23	2.3	1.0	2.0	0.3		
Papaaroa	RAM24	1.3	1.4	3.0	1.3		

Stream Sampling Site	Site ID	May	Jun	Jul	Aug	Sep	Oct
Avana	RAS01	1.0	NW	1.0	NW	0.7	NW
Paringaru	RAS02	6.7	0.3	2.7	NW	NW	NW
Akapuao	RAS03	5.0	NW	5.0	NW	NW	NW
Totokoitu	RAS04	NW	0.3	0.3	0.3	4.4	NW
Betela	RAS06	3.7	3.1	2.5	4.5	NW	4.0
Avatiu	RAS08	1.0	1.4	2.0	NW	NW	NW
Vaiterenga	RAS10	3.3	NW	4.0	NW	NW	NW
Areiti	RAS11	NW	7.3	68.8	3.8	36.7	25.0
Takuvaine	RAS12	NW	NW	NO DATA	NW	NO DATA	NW
Pouara	RAS13	NW	NW		NW		NW
Avana Mouth	RAS14	NW	NW		NW		NW
Papua	RAS15	NW	NW	NW	NW	NW	NW



GRADING SCALE			REFERENCE
Excellent	A	< 1.0	Bell 1992, total suspended solids recommended limit is ≤5mg/L for healthy coral reef.
Very Good	B	1.0 ≥ 2.5	
Good	C	2.5 ≥ 5.0	
Poor	D	5 ≥ 10	
Very Poor	E	10 ≥ 20	
Extremely Poor	F	> 20	

### 3. DISSOLVED OXYGEN - RAROTONGA - Percent (%)

Lagoon Sampling Site	Site ID	May	Jun	Jul	Aug	Sep	Oct
Pouara Raui	RAM03	125	129	137	118	181	127
Avana Mudflats	RAM04	110	114	101	115	109	120
Paringaru	RAM05	115	118	102	119	120	136
Tikioki Packing Shed	RAM06	123	126	119	130	125	128
Totokoitu Station	RAM08	127	118	119	125	122	128
Papua	RAM09	125	124	125	126	131	126
Arorangi School	RAM11	132	131	131	129	125	140
Social Centre	RAM13	130	126	124	127	127	133
Muri Buoy	RAM16	114	113	104	118	96	118
Betela Beach	RAM17	130	122	121	128	126	135
Avatiu	RAM18	116	154	134	136	165	142
Muri Koka	RAM19	118	115	101	122	113	123
Ngatipa	RAM20	119	122	NO DATA	140	NO DATA	137
Matavera Outfall	RAM21	123	131		123		127
Muri Aroko	RAM22	114	115		116		119
Tikioki	RAM23	119	131		128		127
Papaaroa	RAM24	127	123		128		129

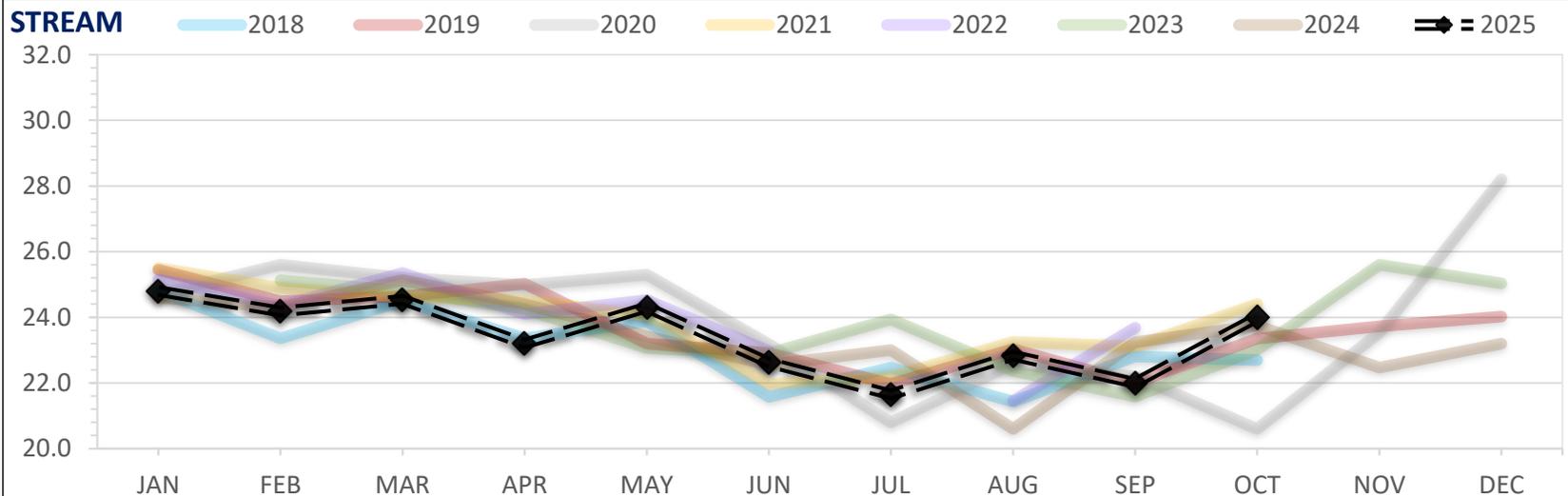
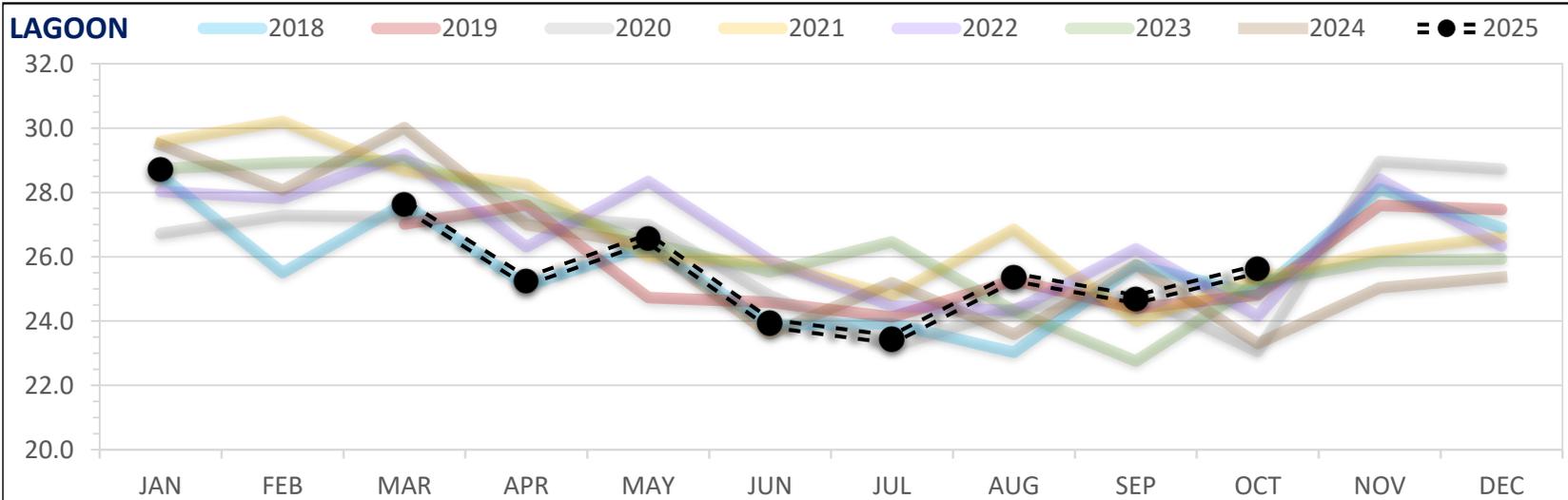
Stream Sampling Site	Site ID	May	Jun	Jul	Aug	Sep	Oct
Avana	RAS01	82	NW	95	NW	76	NW
Paringaru	RAS02	93	74	79	NW	NW	NW
Akapuao	RAS03	61	NW	61	NW	NW	NW
Totokoitu	RAS04	NW	99	95	81	ND	NW
Betela	RAS06	72	97	91	53	NW	79
Avatiu	RAS08	82	99	91	NW	NW	NW
Vaiterenga	RAS10	43	NW	62	NW	NW	NW
Areiti	RAS11	NW	75	64	49	62	55
Takuvaine	RAS12	NW	NW	NO DATA	NW	NO DATA	NW
Pouara	RAS13	NW	NW		NW		NW
Avana Mouth	RAS14	NW	NW		NW		NW
Papua	RAS15	NW	NW		NW		NW



GRADING SCALE			REFERENCE
Excellent	A	>95	Department of Health, Clean Water Branch Hawaii 1994: Dissolved oxygen recommended limit is ≥75% saturation for oceanic waters, embayments, open coastal waters & estuaries; ≥80% saturation for streams.
Very Good	B	90 ≥ 95	
Good	C	80 ≥ 90	
Poor	D	60 ≥ 80	
Very Poor	E	40 ≥ 60	
Extremely Poor	F	< 40	

#### 4. AVERAGE TEMPERATURE - RAROTONGA - Degrees Celcius (°C)

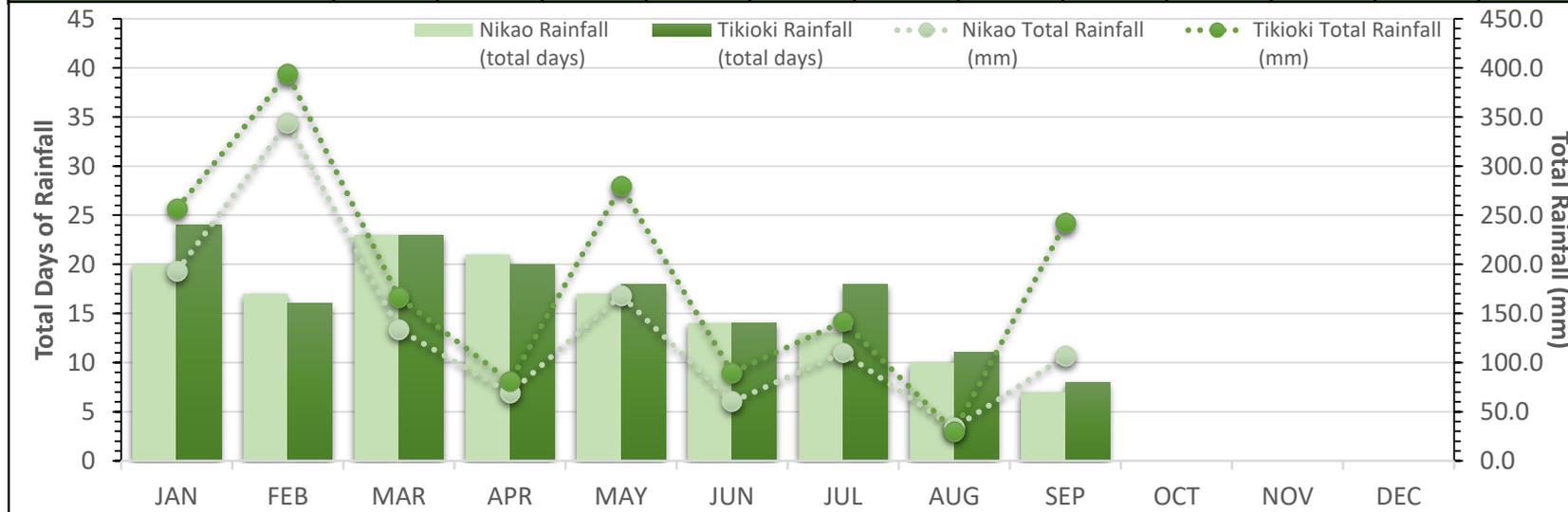
2025	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Lagoon	28.7	ND	27.6	25.2	26.6	23.9	23.4	25.4	24.7	25.6		
Stream	24.8	24.2	24.5	23.2	24.3	22.6	21.7	22.8	22.0	24.0		



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## 5. RAROTONGA RAINFALL - NIKAO & TIKIOKI - Total Rainfall (mm) & Total Days of Rainfall

Month	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
<b>Nikao Total Rainfall (mm)</b>	192.6	344.3	133.6	68.8	168.3	60.0	110.2	33.7	106.1			
<b>Nikao Rainfall (total days)</b>	20	17	23	21	17	14	13	10	7			
<b>Nikao Highest 1-Day (mm)</b>	37.4	72.5	43.0	10.6	28.5	19.1	80.6	15.2	50.6			
<b>Nikao Highest 1-Day (date)</b>	9th	13th	3rd	2nd	24th	16th	6th	7th	18th			
<b>Tikioki Total Rainfall (mm)</b>	256.6	393.6	166.4	80.8	279.2	89.8	141.8	30.2	241.8			
<b>Tikioki Rainfall (total days)</b>	24	16	23	20	18	14	18	11	8			
<b>Tikioki Highest 1-Day (mm)</b>	83.8	94.4	53.6	13.0	67.8	48.0	79.6	15.4	145.0			
<b>Tikioki Highest 1-Day (date)</b>	9th	20th	30th	6th	15th	16th	6th	6th	15th			



Report Date: 10.10.2025			RAROTONGA LAB STUDY REPORT – OCTOBER				Lab Report No.: 10L5329 – 10L5350				
SAMPLE DESCRIPTION											
Date Samples Collected:		Name of Sample:	Collected By:	Submitted By:	Time of Receipt:		Physical Description:		Quantity Per Site Received:		
Tuesday 7 <sup>th</sup> October		Marine	NES		11:45AM		Clear		2.5L		
		Stream	MMR		10:50AM		Clear and slightly turbid				
Study No.		1	2	3	4	5		6		7	
SITE ID	LAB ID	Enterococci (MPN/100ml)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (%)	Dissolved Oxygen (mg/L)		pH	Total Suspended Solids (mg/L)		
MARINE											
RAM03	10L5329	10	24.5	35.2	126.9	8.66		8.08	0.4		
RAM04	10L5330	211	25.7	34.0	119.6	8.05		8.01	0.4		
RAM05	10L5331	414	26.6	34.6	136.3	8.99		8.09	1.9		
RAM06	10L5332	<1	26.2	35.0	128.3	8.52		8.06	0.3		
RAM08	10L5333	20	25.7	35.1	128.3	8.57		7.81	1.3		
RAM09	10L5334	10	24.4	35.0	126.2	8.63		7.96	0.3		
RAM11	10L5335	10	26.4	34.8	140.0	9.27		8.04	1.3		
RAM13	10L5336	<1	26.0	34.6	133.2	8.90		8.00	0.3		
RAM16	10L5337	63	25.2	35.1	117.6	7.93		8.01	0.3		
RAM17	10L5338	<1	24.5	35.3	135.3	9.23		7.98	0.3		
RAM18	10L5339	<1	27.0	34.8	142.3	9.32		8.10	2.3		
RAM19	10L5340	75	25.9	34.6	122.5	8.19		8.04	2.3		
RAM20	10L5341	228	25.2	34.0	136.7	9.28		7.95	1.3		
RAM21	10L5342	<1	25.4	35.3	126.9	8.52		8.11	2.3		
RAM22	10L5343	97	25.5	34.2	119.3	8.04		8.00	0.3		
RAM23	10L5344	<1	25.9	30.7	126.8	8.67		7.96	0.3		
RAM24	10L5345	<1	25.4	35.1	128.8	8.66		7.97	1.3		
STREAM											
RAS06	10L5346	1046	23.9	0.1	78.5	6.61		6.80	4.0		
RAS11	10L5347	58	24.1	0.4	54.6	4.58		6.50	25.0		
Study Method		IDEXX Enterolert*	YSI Manual	YSI Manual	YSI Manual	YSI Manual		YSI Manual	MMR Lab Manual Water Quality Monitoring V5		
Recommended Limit		Ref. Comments	Ref. Comments	Ref. Comments	Ref. Comments	Ref. Comments		Ref. Comments	Ref. Comments		
Resample #	Date Sample Collected	Time of Receipt	Physical Description	Quantity Per Site Received	Marine Study Parameter	Unit	RAM04 (10L5348)	RAM05 (10L5349)	RAM20 (10L5350)	Study Method	Recommended Limit
1	09.10.2025	10AM	Clear	500mL	Enterococci	MPN/100mL	10	<1	<1	IDEXX Enterolert*	Ref. Comments

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## Abbreviation

NL: Not Listed, MPN: Most Probable Number, cfu: Colony Forming Unit, mL: milli Litre, FAU: Formazin Attenuation Unit, NTU: Nephelometric Turbidity Unit, ppt: Parts Per Thousand, DB: Designated Bathing Beach, MB: Moderate Use of Bathing, LB: Light Use of Bathing, IB: Infrequent Use of Bathing  
NA: Not Available, however data will be available at a later date; ND: No Data due to equipment failure or logistics problems or time delay or methodology problem or combination of all; NW: No Water, stream dry or water stagnant or water level too low for sample collection or water dirty/murky.

## Comments

1. Temperature<sup>#</sup>  
Subtropical regions (south of Cape Canaveral and Tampa Bay, Florida, and Hawaii).  
Short-term Max. 32.2°C, Max. True daily mean 29.4°C (average of 24-hourly temperature reading).  
Temperature is the measure of warmth and coldness, reported as an average and measured in degrees celcius (°C).
2. pH  
Changes to pH can be caused by a range of potential water quality problems (e.g., low values due to acid sulphate runoff). pH values are also related to soil geology and may be naturally low or high (in limestone areas). High pH values can also be caused temporarily when high rates of photosynthesis by aquatic plants (including algae) lead to a decrease in carbon dioxide, and therefore a decrease in carbonic acid in the water.
3. Salinity  
A measure of the amount of dissolved salts in the water, and therefore an indicator of salinity. Excess salinity in freshwater streams occurs as a result of excess soil salinity, which may be caused by excess land clearing and changes to the groundwater table. Salinity is reported as parts per thousand (ppt).
4. Dissolved Oxygen<sup>^</sup>  
DO levels indicate how much oxygen is in the water. Low DO levels indicate an abnormal disturbance in the ecosystem such as an algal bloom. DO is measured in percentage (%).  
Low DO: 3.5 mg/L at 26C leads to 100% mortality of *Acipenser oxyrhincus*  
2.7 mg/L at 19C leads to 22% mortality of *Acipenser oxyrhincus*  
<3.7 mg/L Demersal finfish biomass diminishes  
<3.5 mg/L Species richness diminishes  
Below 2 mg/L infaunal species migrate to sediment surface and epifaunal species move to better aerated water.  
Oxygen is essential for life processes of most aquatic organisms. Many aquatic organisms will suffocate if there is insufficient oxygen in the water.
5. Suspended Solids<sup>@</sup>  
Settleable and suspended solids should not reduce the depth of the compensation point for photosynthetic activity by more than 10% from the seasonably established norm for aquatic life. Total suspended solids (TSS) are non-living (inorganic) such as silt and mud; and organic matter such as animal and plant material found in the water. The presence of large amounts of particles are responsible for creating the murky appearance of dirty water and can quickly kill coral reefs. TSS is measured in milligrams per litre (mg/L).
6. Turbidity  
Water clarity (the degree of light penetration) is important as aquatic plants depend on light to photosynthesize and produce oxygen. Large amounts of sediment in a water body can also smother benthic organisms. Suspended solid results are interactive and interdependent with turbidity. Expert interpretation needed. Turbidity is measured as FAU.
7. Enterococci<sup>β</sup>  
The presence of bacteria Enterococci *sp* is monitored as an indicator of human and animal waste pollution. The higher the numbers of Enterococci bacteria present in a sample, the greater the amount of faecal pollution in the water. Bacteria count is measured in Most Probable Number of Enterococci cells per 100mL of sample (MPN/100mL).
8. Nutrients (Nitrate, Nitrite, Ammonia, Phosphate)  
High nutrient concentrations in a water body (eutrophication) may lead to excessive weed and algal growth. Excess nutrients enter a water body through several means, including discharge of treated sewage, storm water, and in run-off from land, for example as fertiliser, animal waste, or decaying plant matter.
9. Chlorophyll-a  
Chlorophyll-a is a pigment found in green plants, including aquatic plant. Measuring the amount of chlorophyll-a in the water therefore indicates the amount of green algae present in the water. High concentrations of algae (algal blooms) may harm other aquatic organisms, either through the production of toxins, reduction of available light through covering the water surface, or by using all available oxygen during respiration at night. Chlorophyll-a is measured in micrograms per litre (µg/L).
10. Rainfall  
Rarotonga: daily rainfall data is provided by the Cook Islands Meteorological Service.  
Aitutaki: daily rainfall data is recorded by MMR Staff (Aitutaki Marine Research Centre – AMRC) at Amuri and by Rowan Strickland at Vaipae.  
Rainfall is measured in millimetres (mm) and reported as an average per month, total number of days that had no rainfall and the highest amount of rainfall in 1-day.

<sup>#</sup>EPA Quality Criteria for Water Gold Book 1986

<sup>^</sup>EPA Ambient Aquatic Life Water Quality Criteria for DO (Saltwater): Cape Cod to Cape Hatteras Nov 2000

<sup>@</sup>EPA Quality Criteria for Water Red Book 1976

<sup>β</sup>WHO Guidelines on Recreational Water Quality for Coastal and Fresh Waters 2021

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