



## RAROTONGA WATER QUALITY REPORT SEPTEMBER 2025

### SUMMARY

Water samples were collected on Tuesday 2<sup>nd</sup> September. Weather was fine and sunny with tides shifting from low to high during sample collection. All twelve lagoon sites were accessible and sampled. Most lagoon sites were safe for swimming. Three out of eight streams were flowing and sampled. Juvenile fish were present in sampled streams. Stagnancy and no water were observed in the remaining streams, therefore could not be sampled. Due to a minor mechanical issue, the dissolved oxygen reading for Totokoitu stream is not available in this report. 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	<1	2.6	181
Avana Mudflats	RAM04	74	2.0	109
Paringaru	RAM05	10	1.9	120
Tikioki Packing Shed	RAM06	31	2.2	125
Totokoitu Station	RAM08	20	16.7	122
Papua	RAM09	52	10.1	131
Arorangi School	RAM11	31	7.4	125
Social Centre	RAM13	110	3.9	127
Muri Buoy	RAM16	<1	0.3	96
Betela Beach	RAM17	20	5.6	126
Avatiu	RAM18	<1	0.3	165
Muri Koka	RAM19	<1	1.3	113

Stream Site	Site ID	Enterococci (MPN/100ml)	Total Suspended Solids (mg/L)	Dissolved Oxygen (%)
Avana	RAS01	435	0.7	76
Paringaru	RAS02	NW	NW	NW
Akapuao	RAS03	NW	NW	NW
Totokoitu	RAS04	816	4.4	ND
Betela	RAS06	NW	NW	NW
Avatiu	RAS08	NW	NW	NW
Vaiterenga	RAS10	NW	NW	NW
Areiti	RAS11	328	36.7	62

GRADING SCALE	Excellent	Very Good	Good	Poor	Very Poor	Extremely Poor
	Excellent	Very Good	Good	Poor	Very Poor	Extremely Poor



### Lagoon:

- Most sites were safe for swimming due to very good and excellent levels with low Enterococci bacteria results at <1 MPN/100mL to 110 MPN/100mL. However, levels were very poor and extremely poor with high results at four sites, namely Pouara Rai, Totokoitu Station, Arorangi School and Betela Beach. These sites were resampled. Results ranged between <1 MPN/100mL and 31 MPN/100mL at excellent levels. This indicated that the areas were safe for swimming.
- Total suspended solids results were below 5.0 mg/L with good to excellent levels at most sites, except at Totokoitu Station, Papua, Arorangi School and Betela Beach that showed high results above 5.0 mg/L with poor and very poor levels.

- Dissolved oxygen levels were above the recommended threshold of 80% showing excellent levels at all sites.
- Temperature ranged from 23.2 degrees at Muri Buoy to 27.3 degrees at Avatiu with a mean of 24.7 degrees.
- Salinity was stable ranging from 32.5 ppt at Avana Mudflats to 35.6 ppt at Social Centre with a mean of 34.5 ppt.
- pH ranged from 7.93 at Muri Buoy to 8.30 at Pouara Rai with a mean of 8.06.

**Stream:**

- Enterococci bacteria ranged from poor levels with 328 MPN/100mL at Areiti to extremely poor levels with 816 MPN/100mL at Totokoitu.
- Levels of total suspended solids were good with 4.4 mg/L at Totokoitu, excellent with 0.7 mg/L at Avana and extremely poor with 36.7 mg/L at Areiti.
- Poor levels of dissolved oxygen at 76% and 62% was recorded at Avana and Areiti, respectively.
- Temperature ranged from 20.9 degrees at Totokoitu to 22.6 degrees at Areiti with an average of 22 degrees.
- Salinity readings were stable at Totokoitu with 0.1 ppt and at Areiti with 0.4 ppt. Salinity was slightly elevated at Avana with 7.5 ppt. Overall mean was 2.7 ppt.
- pH readings ranged from 6.72 at Avana to 7.21 at Areiti with a mean of 6.97.

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	Apr	May	Jun	Jul	Aug	Sep
Pouara Raui	RAM03	<1	10	<1	<1	<1	<1
Avana Mudflats	RAM04	10	160	75	20	20	74
Paringaru	RAM05	135	10	10	75	<1	10
Tikioki Packing Shed	RAM06	<1	10	<1	134	<1	31
Totokoitu Station	RAM08	30	<1	148	63	41	20
Papua	RAM09	63	10	10	185	<1	52
Arorangi School	RAM11	10	10	86	109	10	31
Social Centre	RAM13	<1	<1	<1	<1	<1	110
Muri Buoy	RAM16	10	10	<1	<1	<1	<1
Betela Beach	RAM17	74	<1	187	<1	10	20
Avatiu	RAM18	<1	160	<1	<1	10	<1
Muri Koka	RAM19	20	10	20	20	10	<1
Ngatipa	RAM20	NO DATA	20	10	NO DATA	<1	NO DATA
Matavera Outfall	RAM21		<1	<1			
Muri Aroko	RAM22		20	63			
Tikioki	RAM23		<1	10			
Papaaroa	RAM24		<1	31			

Stream Site	Site ID	Apr	May	Jun	Jul	Aug	Sep
Avana	RAS01	NW	378	NW	649	NW	435
Paringaru	RAS02	NW	921	411	1203	NW	NW
Akapuao	RAS03	NW	649	NW	>2420	NW	NW
Totokoitu	RAS04	NW	NW	816	488	2420	816
Betela	RAS06	416	980	308	1553	1986	NW
Avatiu	RAS08	NW	461	109	299	NW	NW
Vaiterenga	RAS10	NW	>2420	NW	>2420	NW	NW
Areiti	RAS11	830	NW	28	>2420	488	328
Takuvaine	RAS12	NO DATA	NW	NW	NO DATA	NW	NO DATA
Pouara	RAS13		NW	NW			
Avana Mouth	RAS14		NW	NW			
Papua	RAS15		NW	NW			



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

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

Lagoon Sampling Site	Site ID	Apr	May	Jun	Jul	Aug	Sep
Pouara Raui	RAM03	1.7	3.3	0.3	1.3	2.0	2.6
Avana Mudflats	RAM04	4.7	0.5	1.5	0.6	3.0	2.0
Paringaru	RAM05	6.8	5.5	1.6	2.9	2.0	1.9
Tikioki Packing Shed	RAM06	4.7	3.0	1.6	1.3	2.0	2.2
Totokoitu Station	RAM08	7.1	5.6	4.7	33.3	4.3	16.7
Papua	RAM09	4.7	0.3	2.4	7.8	2.0	10.1
Arorangi School	RAM11	12.6	2.3	1.0	6.8	4.1	7.4
Social Centre	RAM13	5.4	1.3	3.3	1.9	2.0	3.9
Muri Buoy	RAM16	5.2	1.3	0.3	0.5	2.0	0.3
Betela Beach	RAM17	7.0	0.3	2.0	25.2	5.0	5.6
Avatiu	RAM18	4.2	5.4	1.0	17.9	3.0	0.3
Muri Koka	RAM19	1.9	2.7	1.0	0.5	4.0	1.3
Ngatipa	RAM20	NO DATA	2.3	1.0	NO DATA	0.3	NO DATA
Matavera Outfall	RAM21		4.3	1.0		2.0	
Muri Aroko	RAM22		1.3	1.0		1.0	
Tikioki	RAM23		2.3	1.0		2.0	
Papaaroa	RAM24		1.3	1.4		3.0	

Stream Sampling Site	Site ID	Apr	May	Jun	Jul	Aug	Sep
Avana	RAS01	NW	1.0	NW	1.0	NW	0.7
Paringaru	RAS02	NW	6.7	0.3	2.7	NW	NW
Akapuao	RAS03	NW	5.0	NW	5.0	NW	NW
Totokoitu	RAS04	NW	NW	0.3	0.3	0.3	4.4
Betela	RAS06	3.7	3.7	3.1	2.5	4.5	NW
Avatiu	RAS08	NW	1.0	1.4	2.0	NW	NW
Vaiterenga	RAS10	NW	3.3	NW	4.0	NW	NW
Areiti	RAS11	30.9	NW	7.3	68.8	3.8	36.7
Takuvaine	RAS12	NO DATA	NW	NW	NO DATA	NW	NO DATA
Pouara	RAS13		NW	NW		NW	
Avana Mouth	RAS14		NW	NW		NW	
Papua	RAS15		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	Apr	May	Jun	Jul	Aug	Sep
Pouara Raui	RAM03	107	125	129	137	118	181
Avana Mudflats	RAM04	93	110	114	101	115	109
Paringaru	RAM05	100	115	118	102	119	120
Tikioki Packing Shed	RAM06	108	123	126	119	130	125
Totokoitu Station	RAM08	104	127	118	119	125	122
Papua	RAM09	109	125	124	125	126	131
Arorangi School	RAM11	116	132	131	131	129	125
Social Centre	RAM13	113	130	126	124	127	127
Muri Buoy	RAM16	90	114	113	104	118	96
Betela Beach	RAM17	108	130	122	121	128	126
Avatiu	RAM18	118	116	154	134	136	165
Muri Koka	RAM19	95	118	115	101	122	113
Ngatipa	RAM20	NO DATA	119	122	NO DATA	140	NO DATA
Matavera Outfall	RAM21		123	131			
Muri Aroko	RAM22		114	115			
Tikioki	RAM23		119	131			
Papaaroa	RAM24		127	123			

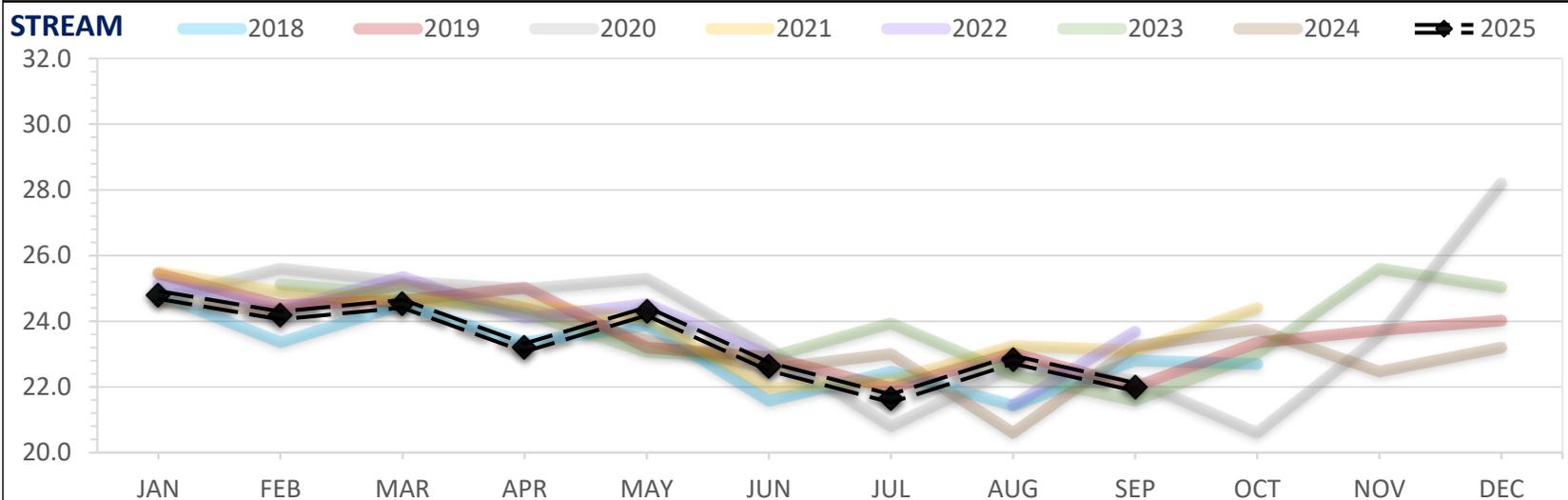
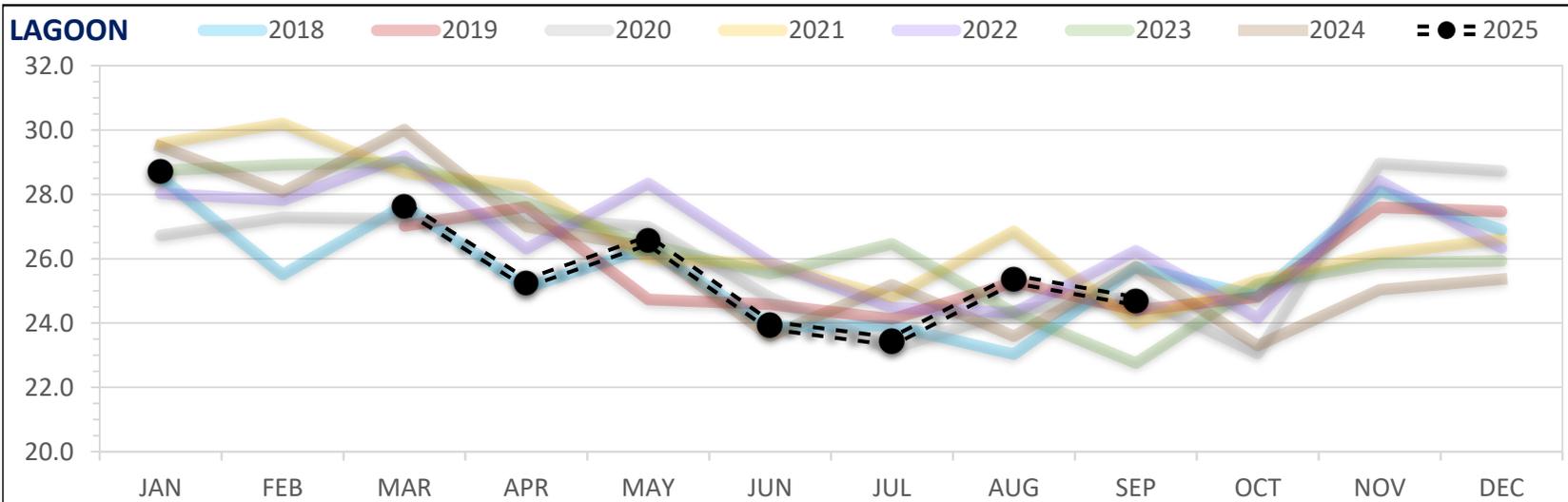
Stream Sampling Site	Site ID	Apr	May	Jun	Jul	Aug	Sep
Avana	RAS01	NW	82	NW	95	NW	76
Paringaru	RAS02	NW	93	74	79	NW	NW
Akapuao	RAS03	NW	61	NW	61	NW	NW
Totokoitu	RAS04	NW	NW	99	95	81	ND
Betela	RAS06	55	72	97	91	53	NW
Avatiu	RAS08	NW	82	99	91	NW	NW
Vaiterenga	RAS10	NW	43	NW	62	NW	NW
Areiti	RAS11	53	NW	75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

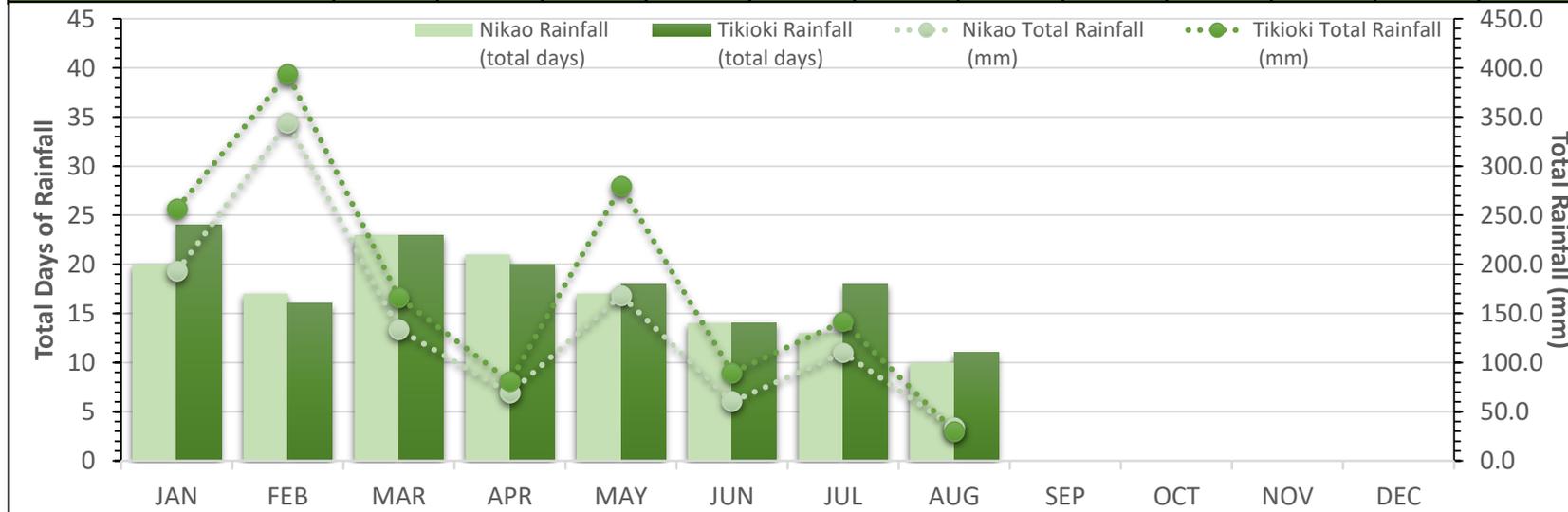
2025	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Lagoon	28.7	ND	27.6	25.2	26.6	23.9	23.4	25.4	24.7			
Stream	24.8	24.2	24.5	23.2	24.3	22.6	21.7	22.8	22.0			



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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				
<b>Nikao Rainfall (total days)</b>	20	17	23	21	17	14	13	10				
<b>Nikao Highest 1-Day (mm)</b>	37.4	72.5	43.0	10.6	28.5	19.1	80.6	15.2				
<b>Nikao Highest 1-Day (date)</b>	9th	13th	3rd	2nd	24th	16th	6th	7th				
<b>Tikioki Total Rainfall (mm)</b>	256.6	393.6	166.4	80.8	279.2	89.8	141.8	30.2				
<b>Tikioki Rainfall (total days)</b>	24	16	23	20	18	14	18	11				
<b>Tikioki Highest 1-Day (mm)</b>	83.8	94.4	53.6	13.0	67.8	48.0	79.6	15.4				
<b>Tikioki Highest 1-Day (date)</b>	9th	20th	30th	6th	15th	16th	6th	6th				



Report Date: 05.09.2025			RAROTONGA LAB STUDY REPORT – SEPTEMBER				Lab Report No.: 09L5299 – 09L5317								
SAMPLE DESCRIPTION															
Date Samples Collected:		Name of Sample:		Collected By:		Submitted By:		Time of Receipt:		Physical Description:		Quantity Per Site Received:			
Tuesday 2 <sup>nd</sup> September		Marine		NES		11:40am		Clear		2.5L					
		Stream		MMR		11:05am		Clear & 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	09L5299	637		24.2		34.6		181.1		12.46		8.30		2.6	
RAM04	09L5300	74		24.0		32.5		109.1		7.63		7.97		2.0	
RAM05	09L5301	10		24.4		34.7		120.4		8.26		8.01		1.9	
RAM06	09L5302	31		24.6		34.7		125.4		8.56		8.06		2.2	
RAM08	09L5303	605		24.1		33.3		121.9		8.46		8.03		16.7	
RAM09	09L5304	52		25.1		35.0		130.7		8.83		8.06		10.1	
RAM11	09L5305	426		25.4		35.0		125.0		8.41		8.09		7.4	
RAM13	09L5306	110		25.3		35.6		126.5		8.49		8.07		3.9	
RAM16	09L5307	<1		23.2		34.9		95.9		6.70		7.93		0.3	
RAM17	09L5308	780		25.1		34.1		125.5		8.53		8.05		5.6	
RAM18	09L5309	<1		27.3		35.4		165.3		10.75		8.29		0.3	
RAM19	09L5310	<1		23.5		33.8		113.3		7.94		7.94		1.3	
STREAM															
RAS01	09L5311	435		22.5		7.5		76.2		6.32		6.72		0.7	
RAS04	09L5312	816		20.9		0.1		ND		ND		6.97		4.4	
RAS11	09L5313	328		22.6		0.4		62.1		5.35		7.21		36.7	
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	RAM03 (09L5314)	RAM08 (09L5315)	RAM11 (09L5316)	RAM17 (09L5317)	Study Method	Recommended Limit
1	03.09.2025	3PM	Clear	500mL	Enterococci	MPN/100mL	<1	20	31	20	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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