

Bathing Beach Water Quality
State of the Environment
Monitoring Report
Summer 2013-2014

Technical Report 2014-13

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Executive summary

This report provides an assessment of microbial water quality at 12 bathing beach sites in the Taranaki region, based on routine summer monitoring of faecal indicator bacteria (enterococci, *E. coli* and faecal coliforms) conducted by the Council between 5 November 2013 and 3 April 2014. The report focusses on enterococci results, as this indicator is considered to provide the closest correlation with risks of health effects in New Zealand coastal waters. Results have been assessed for compliance with microbiological water quality guidelines prepared by the Ministry for the Environment (MfE) and the Ministry of Health (MfE, 2003).

Thirteen samples were collected at every monitored beach under dry weather conditions for state of the environment monitoring (SEM) purposes. An extra 7 samples were collected regardless of weather conditions at 5 sites, to satisfy MfE grading purposes.

During the 2013-2014 summer season, microbiological water quality was generally very good across bathing beaches in the Taranaki region. Low median enterococci counts were recorded for all beaches monitored (≤ 29 enterococci cfu/100ml). Of the 156 SEM samples, 94% were below the guideline MfE 'Alert' level (140 enterococci cfu/100ml). Out of the 191 samples collected for both SEM and for additional monitoring purposes, 95% were below the Alert level. Of the few samples which individually entered the Alert guideline category (5%), half were associated with rainfall/freshwater influence.

The guideline MfE 'Action' mode is reached when enterococci counts in two consecutive samples exceed 280 enterococci cfu/100ml. No site reached the Action mode during the 2013-2014 season.

Mann-Kendall tests were performed in order to assess long term trends in microbiological water quality. Two sites show a significant decrease in median enterococci counts over the 12-19 years monitored (Fitzroy and Ngamotu, $p < 0.05$), indicating an overall improvement in microbiological water quality. No site showed a significant increase in median enterococci count i.e. deterioration in microbiological water quality.

Fitzroy and Opunake were the region's cleanest bathing beach sites with median enterococci counts of ≤ 1 cfu/100ml and no samples reaching Alert mode throughout the 2013-2014 season. Oakura Surf Club and Back Beach recorded the highest median enterococci counts of the season (29 and 27 cfu/100ml respectively). These two sites also exceeded intermediate MfE guideline levels more than other beaches in the region, with Back Beach reaching MfE Alert level three times and Oakura Surf Club entering MfE Alert level twice.

During the 2013-2014 season, 4 of the 12 beach sites recorded the lowest or equal lowest SEM enterococci median counts in the 18 years of the programme to date (Fitzroy, East End, Ngamotu, Ohawe). This may reflect prolonged dry conditions towards the end of the summer.

Microbiological water quality results were regularly reported on the Taranaki Regional Council website (www.trc.govt.nz) and there was timely liaison with territorial local authorities and the Health Protection Unit of the Taranaki District Health Board throughout the summer bathing season of 2013-2014.

Through the Council's LTP, the Council's target in respect of the microbiological state of coastal bathing sites is that there is *maintenance or increase in the number of sites from 2003 compliant with 2003 Ministry of Health contact recreational guidelines*. In 2003, 10 of 11 coastal

bathing sites were compliant with the guidelines ('Action' levels). In the season under review, 12 of 12 beaches were compliant with the guidelines. The LTP target was therefore met.

Continuation of the bathing beach SEM programme is recommended in the 2014-2015 year.

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1. Introduction

The coastal waters of New Zealand are used for a broad range of recreational activities, including bathing, surfing, diving, sailing, kayaking, and shellfish gathering. Maintaining the quality of this recreational water is therefore an important resource management and environmental health issue.

1.1 State of the environment monitoring (SEM)

Regional councils have responsibilities under the Resource Management Act (1991) to monitor the state of the environment. The purpose of state of the environment monitoring (SEM) is to collect sufficient data to produce information on the general health of the environment. This information can then be used to measure how well management practices, policies and laws are working, and whether environmental outcomes are being achieved. As part of SEM, environmental performance indicators (EPI's) are used to measure human activities and their effects on the environment. Included amongst these EPI's, faecal indicator bacteria (enterococci, *E. coli* and faecal coliforms) can be monitored to assess the contamination of water by human or animal excreta. Levels of these faecal indicators are of particular interest in coastal waters used for recreational activities due to the potential health risks associated.

The Taranaki Regional Council has monitored faecal indicator bacteria at bathing beaches along the Taranaki coast since 1979, with systematic surveys undertaken from 1987. A more comprehensive annual bathing beach monitoring programme was implemented during the 1995-1996 summer as an on-going component of the SEM programme for the Taranaki region.

The SEM bacteriological bathing water quality programme has three objectives:

- to characterise the bacteriological quality of principal recreation waters in the Taranaki area, and more specifically to determine their suitability for contact recreation;
- to identify changes in contact recreational water quality over time. Therefore the detection of trends is an important component in programme design;
- to assess compliance with recreational water quality guidelines.

[Note: Contact recreation concerns water-based activities involving a high probability of accidental water ingestion. This mainly applies to bathing, but may also include other high-contact water sports e.g. jet-skiing, surfing, kayaking]

2. Contact recreation water quality standards and guidelines

2.1 Microbiological water quality guidelines for marine recreational areas (2003)

Guidelines for microbiological water quality of marine recreational areas have been prepared by the Ministry for the Environment in conjunction with the Ministry of Health (MfE, 2003). The guidelines use a combination of a qualitative risk grading of the catchment, together with direct measurements of appropriate faecal indicators to assess the suitability of a site for recreation (see 2.2).

In addition, 'Alert' and 'Action' guideline levels are used for surveillance throughout the bathing season. These guideline levels are summarized in Table 1 and are based on keeping illness risk associated with recreational water use to less than approximately 2%. Levels are based on enterococci counts as these bacteria are the preferred indicators for marine waters. Research has shown that enterococci are the indicator most closely correlated with health effects in New Zealand marine waters, in common with general findings overseas (New Zealand Marine Bathing Study). In coastal waters, faecal coliforms and *E. coli* are not as well correlated with health risks, but can be used as indicators, in addition to enterococci, where enterococci levels alone may be misleading.

Table 1 Surveillance, Alert and Action levels for marine waters (2003)

	Mode		
	Surveillance	Alert	Action
Enterococci (cfu/100ml)	No single sample >140	Single sample >140	Two consecutive single samples >280
Procedure	<ul style="list-style-type: none"> Continue routine monitoring 	<ul style="list-style-type: none"> Increase sample to daily Undertake sanitary survey Identify sources of contamination Consult CAC to assist in identifying possible source 	<ul style="list-style-type: none"> Increase sample to daily Undertake sanitary survey Identify sources of contamination Consult CAC to assist in identifying possible source Erect warning signs Inform the public through the media that a public health problem exists

CAC = Catchment Assessment Checklist

2.2 Suitability for recreation grading (SFRG) of sites

The 2003 Microbiological Water Quality Guidelines (MfE, 2003) provide for the grading of recreational water bodies based on two components:

- The Microbiological Assessment Category (MAC)*: this is established on the basis of five years' enterococci data for a particular site, providing a quantitative measurement of the actual water quality over time. Sites are assigned MAC categories ranging from A to D, with definitions provided in Table 2. For the Taranaki region, the Taranaki Regional Council provides the Ministry for the Environment with these data collected as part of the annual bathing beach monitoring programme.

- *The Sanitary Inspection Category (SIC)*: generates a measure of the susceptibility of a water body to faecal contamination. A site is allocated a category of either Very High, High, Moderate, Low or Very Low, and is determined using the SIC flow chart. Information used in the flow chart comes from the Catchment Assessment Checklist (CAC) which provides qualitative risk information on the catchment. Detailed information about SIC, including the SIC flow chart and the CAC can be found in the 2003 Microbiological Water Quality Guidelines (MfE, 2003).

The SIC is combined with the MAC to determine a Suitability for Recreation Grade (SFRG) for each site. The SFRG therefore describes the general condition of a site based on both qualitative risk grading of the catchment and the quantitative measurement of faecal indicators. A grade is established on the basis of the most recent five years' data and recalculation of a grade is typically performed annually.

Table 2 Microbiological Assessment Categories

MAC	MAC definitions for marine waters
A	Sample 95 percentile \leq 40 enterococci/100ml
B	Sample 95 percentile 41 - 200 enterococci/100ml
C	Sample 95 percentile 201 - 500 enterococci/100ml
D	Sample 95 percentile $>$ 500 enterococci/100ml

SFRGs, as defined by the Ministry for the Environment, are:

- *Very Good*: considered satisfactory for swimming at all times.
- *Good*: satisfactory for swimming most of the time. Exceptions may include following rainfall.
- *Fair*: generally satisfactory for swimming, though there are many potential sources of faecal material. Caution should be taken during periods of high rainfall, and swimming avoided if water is discoloured.
- *Poor*: generally unsuitable for swimming, as indicated by historical results. Swimming should be avoided, particularly by the very young, the very old and those with compromised immunity.
- *Very Poor*: avoid swimming.

Sixteen of the 19 coastal sites monitored by the Council had sufficient data available to calculate SFRG grades for the period spanning November 2009 to April 2014 (Appendix II). Of these 16 sites, 10 were graded 'good', 4 were graded 'fair' and 2 were graded 'poor'. None of the beaches graded 'very poor'. As 15 of the 16 beaches were assigned a SIC of 'moderate' it was not possible for any of these beaches to obtain a 'very good' SFRG grading regardless of the enterococci results used to calculate MAC. This was mainly related to either the agricultural nature of the catchment areas or the presence of nearby streams and rivers which heavily influenced the SIC assessment results.

It must be emphasized that the SFRG grade provides a conservative/precautionary guideline intended for assessing the suitability of beaches for contact recreation from a public health perspective. The grade is of limited use for assessing the state of the environment, as it includes the SIC: a static assessment based on qualitative information. Instead, the remainder of this report will focus on presenting and

interpreting actual faecal indicator data collected during routine monitoring. This quantitative information enables the assessment of general trends in coastal water quality, and can be used to measure how well management practices and policies are working, and whether environmental outcomes are being achieved.

It should be noted that the Ministry itself states that the SFRG 'reflects a precautionary approach to managing public health risks and does not represent an accurate picture of water quality in the catchment. ...The grades reflect a precautionary approach to managing health risk and are not designed to represent health risks on a particular day. They tend to reflect the poorest water quality measured at a site rather than the average water quality. A site may be graded as poor but still be suitable for swimming much of the time....The indicator does not replace the site-specific information available on council websites'¹

Note: Table 3 takes into account data from both standard SEM samples along with extra samples required by MfE (see Section 3).

Table 3 Suitability for recreation grade for the period November 2009 to April 2014

Site	Sanitary Inspection Category *	Microbiological assessment Enterococci (nos/100ml)			SFR Grade	% of all samples in compliance (ie: <280 enterococci)
		95 %ile	Number of samples	Category		
Onaero	Moderate 13	240	100	C	Fair	96
Waitara (East)	Moderate 13	333	65	C	Fair	93
Waitara (West)	Moderate 13	145	65	B	Good	96
Bell Block	Moderate 3	648	43	D	Poor	90
Fitzroy	Moderate 3	45	102	B	Good	99
East End	Moderate 3	144	96	B	Good	97
Ngamotu	Moderate 3	78	101	B	Good	98
Back	Low 14	616	26	D	Poor	92
Oakura (SC)	Moderate 13	286	101	C	Fair	95
Oakura (CG)	Moderate 13	43	67	B	Good	100
Opunake	Moderate 3	33	100	A	Good	100
Ohawe	Moderate 13	260	65	C	Fair	95
Patea (Mana Bay)	Moderate 13	40	58	A	Good	100
Patea	Moderate 13	79	26	B	Good	100
Waverley	Moderate 13	11	26	A	Good	100
Wai-inu	Moderate 13	15	26	A	Good	100
Wai-iti	Moderate 13	Insufficient data to calculate				
Urenui	Moderate 13	Insufficient data to calculate				
Onaero settlement	Low 14	Insufficient data to calculate				

* 13 = River - agricultural activities/birds/feral animals

14 = River - focal points of discharge

3 = Urban stormwater

**Insufficient data – a minimum of 20 samples is needed to calculate MAC

¹ Suitability for swimming: Indicator update July 2013: INFO 690, Ministry for the Environment

3. Monitoring methodology

3.1 SEM sample collection

The monitoring network is designed to assess coastal water quality in terms of its suitability for contact recreation. As such, the network targets the main bathing times and avoids, as far as possible, the influence of diffuse sources (i.e. streams and rivers) on coastal water quality. For these reasons the following criteria have been adopted during sampling:

Sample collection, field measurements, transport and analyses were undertaken according to documented Taranaki Regional Council procedures. It was intended that on average, four samples would be collected from each of the sites in each month when hydrological flow conditions permitted, within two hours of high tide. SEM sampling was performed only under dry weather flow conditions (i.e. not within three days of a fresh). Bathing water samples were taken between the hours of 0900 and 1800 hours (NZDT) to reflect the most likely period for swimming usage. Where necessary, a 2 m sampling pole was used for bacteriological sample collection immediately beneath the water surface and at a minimum of knee depth at the sites (Photo 1). Thirteen samples were collected from each site during the season.

Results for the 2013-2014 bathing season were posted on the Taranaki Regional Council website (www.trc.govt.nz) as soon as checking had been completed. Where single results fell in the Action mode, further sampling was performed when necessary i.e. where historical databases and staff expertise indicated this was warranted.

3.2 Sample analysis

Samples were analyzed for enterococci, *E. coli*, faecal coliforms and conductivity. *E. coli* and faecal coliform numbers were obtained using the mTEC agar method #9213-d, Standard Methods for the Examination of Waters and Wastewaters (APHA, 2005). Enterococci were quantified using the EPA modified method #1600 on mEI agar (EPA, 1986).

At each of the sites the following additional information was recorded: time, water temperature, weather condition, wind condition, surf condition, colour/appearance of water, and number of bathers and other users.

3.3 Programme design

The locations of the twelve sites sampled in the 2013-2014 programme are shown in Figure 1 and Table 4.

Table 4 Location of bathing water bacteriological sampling sites 2013-2014

Beach	Location	GPS	Site code
Onaero	Opposite surf lifesaving club	2628254-6244898	SEA900085
Waitara	East Beach	1706602-5683915	SEA901033
Waitara	West Beach	1705951-5683802	SEA901037
Bell Block	West of Mangati Stream	2609210-6242224	SEA902001
Fitzroy	Opposite surf lifesaving club	2605036-6239351	SEA902025
East End	Opposite surf lifesaving club	2604605-6239000	SEA902035
Ngamotu	Centre of beach	2600022-6237765	SEA902062
Back	To the north of the Herekawe Stream	2598198-6236896	SEA902070
Oakura	Opposite surf lifesaving club, south of Wairau Stream	2591974-6231726	SEA903030
Oakura	Opposite motorcamp, south of Waimoku Stream	2591700-6231600	SEA903032
Opunake	Centre of beach	2583775-6193800	SEA904090
Ohawe	Adjacent to boat ramp, east of Waingongoro River	2612688-6179169	SEA906010

Primary beach sites are monitored each year (Figure 1). Remaining beach sites are sampled on a three year rotation, with Year 2 beaches sampled during the 2013-2014 monitoring programme (Table 5).

Table 5 Coastal bathing beach sampling programme

Annually sampled	Year 1	Year 2	Year 3
Fitzroy	Patea	Bell Block	Wai-iti
Ngamotu	Patea Bay **	East End	Urenui
Oakura CG	Waverley	Back Beach	Onaero Settlement
Oakura SC	Wai-inu		
Opunake			
Ohawe *			
Onaero (opp. surf club)			
Waitara East			
Waitara West			

*since 1996-97

** since 2000-01 summer period



Photo 1 Bacteriological sampling

3.3.1 Additional monitoring (MfE guidelines)

The revised guidelines (MfE, 2003) require weekly surveillance monitoring during the 5-month recreational period, with a minimum of 20 sampling dates, regardless of weather conditions or state of the tide. Following consultation with the territorial local authorities and the Taranaki District Health Board, TRC added seven sampling dates to the SEM protocol at five of the most popular marine recreational sites (Onaero, Fitzroy, Ngamotu, Oakura and Opunake beaches) in the 2002-2003 period. These seven sampling dates were systematically selected (one per week) in weeks not sampled by the SEM programme. Sampling was undertaken regardless of prior weather conditions or tides but adhering to all other SEM programme protocols. [NB: These data will not be used for trend analysis purposes as they do not comply with the format of the originally established SEM programme].

3.4 Long-term trend analysis

For sites with sufficient data (≥ 10 years), non-parametric trend analysis was performed using annual median enterococci data. For each site, a LOWESS (Logically Weighted Scatterplot) line (tension 0.4) was fitted to a temporal scatter plot of the enterococci median data. Statistical significance of the trend was tested using a Mann-Kendall test. The sign (+/-) of the Kendall tau value was used to assess whether the trend was positive or negative and the significance of the trend was determined using the p value ($p < 0.05 = \text{significant}$).

When multiple correlations are undertaken, there is a chance that some will be found to be significant purely by chance. In order to deal with this potential problem, the Benjamini-Hochberg False Discovery Rate (FDR) method was applied to the results of the Mann-Kendall test. Further justification for this statistical approach can be found in Stark and Fowles (2006).

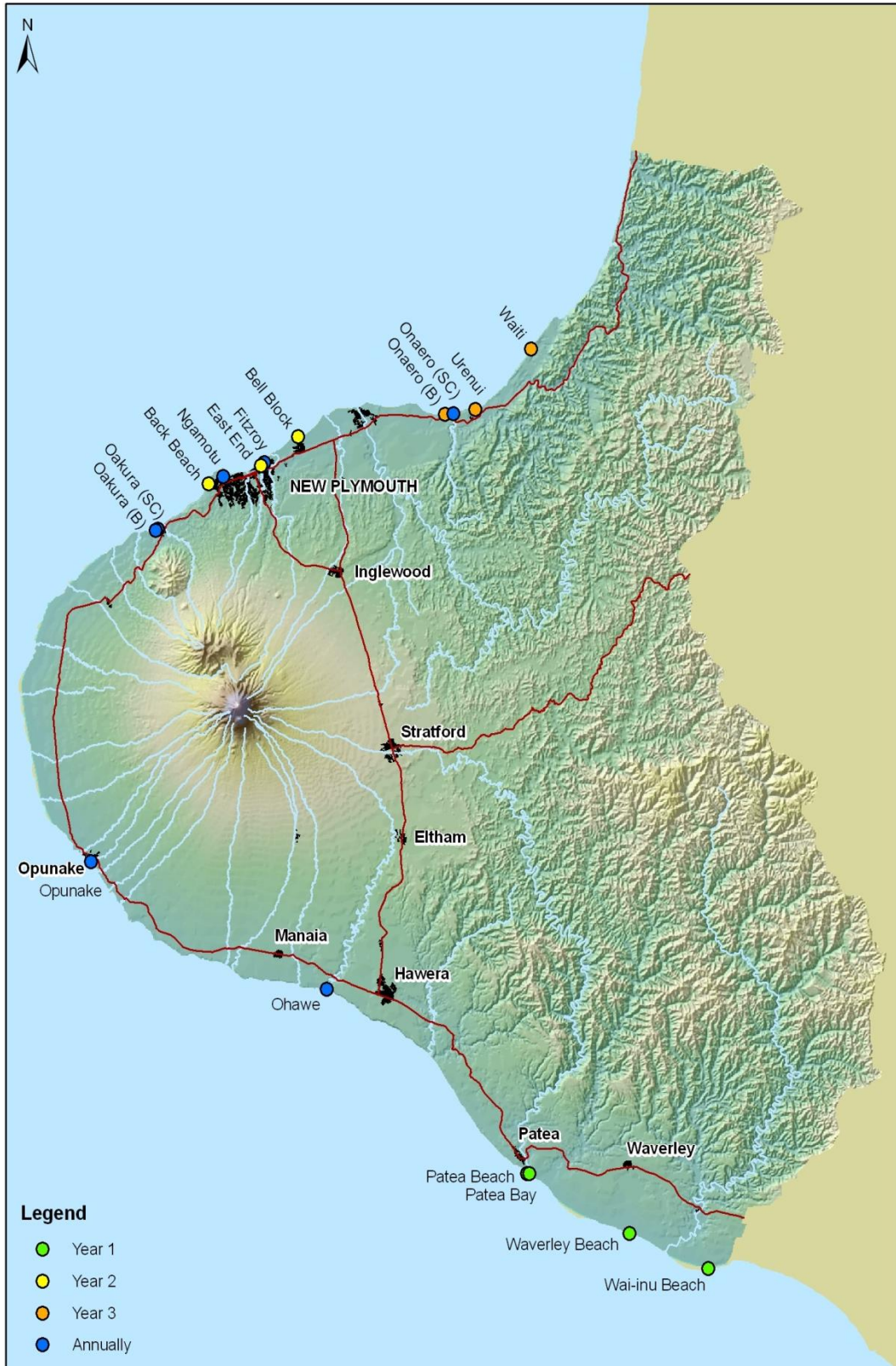


Figure 1 SEM beach bathing bacteriological survey sites

4. Results

From 5 November 2013 to 3 April 2014 a total of 13 samples were collected at each site for the purpose of state of the environment monitoring (SEM). Whenever possible, no SEM sampling was undertaken within three days following significant river freshes. However, occasionally sampling was affected by localized rainfall and elevated river flows. An additional seven samples were taken at five of the beaches (Onaero, Fitzroy, Ngamotu, Oakura and Opunake) regardless of weather conditions for the purpose of MfE monitoring (as discussed in Section 3.3.1). All results within this report are presented and discussed on a site-by-site basis for the sampling period. The timing of high tide on the dates sampled is provided in Appendix I.

Sampling was confined to weekdays, with no public holidays included. For these reasons, recreational usage of the waters was generally less intensive, often with no apparent usage at the time of sampling. However, all sites are known to be regularly utilized for bathing and other contact recreational activities, particularly at weekends, dependent on suitable weather conditions.

4.1 Onaero Beach

4.1.1 SEM programme

Onaero Beach (Photo 2), located in north Taranaki, is a relatively popular bathing beach, particularly over the Christmas holiday period. The Onaero River drains to the southern end of the beach, making a significant contribution to bacteria counts following rainfall events.

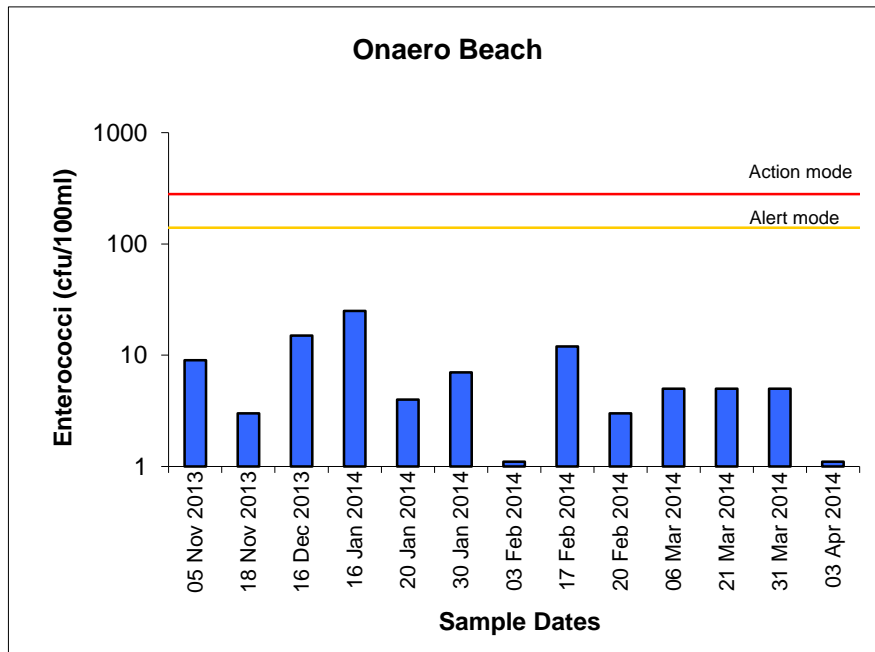


Photo 2 Onaero Beach

The data for this site are presented in Table 6 and Figure 2, with a statistical summary provided in Table 7.

Table 6 Bacteriological results for Onaero Beach

Date	Time (NZST)	Conductivity @ 20°C (mS/m)	Bacteria			Temp (°C)
			<i>E. coli</i> (cfu/100ml)	Enterococci (cfu/100ml)	Faecal coliforms (cfu/100ml)	
05 Nov 2013	09:40	4460	37	9	39	17.1
18 Nov 2013	09:50	4580	19	3	19	17.9
16 Dec 2013	09:45	4490	29	15	29	20.4
16 Jan 2014	10:30	4570	35	25	35	18.5
20 Jan 2014	10:30	4720	1	4	<1	18.1
30 Jan 2014	09:35	4760	<1	7	<1	17.9
03 Feb 2014	10:35	4730	<1	1	<1	17.8
17 Feb 2014	09:25	4710	11	12	11	18.1
20 Feb 2014	11:10	4690	3	3	3	20.9
06 Mar 2014	11:45	4720	1	5	3	17.2
21 Mar 2014	10:45	4650	29	5	29	19.2
31 Mar 2014	10:15	4720	1	5	1	18.9
03 Apr 2014	10:40	4680	3	1	3	19.8

**Figure 2** Enterococci numbers for the 13 SEM samples taken from Onaero Beach**Table 7** Statistical summary for Onaero Beach

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	4460	4760	4690
<i>E. coli</i>	cfu/100ml	13	<1	37	3
Enterococci	cfu/100ml	13	1	25	5
Faecal coliforms	cfu/100ml	13	<1	39	3
Temperature	°C	13	17.1	20.9	18.1

No high individual enterococci counts were recorded throughout the season (all counts ≤ 25 cfu/100ml) and the median enterococci count was low (Table 7).

4.1.2 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarized in Table 8. Enterococci counts in all SEM samples were below both Alert and Action guideline levels.

Table 8 Bacterial guidelines performance at Onaero Beach

Parameter	Number of exceedances of enterococci guidelines			
	ALERT Single sample >140 cfu/100ml		ACTION Two consecutive samples >280 cfu/100 ml	
Enterococci	0/13	0%	0/13	0%

4.1.3 Comparison with previous summer surveys

Summary statistics for enterococci data collected at Onaero Beach over 15 summers are presented in Table 9 and Figure 3.

Table 9 Summary enterococci data (cfu/100ml) for summer surveys at Onaero Beach

Summer	96/97	99/00	01/02	02/03	03/04	04/05	05/06	
Minimum	1	4	5	< 1	< 1	< 1	< 1	
Maximum	26	40	140	4200	52	1000	46	
Median	13	12	17	9	5	15	4	
Summer	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14
Minimum	2	< 1	2	3	< 1	1	< 1	1
Maximum	560	59	64	27	96	42	32	25
Median	7	4	13	13	11	4	15	5

The median enterococci count obtained for the 2013-2014 summer (5 cfu/100ml) (Table 9, Figure 3) was towards the lower end of the range previously recorded at this site. The maximum enterococci count (25 cfu/100ml) was the lowest recorded at Onaero Beach to date (Table 9).

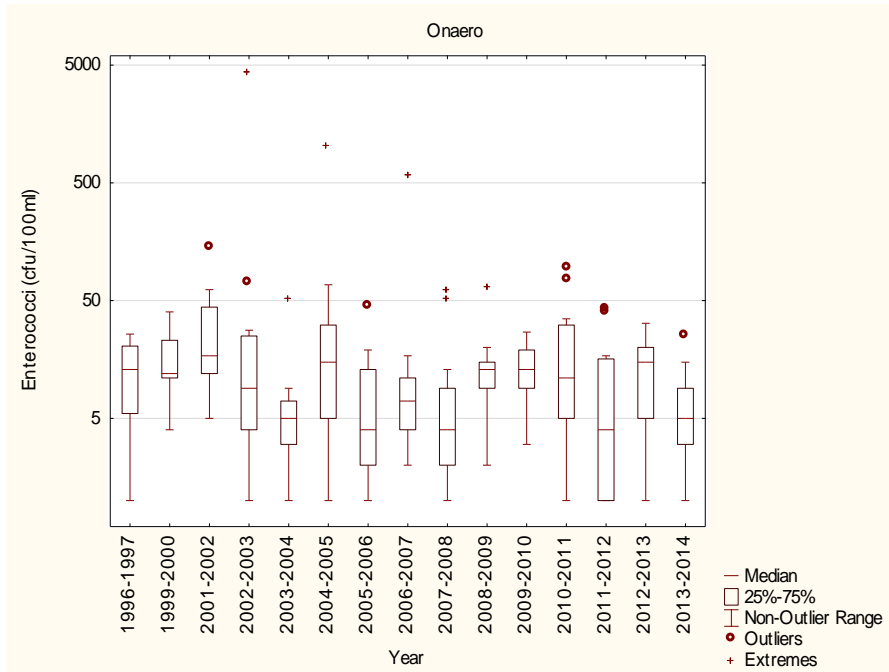


Figure 3 Box and whisker plots of enterococci for all summer SEM surveys at Onaero Beach

4.1.4 Long-term trend analysis

Trend analysis was performed by applying a LOWESS fit (tension 0.4) to a time scatterplot of the median enterococci data for 12 summer seasons (Figure 4) and testing the significance of any trend using the Mann-Kendall test at the 5% level, followed by Benjamini-Hochberg False Discovery Rate (FDR) analysis.

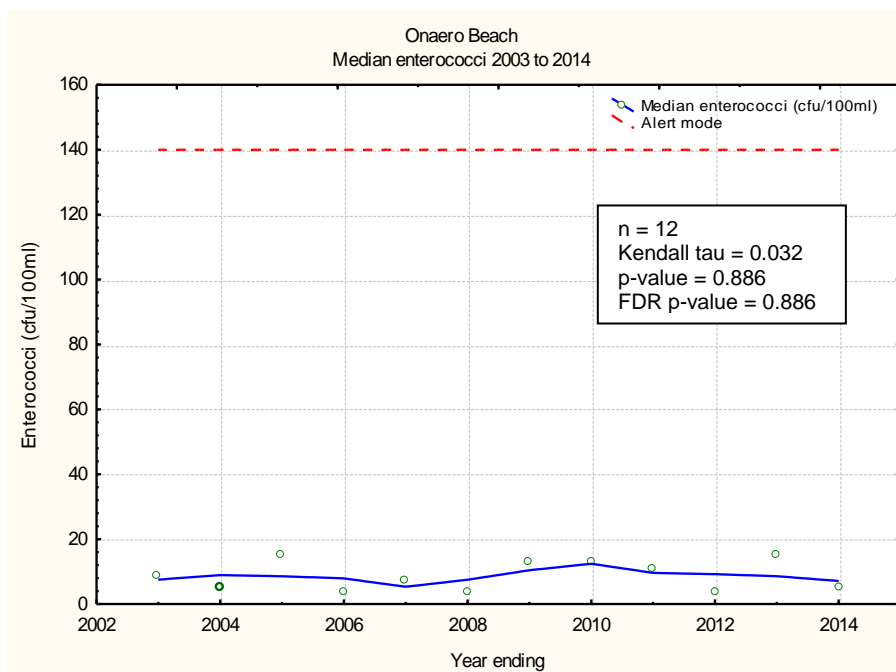


Figure 4 LOWESS trend analysis of median enterococci data at Onaero Beach

Over the 12 seasons monitored, there was a positive trend in median enterococci counts (Kendall tau = 0.032) that was not significant at the 5% level ($p = 0.886$).

4.1.5 MfE guidelines additional sampling

For the purpose of MfE monitoring, seven additional samples were collected at regular intervals under varying weather conditions during the survey season. All data, including additional MfE samples, are presented in Table 10 and Figure 5, with a statistical summary provided in Table 11.

Table 10 Bacteriological results for MfE samples at Onaero Beach

Date	Time (NZST)	Conductivity @ 20°C (mS/m)	Bacteria			Temperature (°C)
			<i>E. coli</i>	Enterococci	Faecal coliforms	
25 Nov 2013	08:00	4400	160	28	160	17.9
10 Dec 2013	08:45	2180	440	99	440	18.6
13 Jan 2014	08:50	3560	200	71	200	18.8
27 Jan 2014	08:50	3250	160	84	160	17.8
10 Feb 2014	09:00	4620	23	32	26	17.8
25 Feb 2014	08:35	4640	28	16	28	17.9
11 Mar 2014	09:30	4590	21	19	21	17.7

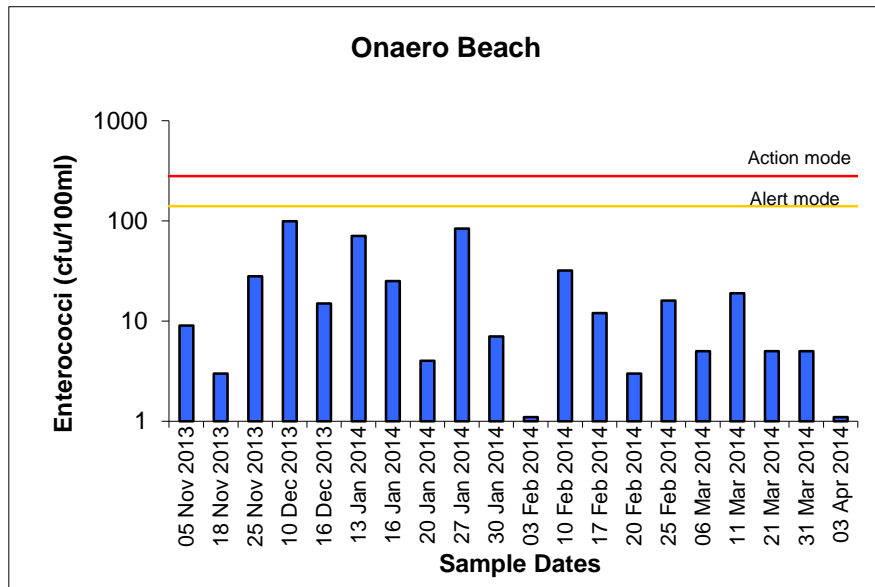


Figure 5 Enterococci numbers for the 20 sample extended survey at Onaero Beach

Table 11 Summary statistics for SEM and MfE samples at Onaero Beach

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	20	2180	4760	4630
<i>E. coli</i>	cfu/100ml	20	0.5	440	22
Enterococci	cfu/100ml	20	1	99	11
Faecal coliforms	cfu/100ml	20	0.5	440	24
Temperature	°C	20	17.1	20.9	18.0

Elevated enterococci counts obtained on MfE sampling dates were associated with lower conductivity (Table 10, N.B. typical conductivity of seawater is 4750 mS/m). The Onaero River which drains to the southern end of the beach is likely to have made a significant contribution to the higher bacteria counts. Although slightly elevated, all enterococci counts remained below MfE Alert level.

4.5.1.1 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage for the full suite of samples (20) is summarised in Table 12. At Onaero Beach, no samples entered the Alert category.

Table 12 Bacterial guidelines performance at Onaero Beach

Parameter	Number of exceedances of enterococci guidelines			
	ALERT		ACTION	
Enterococci	0/20	0%	0/20	0%

4.2 Waitara East Beach

4.2.1 SEM programme

Waitara East Beach is located to the east of the Waitara River mouth (Photo 3). Results at this site are influenced by the Waitara River which drains a large agricultural catchment and often contains high levels of bacteria. The primary treated and disinfected domestic wastes from the Waitara township are discharged through the Waitara Marine Outfall approximately 1800m out to sea.



Photo 3 Waitara East Beach

The data for this site are presented in Table 13 and Figure 6, with a statistical summary provided in Table 14.

Table 13 Bacteriological results for Waitara East Beach

Date	Time (NZST)	Conductivity @ 20°C (mS/m)	Bacteria			Temperature (°C)
			<i>E. coli</i> (cfu/100ml)	Enterococci (cfu/100ml)	Faecal coliforms (cfu/100ml)	
05 Nov 2013	10:20	2840	430	180	430	16.1
18 Nov 2013	09:15	4330	8	7	8	17.3
16 Dec 2013	09:05	4270	20	3	20	19.8
16 Jan 2014	09:30	4520	360	25	360	17.8
20 Jan 2014	11:05	4150	46	17	46	17.4
30 Jan 2014	09:05	4540	51	220	51	17.2
03 Feb 2014	11:10	4700	<1	11	<1	18.3
17 Feb 2014	10:00	4610	3	4	3	17.5
20 Feb 2014	12:05	4570	1	1	1	21.6
06 Mar 2014	12:10	4690	<1	<1	<1	17.2
21 Mar 2014	11:30	4730	<1	8	1	19.2
31 Mar 2014	09:30	4630	1	4	1	18
03 Apr 2014	11:20	4730	<1	<1	<1	19.4

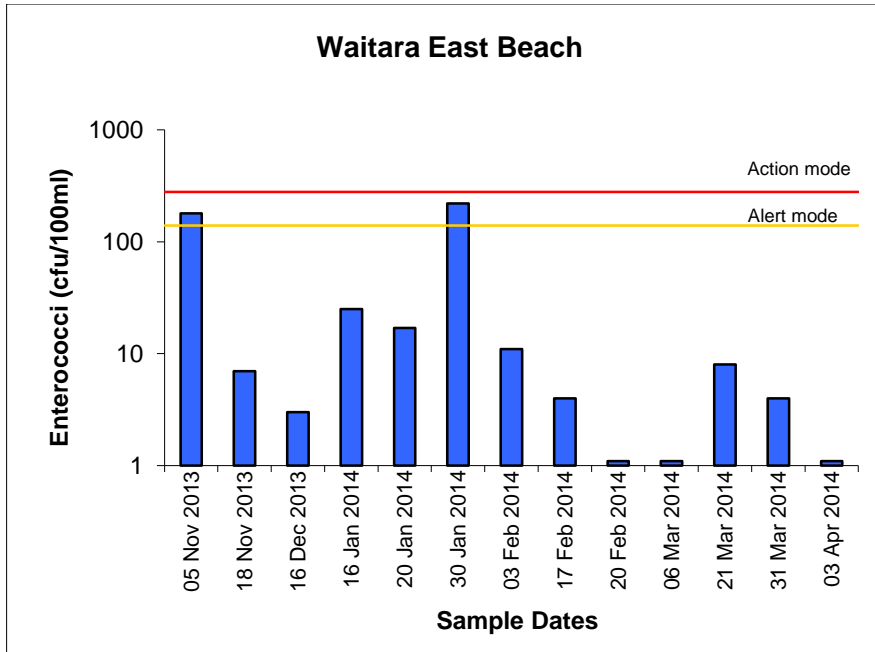


Figure 6 Enterococci numbers for the 13 SEM samples taken from Waitara East Beach

Table 14 Statistical summary for Waitara East Beach

Parameter	Unit	Number	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	2840	4730	4570
<i>E. coli</i>	cfu/100ml	13	<1	430	3
Enterococci	cfu/100ml	13	<1	220	7
Faecal coliforms	cfu/100ml	13	<1	430	3
Temperature	°C	13	16.1	21.6	17.8

The median enterococci count (7 cfu/100ml) was relatively low for this site. The two highest enterococci counts (180 and 220 cfu/100ml) were recorded on 5 November 2013 and 30 January 2014. On both days there was evidence of freshwater influence (4340 and 4690 mS/m, Table 14), although on the latter day in particular this was relatively minor.

4.2.2 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarized in Table 15. Two SEM samples (5 November 2013 and 30 January 2014) reached Alert level (>140 enterococci cfu/100ml) at this site during summer 2013-2014.

Table 15 Bacterial guidelines performance at Waitara East Beach

Parameter	Number of exceedances of enterococci guidelines			
	ALERT		ACTION	
Enterococci	2/13	15%	0/13	0%

4.2.3 Comparison with previous summer surveys

Summary statistics for enterococci data collected at Waitara East Beach over 19 summers are presented in Table 16 and Figure 7. Maximum and median enterococci counts obtained during the 2013-2014 summer season were at the lower end of the range previously recorded at this site (Table 16, Figure 7). Maxima at this site are historically high due to the influence of the Waitara River (Table 16).

Table 16 Summary enterococci data (cfu/100 ml) for summer surveys at Waitara East Beach

Summer	1995-96	1996-97	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04	
Minimum	1	1	1	3	3	1	4	<1	<1	
Maximum	950	960	230	250	230	520	290	410	840	
Median	14	11	17	20	40	9	21	13	17	
Summer	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14
Minimum	1	<1	1	1	<1	<1	<1	1	<1	<1
Maximum	310	88	91	120	2400	210	1000	190	400	220
Median	9	9	27	12	41	15	3	6	37	7

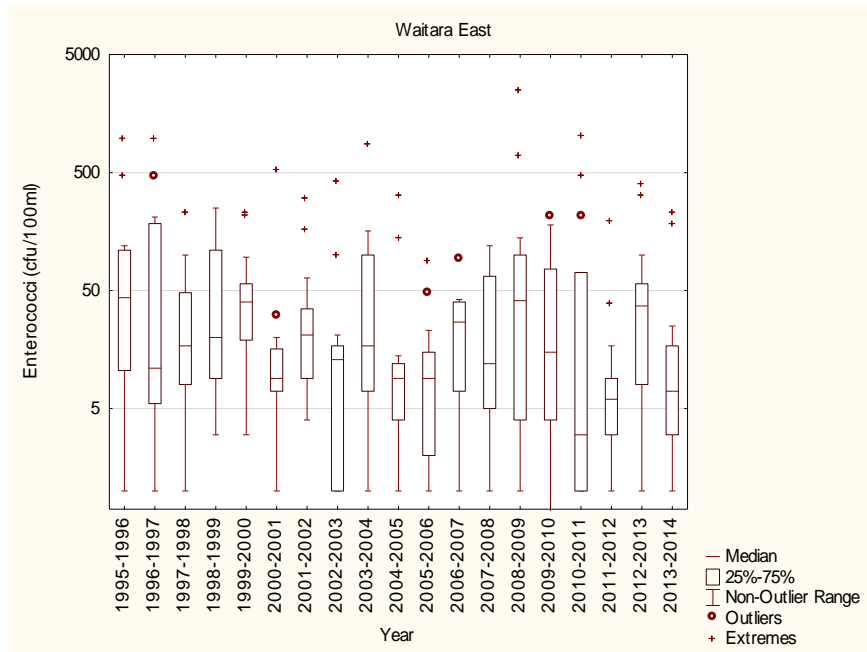


Figure 7 Box and whisker plots of enterococci for all summer surveys at Waitara East Beach

4.2.5 Long-term trend analysis

Trend analysis was performed by applying a LOWESS fit (tension 0.4) to a time scatterplot of the median enterococci data for 18 summer seasons (Figure 8) and testing the significance of any trend using the Mann-Kendall test at the 5% level, followed by Benjamini-Hochberg False Discovery Rate (FDR) analysis.

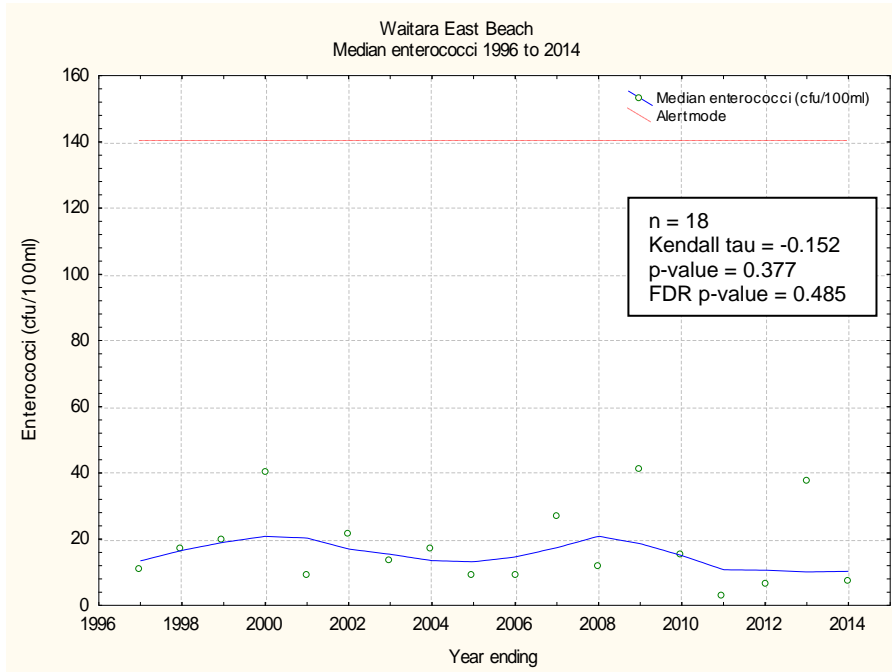


Figure 8 LOWESS trend analysis of median enterococci data at Waitara East Beach

Over the 18 seasons monitored, there was a decreasing trend in median enterococci counts (Kendall tau = -0.152) that was not significant at the 5% level ($p = 0.377$).

4.3 Waitara West Beach

4.3.1 SEM programme

Waitara West Beach is located to the west of the Waitara River mouth (Photo 4). As with Waitara East Beach, the results at this site can be influenced by the Waitara River and the discharge of primary treated disinfected domestic wastes from the Waitara township.



Photo 4 Waitara West Beach

The data for this site are presented in Table 17 and Figure 9, with a statistical summary provided in Table 18.

Table 17 Bacteriological results for Waitara West Beach

Date	Time (NZST)	Conductivity @ 20°C (mS/m)	Bacteria			Temperature (°C)
			<i>E. coli</i> (cfu/100ml)	Enterococci (cfu/100ml)	Faecal coliforms (cfu/100ml)	
05 Nov 2013	10:45	3960	100	31	100	16.6
18 Nov 2013	08:50	4600	1	1	1	17.8
16 Dec 2013	08:40	4480	28	8	31	19.7
16 Jan 2014	09:55	4300	12	11	12	17.6
20 Jan 2014	11:20	4530	7	13	8	17.2
30 Jan 2014	08:45	4550	5	8	5	16.9
03 Feb 2014	11:40	4730	1	3	1	18.8
17 Feb 2014	10:15	4740	1	82	1	17.9
20 Feb 2014	11:40	4630	1	3	1	21.1
06 Mar 2014	12:35	4720	<1	<1	1	17.1
21 Mar 2014	11:55	4720	4	<1	5	19.2
31 Mar 2014	09:00	4680	4	110	4	18.2
03 Apr 2014	11:40	4740	<1	11	<1	19.5

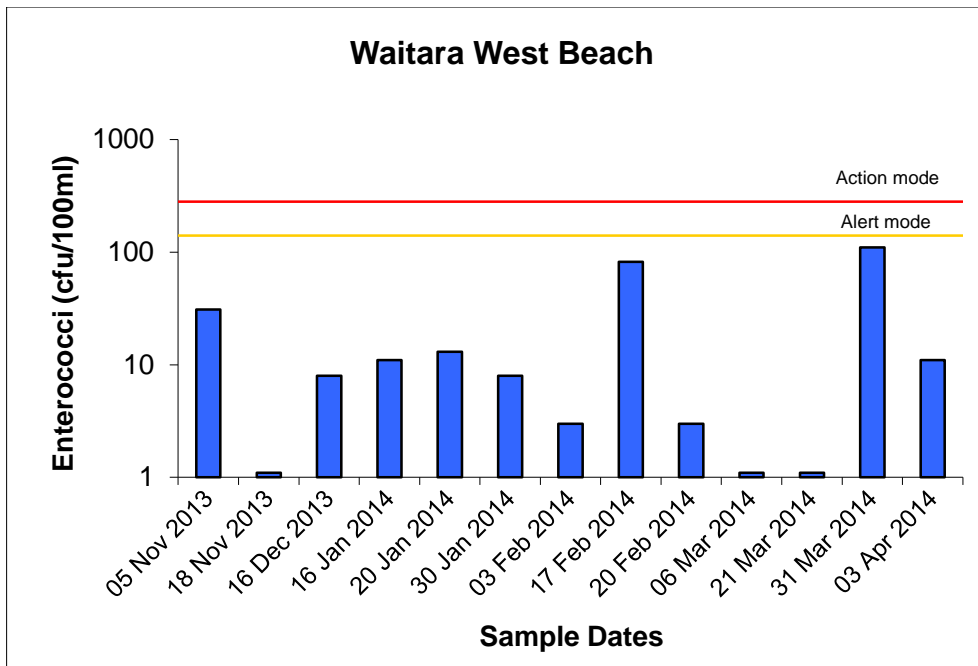


Figure 9 Enterococci numbers for the 13 SEM samples taken from Waitara West Beach

Table 18 Statistical summary for Waitara West Beach

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	3960	4740	4630
<i>E. coli</i>	cfu/100ml	13	<1	100	4
Enterococci	cfu/100ml	13	<1	110	8
Faecal coliforms	cfu/100ml	13	<1	100	4
Temperature	°C	13	16.6	21.1	17.9

4.3.2 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarized in Table 19. Enterococci counts in all samples were below both Alert and Action guideline levels.

Table 19 Bacterial guidelines performance at Waitara West Beach

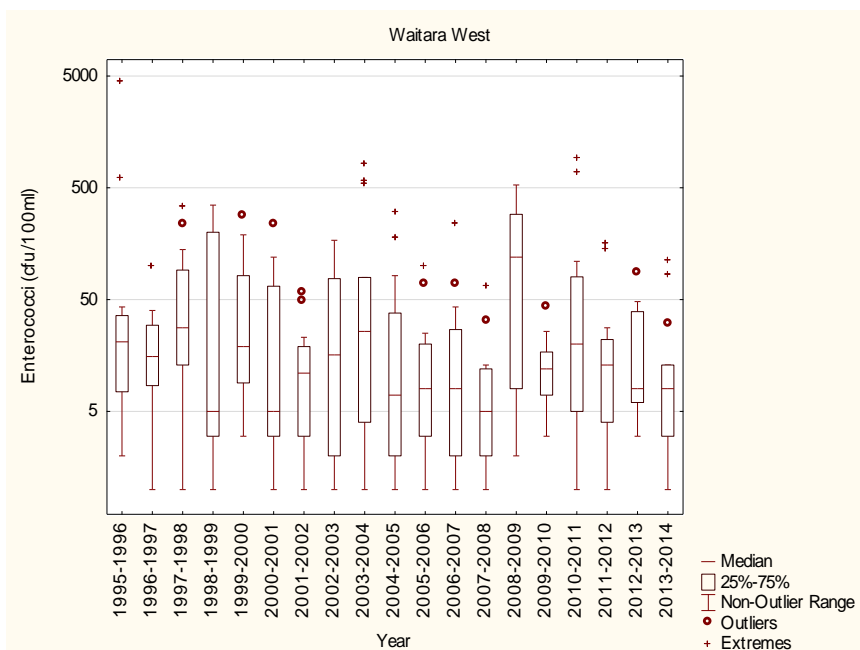
Parameter	Number of exceedances of enterococci guidelines			
	ALERT		ACTION	
Enterococci	0/13	0%	0/13	0%

4.3.3 Comparison with previous summer surveys

Summary statistics for enterococci survey data collected at Waitara West Beach over 19 summers are presented in Table 20 and Figure 10.

Table 20 Summary enterococci data (cfu/100 ml) for summer surveys at Waitara West Beach

Summer	1995-96	1996-97	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04	
Minimum	2	1	1	1	3	1	1	1	1	
Maximum	4300	100	340	350	290	240	57	170	800	
Median	21	16	28	5	19	5	11	16	26	
Summer	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14
Minimum	1	1	1	1	2	3	1	<1	3	<1
Maximum	300	100	240	67	530	42	910	160	90	110
Median	7	8	8	5	120	12	20	13	8	8

**Figure 10** Box and whisker plots of enterococci for all summer SEM surveys at Waitara West Beach

Minima, maxima and median enterococci counts were within the range recorded in previous monitoring periods at this site (Table 20, Figure 10). Maxima at this site are historically high due to the influence of the Waitara River (Table 20).

4.3.4 Long-term trend analysis

Trend analysis was performed by applying a LOWESS fit (tension 0.4) to a time scatterplot of the median enterococci data for 18 summer seasons (Figure 11) and testing the significance of any trend using the Mann-Kendall test at the 5% level, followed by Benjamini-Hochberg False Discovery Rate (FDR) analysis.

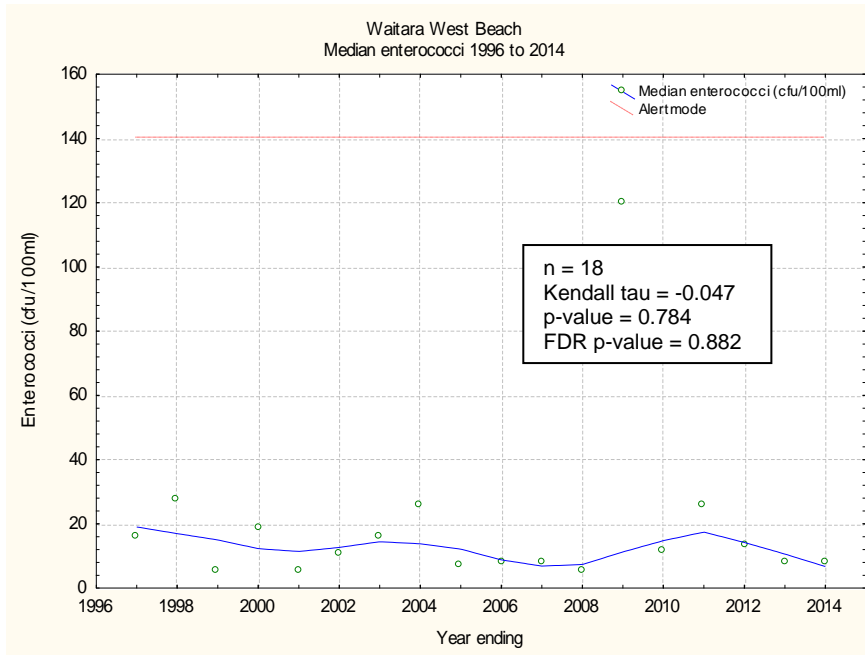


Figure 11 LOWESS trend analysis of median enterococci data at Waitara West Beach

Over the 18 seasons monitored, there was a decreasing trend in median enterococci counts (Kendall tau = -0.047) that was not significant at the 5% level ($p = 0.784$).

4.4 Bell Block Beach

4.4.1 SEM programme

Bell Block Beach (Photo 5) is a moderately popular summer bathing beach located north east of New Plymouth. The Mangati Stream enters the beach in the vicinity of the sample site. This stream drains through a highly modified/industrial catchment, which after rain, may impact significantly on bacteria numbers in the receiving waters.



Photo 5 Bell Block Beach

The data for this site are presented in Table 21 and Figure 12, with a statistical summary provided in Table 22.

Table 21 Bacteriological results for Bell Block Beach

Date	Time (NZST)	Conductivity @ 20°C (mS/m)	Bacteria			Temp (°C)
			<i>E. coli</i> (cfu/100ml)	Enterococci (cfu/100ml)	Faecal coliforms (cfu/100ml)	
05 Nov 2013	08:45	4530	1	11	4	16.1
18 Nov 2013	11:55	4620	1	<1	1	17.8
16 Dec 2013	08:00	4450	43	20	44	19.1
16 Jan 2014	09:15	4610	24	7	24	17.0
20 Jan 2014	12:10	4420	5	4	5	16.6
30 Jan 2014	08:05	4680	2	2	2	16.8
03 Feb 2014	12:30	4670	1	7	1	18.7
17 Feb 2014	11:05	4620	29	29	29	18.4
20 Feb 2014	12:50	4720	3	<1	3	21.3
06 Mar 2014	13:25	4680	5	16	11	17.1
21 Mar 2014	12:45	4740	1	11	1	19.2
31 Mar 2014	08:05	4660	9	16	9	17.3
03 Apr 2014	12:25	4710	4	440*	4	19.4

*Follow up sample taken due to count exceeding 280 cfu/100ml: Follow up result provided in Section 4.4.2

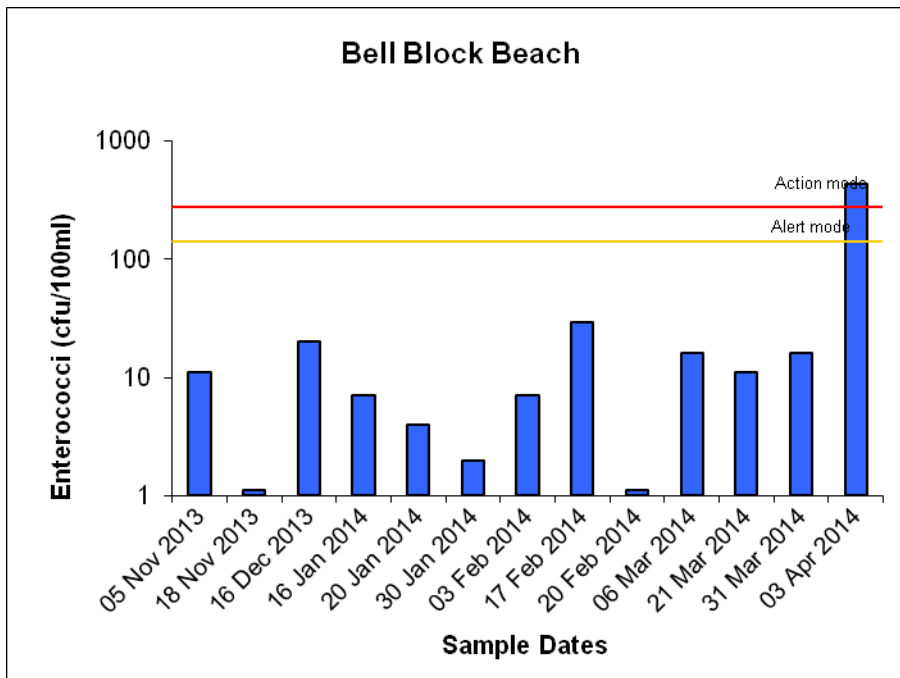


Figure 12 Enterococci counts for the 13 SEM samples taken from Bell Block Beach

Table 22 Statistical results for Bell Block Beach

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	4420	4740	4660
<i>E. coli</i>	cfu/100ml	13	1	43	4
Enterococci	cfu/100ml	13	<1	440	11
Faecal coliforms	cfu/100ml	13	1	44	4
Temperature	°C	13	16.1	21.3	17.8

The highest enterococci count (440 cfu/100ml), recorded on 3 April 2014, remains unexplained as there was no significant rainfall 8 days prior to sampling and negligible freshwater influence (4710 mS/m, Table 22). No unauthorised sewage discharges were reported at the time.

4.4.2 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarized in Table 23. The enterococci count from the sample taken on 3 April 2014 exceeded 280 cfu/100ml. As a consequence, a follow up sample was taken from this site on 7 April 2014. Given that the follow up enterococci count (86 cfu/100ml) did not exceed 280 cfu/100ml, Action mode was not reached at this site during summer 2013-2014.

Table 23 Bacterial guidelines performance at Bell Block Beach

Parameter	Number of exceedances of enterococci guidelines			
	ALERT Single sample >140 cfu/100ml		ACTION Two consecutive samples >280/100ml	
Enterococci	1/13	8%	0/13	0%

4.4.3 Comparison with previous summer surveys

Summary statistics for enterococci data collected at Bell Block Beach are presented in Table 24 and Figure 13.

Table 24 Summary enterococci data (cfu/100 ml) for summer surveys at Bell Block Beach opposite the campground

Summer	1995-96	1998-99	2001-02	2004-05	2007-08
Minimum	3	<1	2	<1	<1
Maximum	480	110	800	600	81
Median	14	4	20	4	42
Summer	2010-11	2013-14			
Minimum	1	<1			
Maximum	9700	440			
Median	5	11			

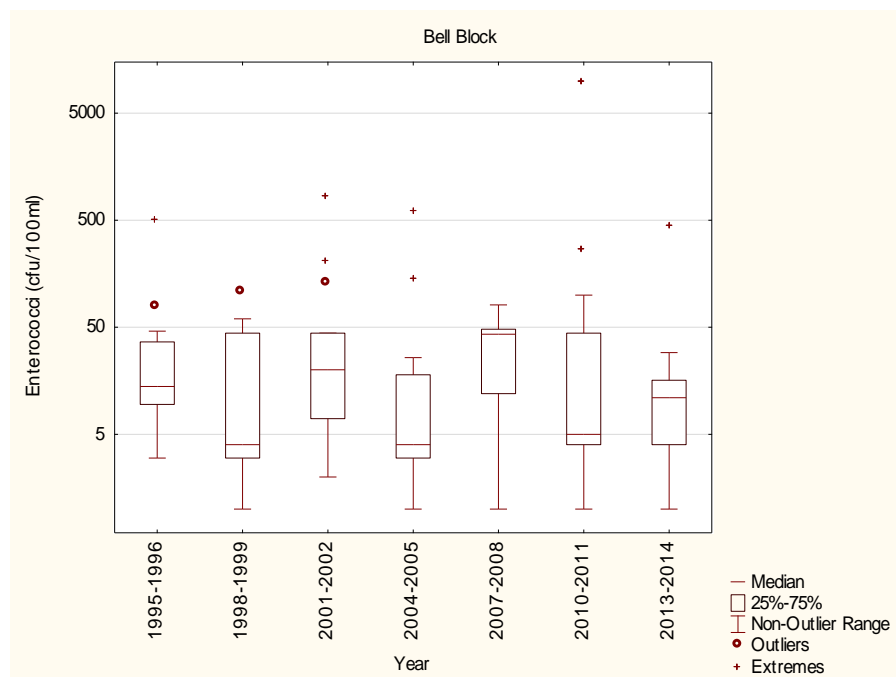


Figure 13 Box and whisker plots of enterococci for all summer SEM surveys at Bell Block Beach

The median enterococci count for the 2013-2014 season was within the range previously recorded at this site.

4.4.4 Long-term trend analysis

Long-term trend analysis was not undertaken on data from this site as there were an insufficient number of samples (only triennial data available).

4.5 Fitzroy Beach

4.5.1 SEM programme

Fitzroy Beach is situated in New Plymouth and is one of the most popular bathing beaches in Taranaki. It is also a very popular surfing beach due to its central location and high quality waves (Photo 6).

The mouth of the Waiwhakaiho River enters the sea at the eastern end of the beach, approximately 800m from the sample site, which on rare occasions can contribute significant amounts of freshwater during floods. Draining from a highly modified agricultural and industrial catchment, this can have a significant impact on bacteriological water quality subsequent to heavy rainfall. The river typically has a high level of contamination from birdlife.



Photo 6 Surfer at Fitzroy Beach

The data for this site are presented in Table 25 and Figure 14, with a statistical summary provided in Table 26.

Table 25 Bacteriological results for Fitzroy Beach

Date	Time (NZST)	Conductivity @ 20°C (mS/m)	Bacteria			Temp (°C)
			<i>E. coli</i> (cfu/100ml)	Enterococci (cfu/100ml)	Faecal coliforms (cfu/100ml)	
05 Nov 2013	09:05	4460	1	3	1	16.2
18 Nov 2013	10:35	4570	5	<1	5	17.3
16 Dec 2013	10:20	4630	<1	<1	<1	19.6
16 Jan 2014	10:15	4590	7	12	8	17.5
20 Jan 2014	10:50	4720	1	1	1	16.8

Date	Time (NZST)	Conductivity @ 20°C (mS/m)	Bacteria			Temp (°C)
			<i>E. coli</i> (cfu/100ml)	Enterococci (cfu/100ml)	Faecal coliforms (cfu/100ml)	
30 Jan 2014	10:25	4610	65	45	69	17.6
03 Feb 2014	12:25	4730	1	<1	1	17.4
17 Feb 2014	12:00	4720	<1	<1	<1	19.4
20 Feb 2014	13:30	4700	<1	<1	<1	21.7
06 Mar 2014	13:00	4740	<1	<1	<1	17.1
21 Mar 2014	13:00	4740	1	3	1	18.4
31 Mar 2014	10:35	4720	<1	<1	<1	No result
03 Apr 2014	13:00	4670	1	<1	1	19.5

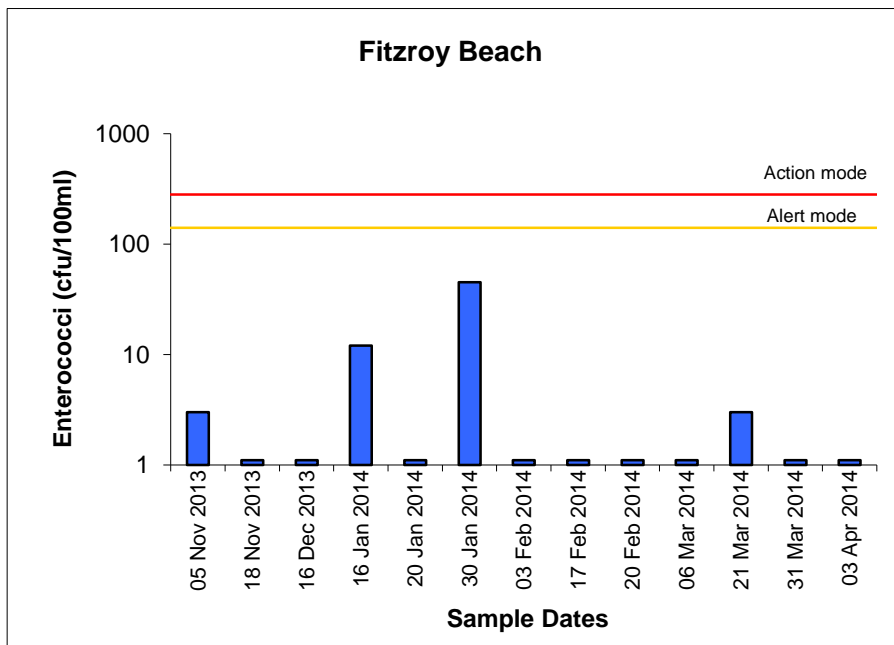


Figure 14 Enterococci numbers for the 13 SEM samples taken from Fitzroy Beach

Table 26 Statistical summary for Fitzroy Beach

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	4460	4740	4700
<i>E. coli</i>	cfu/100ml	13	<1	65	1
Enterococci	cfu/100ml	13	<1	45	<1
Faecal coliforms	cfu/100ml	13	<1	69	1
Temperature	°C	12	16.2	21.7	17.6

Bacteriological water quality at Fitzroy Beach was high throughout the season, with very low median values for all bacteriological parameters (≤ 1 cfu/100ml).

4.5.2 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarized in Table 27. Enterococci counts in all samples were below both Alert and Action guideline levels.

Table 27 Bacterial guidelines performance at Fitzroy Beach

Parameter	Number of exceedances of enterococci guidelines			
	ALERT Single sample 141-280/100ml		ACTION Two consecutive samples >280/100 ml	
Enterococci	0/13	0%	0/13	0%

4.5.3 Comparison with previous summer surveys

Summary statistics for enterococci data collected at Fitzroy Beach over 19 summers are presented in Table 28 and Figure 15.

Table 28 Summary enterococci data (cfu/100 ml) for summer surveys at Fitzroy Beach

Summer	1995-96	1996-97	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04	
Minimum	3	<1	<1	<1	<1	<1	<1	<1	<1	
Maximum	46	280	40	79	17	98	350	580	98	
Median	10	15	7	7	4	7	9	5	3	
Summer	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14
Minimum	<1	<1	<1	<1	<1	1	<1	<1	<1	<1
Maximum	52	85	33	44	110	60	43	930	36	45
Median	4	6	3	3	10	8	4	3	3	<1

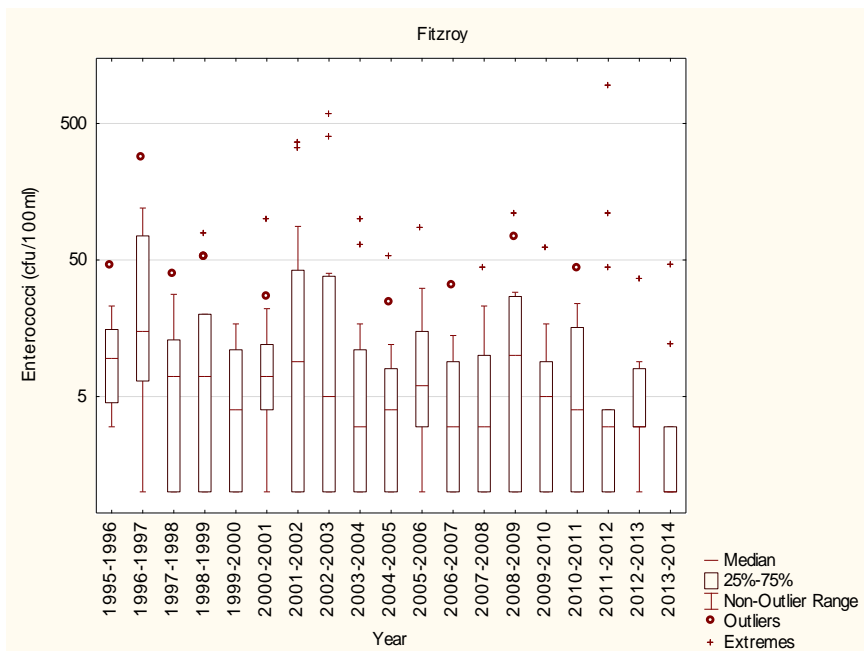


Figure 15 Box and whisker plots of enterococci for all summer SEM surveys at Fitzroy Beach

The median enterococci count (<1 cfu/100ml) at Fitzroy Beach was the lowest to date for this site and the lowest for Taranaki beach bathing sites during the 2013-2014 summer season. The maximum enterococci count was also low relative to other years and sites.

4.5.4 Long-term trend analysis

Trend analysis was performed by applying a LOWESS fit (tension 0.4) to a time scatterplot of the median enterococci data for 19 summer seasons (Figure 16) and testing the significance of any trend using the Mann-Kendall test at the 5% level, followed by Benjamini-Hochberg False Discovery Rate (FDR) analysis.

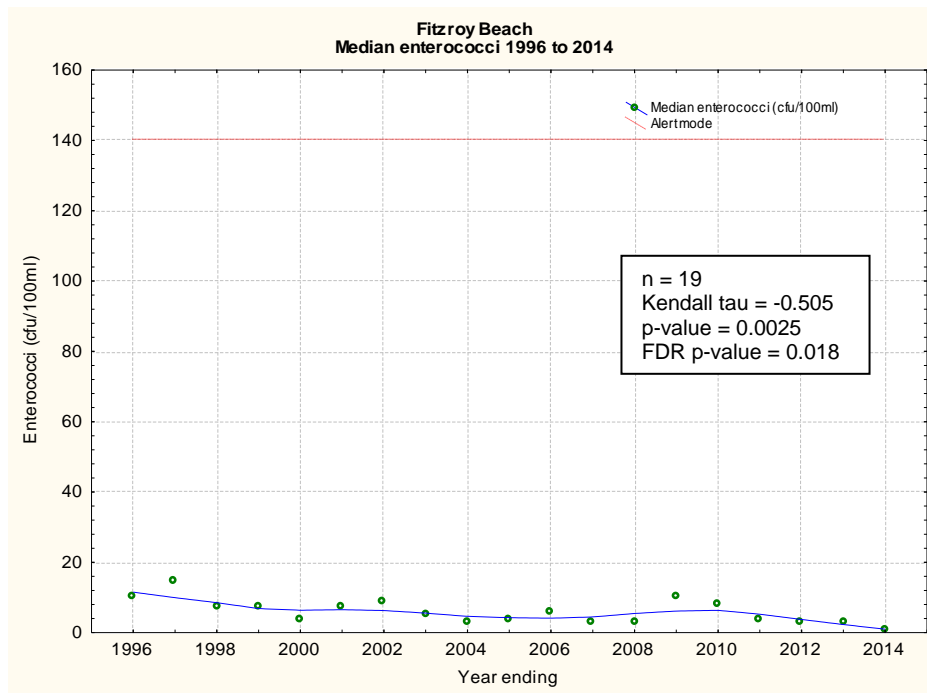


Figure 16 LOWESS trend analysis of median enterococci data at Fitzroy Beach

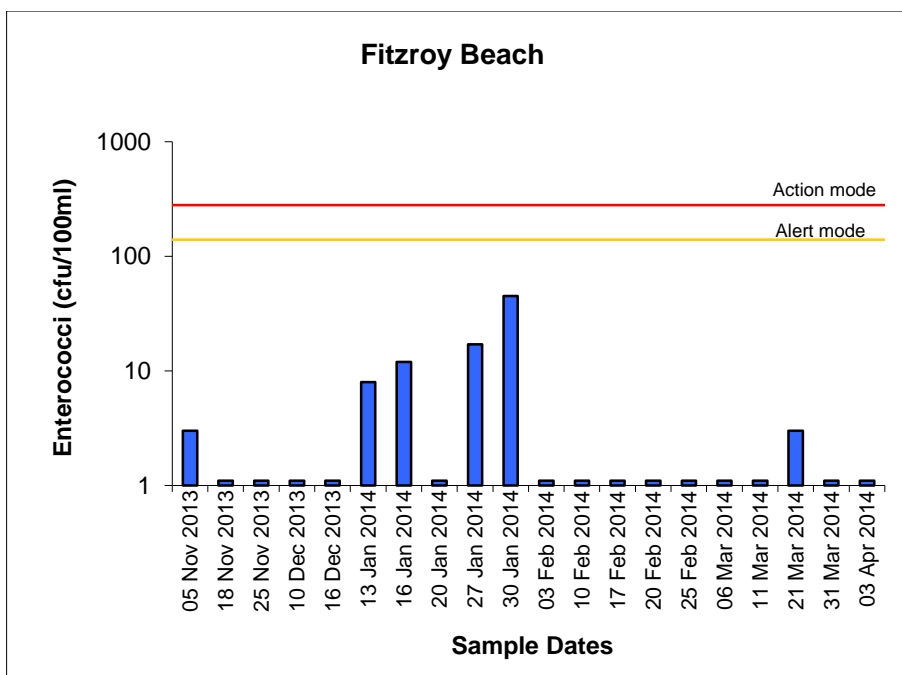
Over the 19 seasons monitored, there was a decrease in median enterococci counts (Kendall tau = -0.505). This negative trend was significant using the Mann-Kendall test ($p = 0.002$) and after FDR application ($p = 0.018$).

4.5.5 MfE guidelines additional sampling

For the purpose of MfE monitoring, seven additional samples were collected at regular intervals and under varying weather conditions during the survey season. All data, including additional MfE samples, are presented in Table 29 and Figure 17, with a statistical summary provided in Table 30.

Table 29 Bacteriological results for MfE samples at Fitzroy Beach

Date	Time	Conductivity @ 20°C (mS/m)	Bacteria			Temperature
	(NZST)		<i>E. coli</i> (cfu/100ml)	Enterococci (cfu/100ml)	Faecal coliforms (cfu/100ml)	(°C)
25 Nov 2013	09:15	4610	11	1	11	18.0
10 Dec 2013	09:45	4640	1	1	1	20.2
13 Jan 2014	09:45	4610	29	8	31	18.4
27 Jan 2014	09:35	4670	60	17	60	16.4
10 Feb 2014	09:45	4750	<1	<1	<1	17.5
25 Feb 2014	08:15	4770	1	<1	1	15.9
11 Mar 2014	10:30	4730	<1	<1	<1	19.9

**Figure 17** Enterococci numbers for the 20 sample extended survey at Fitzroy Beach**Table 30** Summary statistics for SEM and MfE samples at Fitzroy Beach

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	20	4460	4770	4685
<i>E. coli</i>	cfu/100ml	20	<1	65	1
Enterococci	cfu/100ml	20	<1	45	<1
Faecal coliforms	cfu/100ml	20	<1	69	1
Temperature	°C	20	15.9	21.7	17.6

Additional sampling resulted in no changes to the overall seasonal median for enterococci (Table 30), with water quality remaining high throughout the season.

4.5.5.1 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage for the full suite of samples (20) is summarised in Table 31. No samples reached the Alert mode during the 2013-2014 season.

Table 31 Bacterial guidelines performance at Fitzroy Beach

Parameter	Number of exceedances of enterococci guidelines			
	ALERT Single sample >140 cfu/100ml		ACTION Two consecutive samples >280 cfu/100 ml	
Enterococci	0/20	0%	0/20	0%

4.6 East End Beach

4.6.1 SEM programme

East End Beach is situated approximately 500m south-west of Fitzroy Beach in New Plymouth (Photo 7). This beach is popular with summer bathers and has its own Surf Life-saving Club. The Te Henui Stream enters the sea approximately 200m to the south-west of the sample site, which can result in high freshwater inputs during significant rainfall events.



Photo 7 East End Beach

The data for this site are presented in Table 32 and Figure 18, with a statistical summary provided in Table 33.

Table 32 Bacteriological results for East End Beach

Date	Time (NZST)	Conductivity @ 20°C (mS/m)	Bacteria			Temp (°C)
			<i>E. coli</i> (cfu/100ml)	Enterococci (cfu/100ml)	Faecal coliforms (cfu/100ml)	
05 Nov 2013	09:20	4470	4	3	4	16.2
18 Nov 2013	10:20	4570	1	3	1	17.5
16 Dec 2013	10:10	4520	20	3	20	19.6
16 Jan 2014	10:00	4470	29	37	29	17.4
20 Jan 2014	11:00	4720	3	4	3	16.3
30 Jan 2014	10:10	4370	140	130	140	16.7

Date	Time (NZST)	Conductivity @ 20°C (mS/m)	Bacteria			Temp (°C)
			<i>E. coli</i> (cfu/100ml)	Enterococci (cfu/100ml)	Faecal coliforms (cfu/100ml)	
03 Feb 2014	12:15	4730	<1	<1	<1	17.9
17 Feb 2014	11:30	4720	<1	3	<1	18.9
20 Feb 2014	13:15	4510	9	<1	9	22.2
06 Mar 2014	12:50	4740	<1	1	<1	16.7
21 Mar 2014	12:50	4740	1	<1	1	18.6
31 Mar 2014	10:20	4720	4	3	4	No result
03 Apr 2014	12:50	4640	3	4	3	19.2

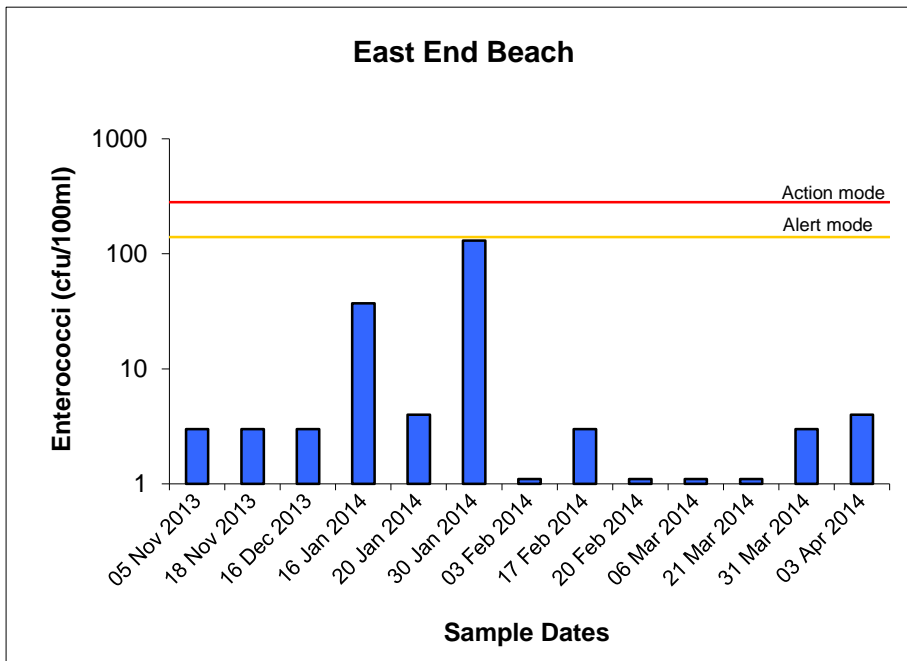


Figure 18 Enterococci counts for the 13 SEM samples taken from East End Beach

Table 33 Statistical results for East End Beach

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	4370	4740	4640
<i>E. coli</i>	cfu/100ml	13	<1	140	3
Enterococci	cfu/100ml	13	<1	130	3
Faecal coliforms	cfu/100ml	13	<1	140	3
Temperature	°C	12	16.2	22.2	17.7

In general, water quality was good at this site with low medians for all faecal indicator bacteria (3 cfu/100ml).

4.6.2 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarized in Table 34. No sample reached Alert level (>140 enterococci cfu/100ml) at this site during summer 2013-2014.

Table 34 Bacterial guidelines performance at East End Beach

Parameter	Number of exceedances of enterococci guidelines			
	ALERT Single sample >140 cfu/100ml		ACTION Two consecutive samples >280/100ml	
Enterococci	0/13	0%	0/13	0%

4.6.3 Comparison with previous summer surveys

Summary statistics for enterococci data collected at East End Beach over 7 summer surveys are presented in Table 35 and Figure 19.

Table 35 Summary enterococci data (cfu/100 ml) for summer surveys at East End Beach opposite the campground

Summer	1995-96	1998-99	2001-02	2004-05	2007-08	2010-11	2013-14
Minimum	3	1	1	<1	1	<1	<1
Maximum	340	88	200	100	140	57	130
Median	18	7	32	4	10	11	3

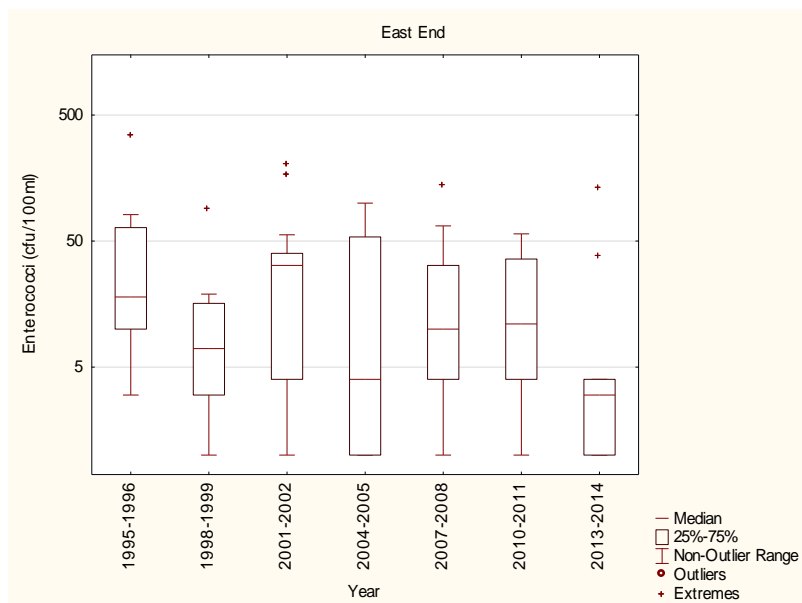


Figure 19 Box and whisker plots of enterococci for all summer SEM surveys at East End Beach

The median enterococci count for the 2013-2014 season was the lowest recorded to date for this site (3 cfu/100ml).

4.6.4 Long-term trend analysis

Long-term trend analysis was not undertaken on data from this site as there were an insufficient number of samples (only triennial data available).

4.7 Ngamotu Beach

4.7.1 SEM programme

Ngamotu Beach (Photo 8) is situated within Port Taranaki, in close proximity to boat traffic and Port activities. It receives urban stormwater and a piped stream. Due to its sheltered location, situated between two breakwaters, this beach is very popular with young children and school groups and is often used for sports events.



Photo 8 Ngamotu Beach

Data for this site are presented in Table 36 and Figure 20, with a statistical summary provided in Table 37.

Table 36 Bacteriological results for Ngamotu Beach

Date	Time (NZST)	Conductivity @ 20°C (mS/m)	Bacteria			Temp (°C)
			<i>E. coli</i> (cfu/100ml)	Enterococci (cfu/100ml)	Faecal coliforms (cfu/100ml)	
05 Nov 2013	09:55	4460	28	19	31	16.1
18 Nov 2013	09:45	4450	3	4	4	18
16 Dec 2013	09:30	4520	9	3	9	20.4
16 Jan 2014	09:20	4780	<1	<1	<1	15.7
20 Jan 2014	11:55	4670	12	51	12	17.1
30 Jan 2014	09:30	4790	19	11	19	15.9
03 Feb 2014	11:40	4740	5	<1	5	18.5
17 Feb 2014	10:50	4720	3	4	4	18.7

Date	Time (NZST)	Conductivity @ 20°C (mS/m)	Bacteria			Temp (°C)
			<i>E. coli</i> (cfu/100ml)	Enterococci (cfu/100ml)	Faecal coliforms (cfu/100ml)	
20 Feb 2014	12:35	4740	1	25	1	21.3
06 Mar 2014	12:15	4740	1	1	1	16.9
21 Mar 2014	12:15	4740	13	20	15	19
31 Mar 2014	09:45	4730	<1	<1	<1	No result
03 Apr 2014	11:50	4740	32	<1	32	19.3

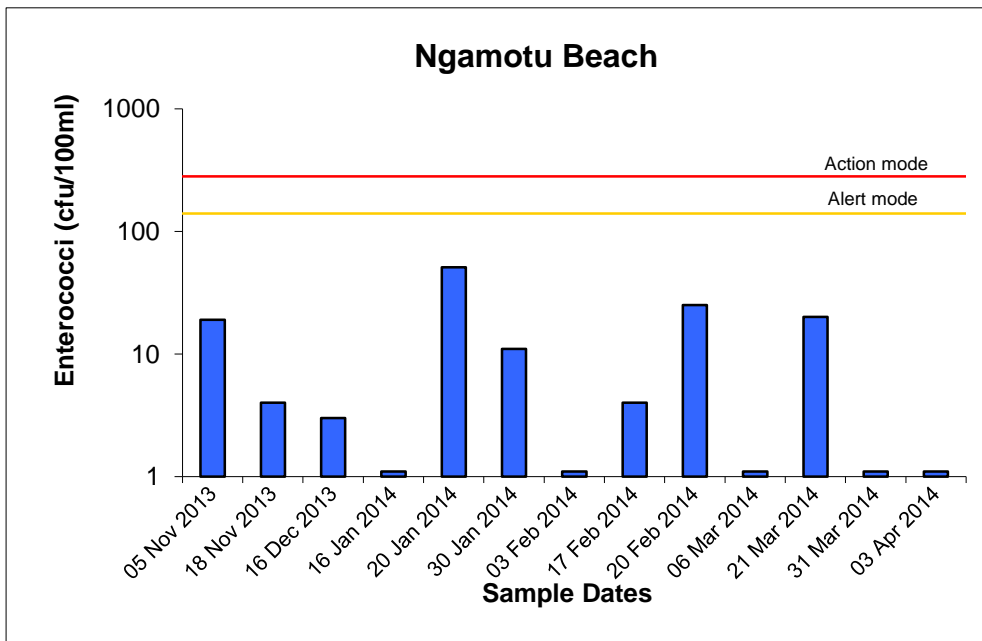


Figure 20 Enterococci numbers for the 13 SEM samples taken from Ngamotu Beach

Table 37 Statistical summary for Ngamotu Beach

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	4450	4790	4740
<i>E. coli</i>	cfu/100ml	13	<1	32	5
Enterococci	cfu/100ml	13	<1	51	4
Faecal coliforms	cfu/100ml	13	<1	32	5
Temperature	°C	12	15.7	21.3	18.5

Low counts were obtained for all SEM faecal indicator bacteria samples through the season (Tables 36 and 37, Figure 20).

4.7.2 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarized in Table 38. Enterococci counts in all samples were below both Alert and Action guideline levels.

Table 38 Bacterial guidelines performance at Ngamotu Beach

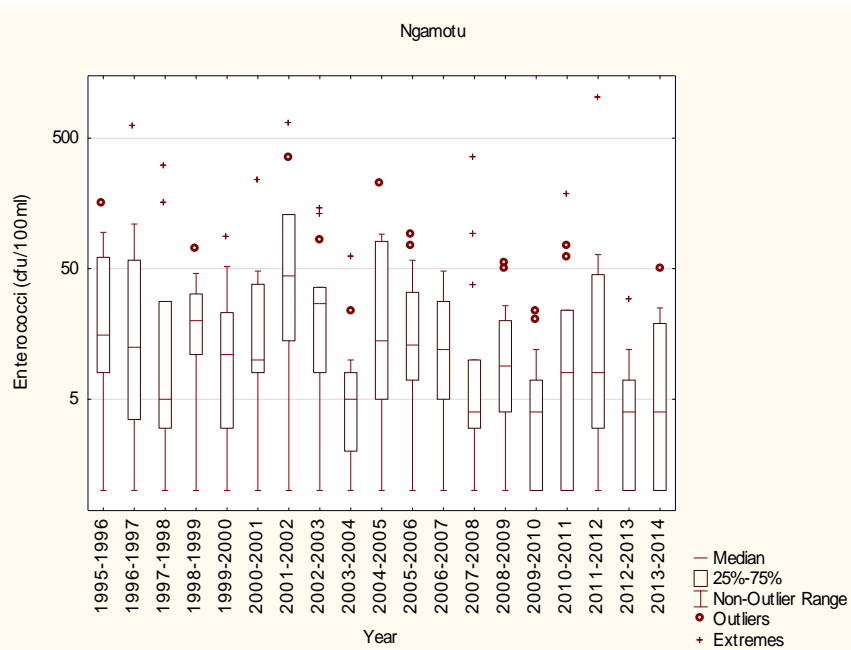
Parameter	Number of exceedances of enterococci guidelines			
	ALERT Single sample 141-280/100ml		ACTION Two consecutive samples >280/100 ml	
Enterococci	0/13	0%	0/13	0%

4.7.3 Comparison with previous summer surveys

Summary statistics for enterococci data collected at Ngamotu Beach over 19 summers are presented in Table 39 and Figure 21.

Table 39 Summary enterococci data (cfu/100 ml) for summer surveys at Ngamotu Beach

Summer	1995-96	1996-97	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04	
Minimum	< 1	1	< 1	< 1	< 1	< 1	1	< 1	< 1	
Maximum	160	600	310	72	85	240	630	140	60	
Median	16	13	5	20	11	10	44	27	5	
Summer	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14
Minimum	< 1	1	1	1	1	<1	<1	1	<1	<1
Maximum	230	90	48	350	55	23	180	1000	29	51
Median	14	13	12	4	9	4	8	8	4	4

**Figure 21** Box & whisker plots of enterococci for all summer SEM surveys at Ngamotu Beach

The median enterococci count (4 cfu/100ml) obtained for the 2013-2014 summer season was the equal lowest recorded at this site. The maximum count was within the lower range recorded at this site to date.

4.7.4 Long-term trend analysis

Trend analysis was performed by applying a LOWESS fit (tension 0.4) to a time scatterplot of the median enterococci data for 19 summer seasons (Figure 22) and testing the significance of any trend using the Mann-Kendall test at the 5% level, followed by Benjamini-Hochberg False Discovery Rate (FDR) analysis.

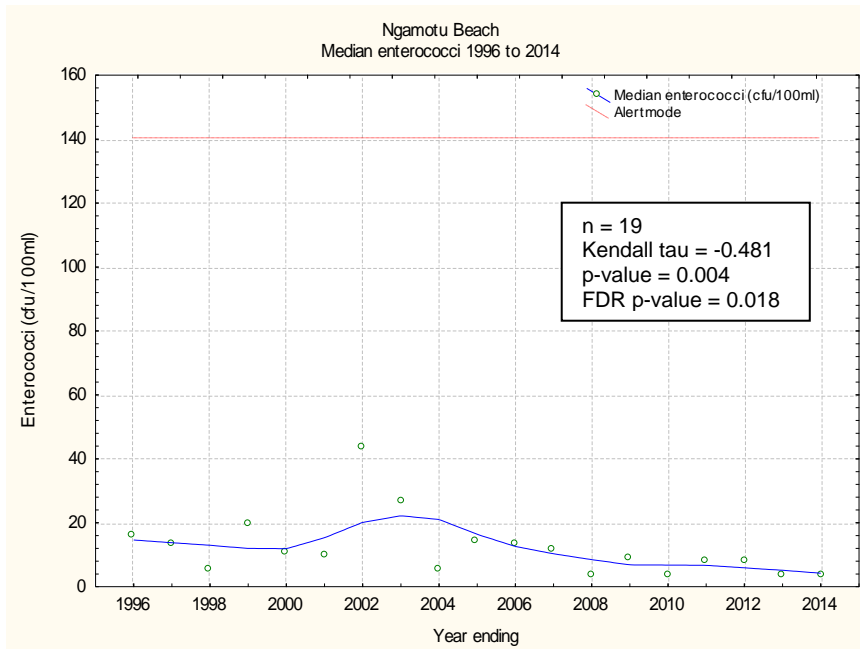


Figure 22 LOWESS trend analysis of median enterococci data at Ngamotu Beach

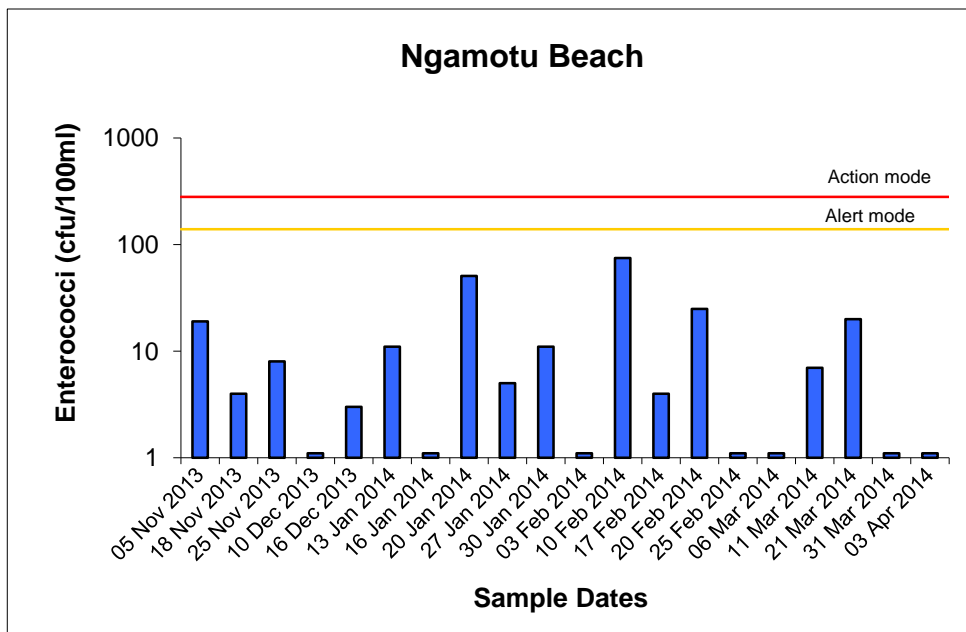
Over the 19 seasons monitored, there was a decrease in median enterococci counts (Kendall tau = -0.481). This negative trend was significant using the Mann-Kendall test ($p = 0.004$) and after FDR application ($p = 0.018$).

4.7.5 MfE guidelines additional sampling

For the purpose of MfE monitoring, seven additional samples were collected at regular intervals and under varying weather conditions during the survey season. All data, including additional MfE samples, are presented in Table 40 and Figure 23, with a statistical summary provided in Table 41.

Table 40 Bacteriological results for MfE samples at Ngamotu Beach

Date	Time	Conductivity @ 20°C (mS/m)	Bacteria			Temperature
	(NZST)		<i>E. coli</i> (cfu/100ml)	Enterococci (cfu/100ml)	Faecal coliforms (cfu/100ml)	(°C)
25 Nov 2013	09:40	4460	7	8	7	19.0
10 Dec 2013	11:00	4630	3	1	3	19.5
13 Jan 2014	10:55	4700	3	11	3	19.8
27 Jan 2014	10:55	4720	1	5	1	18.1
10 Feb 2014	10:55	4680	7	75	9	18.5
25 Feb 2014	09:20	4740	<1	<1	<1	16.3
11 Mar 2014	12:00	4660	8	7	8	20.1

**Figure 23** Enterococci counts for the 20 sample extended survey at Ngamotu Beach**Table 41** Summary statistics for SEM and additional samples at Ngamotu Beach

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	20	4450	4790	4720
<i>E. coli</i>	cfu/100ml	20	<1	32	4
Enterococci	cfu/100ml	20	<1	75	5
Faecal coliforms	cfu/100ml	20	<1	32	5
Temperature	°C	20	15.7	21.3	18.5

Additional sampling resulted in only minor change to the overall seasonal median for all faecal indicator bacteria (Table 41).

4.5.7.1 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage for the full suite of samples (20) is summarised in Table 42. No samples reached the Alert mode during the 2013-2014 season.

Table 42 Bacterial guidelines performance at Ngamotu Beach

Parameter	Number of exceedances of enterococci guidelines			
	ALERT Single sample 141-280/100ml		ACTION Two consecutive samples >280/100 ml	
Enterococci	0/20	0%	0/13	0%

4.8 Back Beach

4.8.1 SEM programme

Back Beach (Photo 9) is situated to the west of New Plymouth. It is a very well used beach for swimming over the summer months and popular with surfers year-round. The Herekawe Stream enters the beach approximately 50m from the sampling site.



Photo 9 Back Beach

The data for this site are presented in Table 43 and Figure 24, with a statistical summary provided in Table 44.

Table 43 Bacteriological results for Back Beach

Date	Time (NZST)	Conductivity @ 20°C (mS/m)	Bacteria			Temp (°C)
			<i>E. coli</i> (cfu/100ml)	Enterococci (cfu/100ml)	Faecal coliforms (cfu/100ml)	
05 Nov 2013	10:15	4500	450	320*	450	16.3
18 Nov 2013	09:30	4640	700	1800*	700	16.7
16 Dec 2013	09:15	4520	100	55	110	19.0
16 Jan 2014	09:05	4680	12	27	12	16.5
20 Jan 2014	12:10	4490	55	170	59	16.2
30 Jan 2014	09:15	4710	64	43	64	15.8
03 Feb 2014	11:20	4690	4	25	4	17.4
17 Feb 2014	10:30	4670	<1	15	<1	18.0
20 Feb 2014	12:20	4660	5	13	5	20.4
06 Mar 2014	12:05	4680	1	1	1	16.5
21 Mar 2014	12:00	4700	15	15	17	17.5
31 Mar 2014	09:30	4700	11	25	11	No result
03 Apr 2014	11:35	4600	1	140	1	18.6

*Follow up sample taken due to count exceeding 280 cfu/100ml: Follow up results provided in Section 4.8.2

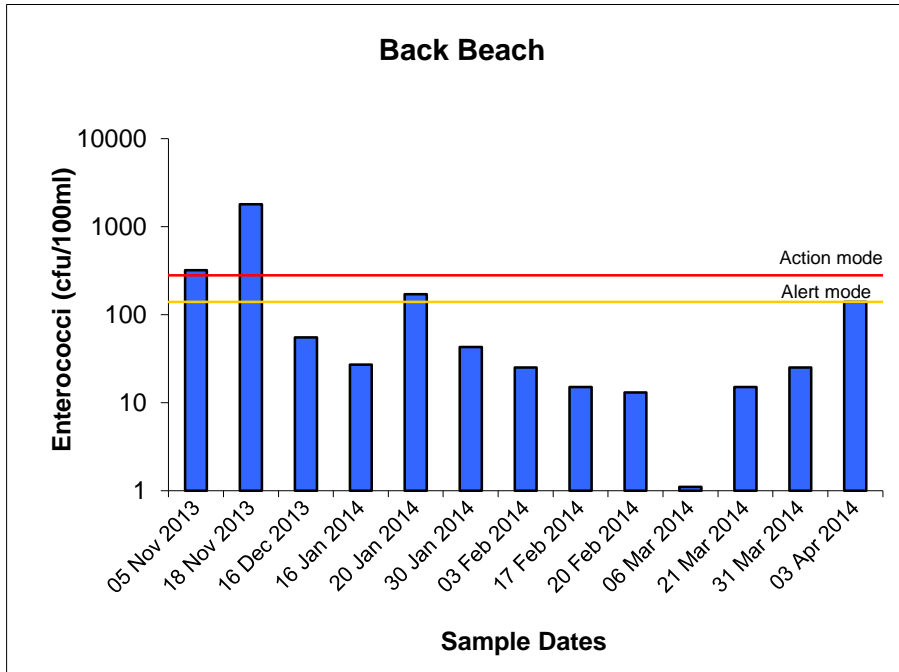


Figure 24 Enterococci counts for the 13 SEM samples taken from Back Beach

Table 44 Statistical results for Back Beach

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	4490	4710	4670
<i>E. coli</i>	cfu/100ml	13	<1	700	12
Enterococci	cfu/100ml	13	1	1800	27
Faecal coliforms	cfu/100ml	13	<1	700	12
Temperature	°C	12	15.8	20.4	17.1

The median enterococci count at this site was relatively high (27 cfu/100ml). A number of high individual counts were recorded on different dates throughout the 2013-2014 summer season, with three exceeding 140 enterococci cfu/100ml (5 November 2013, 18 November 2013 and 20 January 2014). This site can be susceptible to high faecal indicator bacteria counts at high tide due to the sea channeling into a restricted area with potential influence from the Herekawe Stream and potential faecal contamination from a range of wild and domesticated animals.

4.8.2 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarized in Table 45. Three samples (5 November 2013, 18 November 2013 and 20 January 2014) reached Alert level (>140 enterococci cfu/100ml) at this site during summer 2013-2014. Action mode did not occur because follow up samples taken on 8 November 2013 and 20 November 2013 were well below 280 enterococci cfu/100ml (29 and 36 cfu/100ml respectively).

Table 45 Bacterial guidelines performance at Back Beach

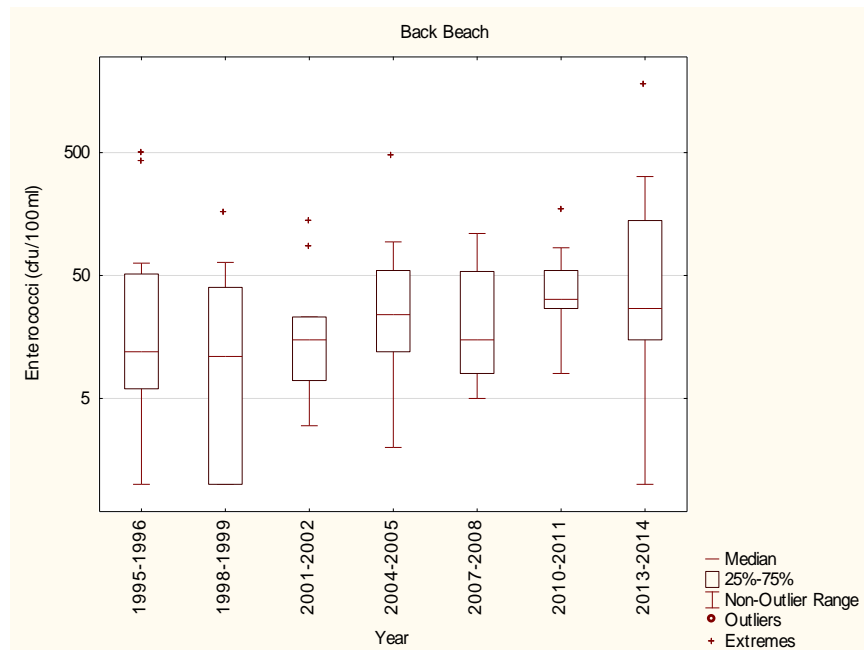
Parameter	Number of exceedances of enterococci guidelines			
	ALERT Single sample >140 cfu/100ml		ACTION Two consecutive samples >280/100ml	
Enterococci	3/13	23%	0/13	0%

4.8.3 Comparison with previous summer surveys

Summary statistics for enterococci data collected at Back Beach over 7 summer surveys are presented in Table 46 and Figure 25.

Table 46 Summary enterococci data (cfu/100 ml) for summer surveys at Back Beach

Summer	1995-96	1998-99	2001-02	2004-05	2007-08	2010-11	2013-14
Minimum	<1	<1	3	2	5	8	1
Maximum	500	160	140	480	110	170	1800
Median	12	11	15	24	15	32	27

**Figure 25** Box and whisker plots of enterococci for all summer SEM surveys at Back Beach

The median enterococci count for the 2013-2014 season (27 cfu/100ml) was at the higher end of the range previously recorded at this site. The maximum enterococci count (1800 cfu/100ml) was the highest recorded at this site to date (Figure 25).

4.8.4 Long-term trend analysis

Long-term trend analysis was not undertaken on data from this site as there were an insufficient number of samples (only triennial data available).

4.9 Oakura Beach SC (opposite surf lifesaving club)

4.9.1 SEM programme

Oakura Beach (Photo 10) is popular with beach bathers during summer, and frequented by surfers all year-round. Two small lowland streams (Waimoku and Wairau) enter the beach on either side of the site, and as a consequence concentrations of faecal indicator bacteria can increase significantly during periods of high rainfall.



Photo 10 Oakura Beach

The data from this site are presented in Table 47 and Figure 26, with a statistical summary provided in Table 48.

Table 47 Bacteriological results for Oakura Beach SC

Date	Time (NZST)	Conductivity @ 20°C (mS/m)	Bacteria			Temp (°C)
			<i>E. coli</i> (cfu/100ml)	Enterococci (cfu/100ml)	Faecal coliforms (cfu/100ml)	
05 Nov 2013	10:45	4350	4	16	5	16.1
18 Nov 2013	08:50	4640	3	4	3	16.6
16 Dec 2013	08:40	4590	11	9	11	18.9
16 Jan 2014	08:40	4690	12	20	13	16.3
20 Jan 2014	13:35	4460	88	190	88	16
30 Jan 2014	08:45	4720	130	39	130	15.9
03 Feb 2014	10:55	4700	13	20	13	18.7
17 Feb 2014	09:55	4560	24	29	24	17.9
20 Feb 2014	11:50	4130	37	96	37	20.9
06 Mar 2014	11:35	4730	23	9	27	16.8

Date	Time (NZST)	Conductivity @ 20°C (mS/m)	Bacteria			Temp (°C)
			<i>E. coli</i> (cfu/100ml)	Enterococci (cfu/100ml)	Faecal coliforms (cfu/100ml)	
21 Mar 2014	11:25	4690	36	63	39	19.1
31 Mar 2014	08:50	4540	25	57	35	No result
03 Apr 2014	11:05	4680	180	650*	180	19.1

*Follow up sample taken due to count exceeding 280 cfu/100ml: Follow up result provided in Section 4.9.2

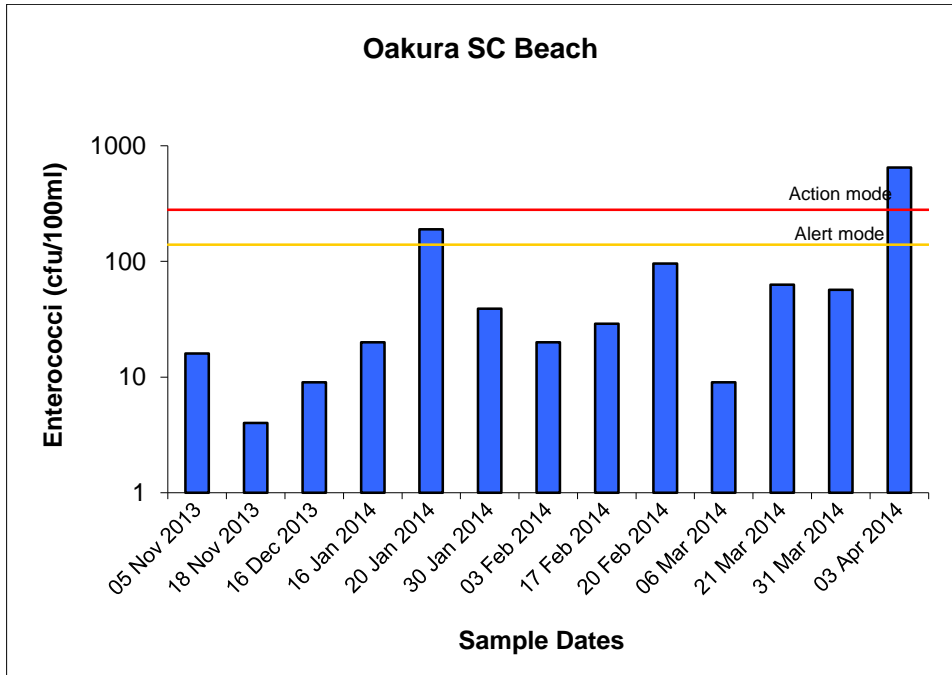


Figure 26 Enterococci numbers for the 13 SEM samples taken from Oakura Beach SC

Table 48 Statistical summary for Oakura Beach SC

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	4130	4730	4640
<i>E. coli</i>	cfu/100ml	13	3	180	24
Enterococci	cfu/100ml	13	4	650	29
Faecal coliforms	cfu/100ml	13	3	180	27
Temperature	°C	12	15.9	20.9	17.4

Compared to other beach bathing sites around the region, the median enterococci count at this site was relatively high (29 cfu/100ml).

The location of the Waimoku and Wairau stream mouths can influence water quality at this site. Microbial source tracking has shown that resident wildfowl are the principal contributors to elevated faecal indicator bacteria counts within these streams, particularly in the case of the Waimoku Stream (TRC 2011-01).

The Waimoku Stream (site WMK000298) was sampled on 13 occasions during the 2013-2014 summer season and faecal indicator bacteria counts were found to be consistently high (430-3300 *E. coli* cfu/100ml, 120-2900 enterococci cfu/100ml).

Throughout the 2013-2014 summer season the location of the Waimoku and Wairau stream mouths gradually moved closer together. Towards the end of the season the streams were only 20-30 m apart. The close proximity of the streams to the beach sampling site is likely to have contributed to the high enterococci count obtained on 3 April 2014 (650 cfu/100ml). The Waimoku Stream was straightened (digging a channel through sand bank) by New Plymouth District Council on 23 May 2014.

4.9.2 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarized in Table 49. Two SEM samples (20 January and 3 April 2014) reached Alert level (>140 enterococci cfu/100ml) at this site during summer 2013-2014. The sample collected on 3 April 2014 exceeded 280 cfu/100ml, however, Action mode did not occur because the follow up sample taken on 7 April 2014 was well below 280 enterococci cfu/100ml (64 cfu/100ml).

Table 49 Bacterial guidelines performance at Oakura Beach SC

Parameter	Number of exceedances of enterococci guidelines			
	ALERT Single sample >140 cfu/100ml		ACTION Two consecutive samples >280 cfu/100 ml	
Enterococci	2/13	15%	0/13	0%

4.9.3 Comparison with previous summer surveys

Summary statistics for enterococci data collected at Oakura Beach opposite the surf lifesaving club over 19 summers are presented in Table 50 and Figure 27.

Table 50 Summary enterococci data (cfu/100ml) for summer surveys at Oakura SC

Summer	1995-96	1996-97	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04	
Minimum	< 3	< 3	< 1	5	< 1	1	4	1	< 1	
Maximum	800	56	60	56	880	16	120	180	94	
Median	31	8	21	16	7	5	25	8	8	
Summer	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14
Minimum	2	1	<1	4	5	5	2	1	7	4
Maximum	250	300	230	160	250	800	100	130	460	650
Median	25	12	11	32	20	45	17	36	17	29

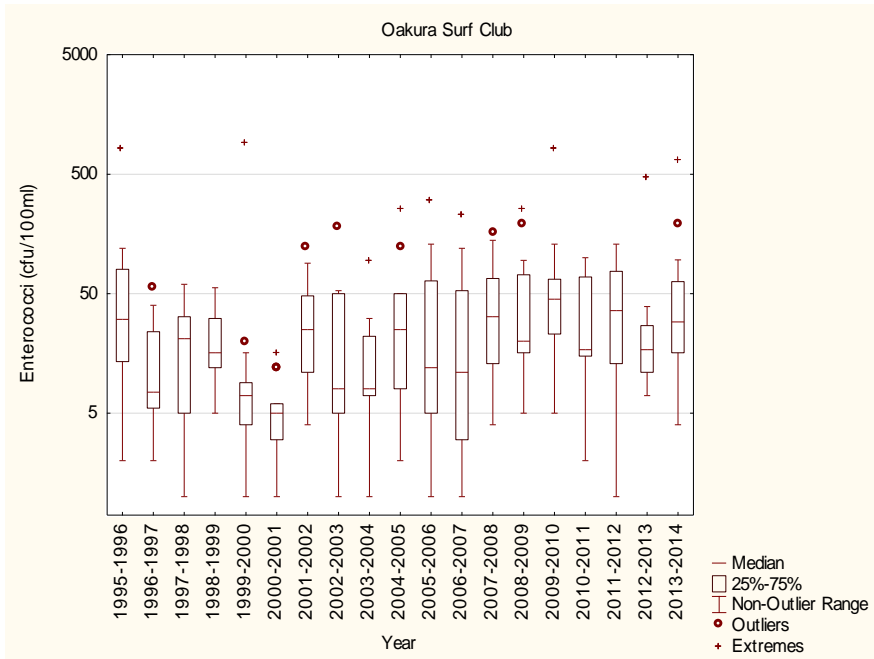


Figure 27 Box & whisker plots of enterococci for all summer SEM surveys at Oakura SC

The median enterococci count (29 cfu/100ml) obtained for the 2013-2014 summer season was within the relatively high range of values previously recorded at this site (Table 50, Figure 27). Interannual variation in median enterococci counts at this site can be largely attributed to the changing location of the small stream mouths relative to the sampling site.

4.9.4 Long-term trend analysis

Trend analysis was performed by applying a LOWESS fit (tension 0.4) to a time scatterplot of the median enterococci data for 19 summer seasons (Figure 28) and testing the significance of any trend using the Mann-Kendall test at the 5% level, followed by Benjamini-Hochberg False Discovery Rate (FDR) analysis.

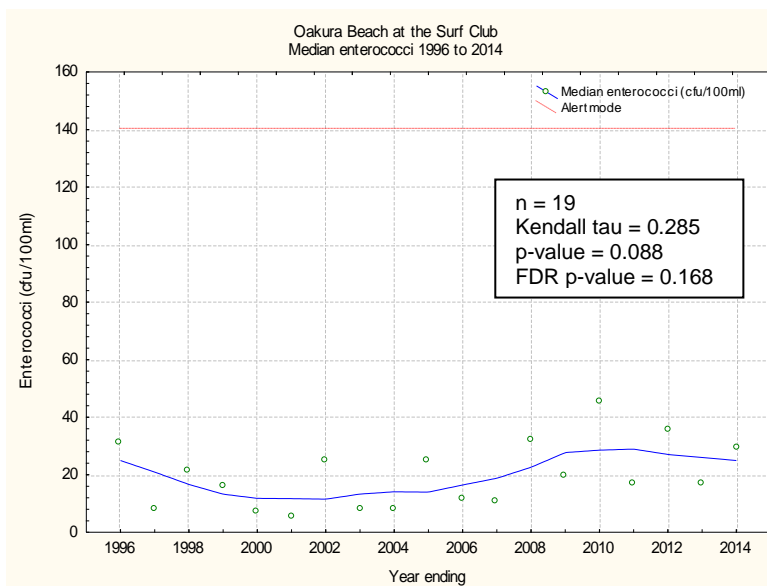


Figure 28 LOWESS trend analysis of median enterococci data at Oakura Beach SC

Over the 19 seasons monitored, there was a positive trend (i.e. an increase) in median enterococci counts (Kendall tau = 0.285) that was not significant at the 5% level ($p = 0.088$).

4.9.5 MfE guidelines additional sampling

For the purpose of MfE monitoring, seven additional samples were collected at irregular intervals and under varying weather conditions during the survey season. All data, including additional MfE samples, are presented in Table 51 and Figure 29, with a statistical summary provided in Table 52.

Table 51 Bacteriological results for MfE samples at Oakura Beach SC

Date	Time	Conductivity @ 20°C (mS/m)	Bacteria			Temperature (°C)
	(NZST)		<i>E. coli</i> (cfu/100ml)	Enterococci (cfu/100ml)	Faecal coliforms (cfu/100ml)	
25 Nov 2013	10:05	3770	92	65	96	17.5
10 Dec 2013	11:25	4040	89	63	89	19.2
13 Jan 2014	11:15	4620	19	24	19	18.2
27 Jan 2014	11:40	4680	9	7	11	17.4
10 Feb 2014	11:15	4660	71	77	71	19.0
25 Feb 2014	10:30	4680	5	21	5	16.6
11 Mar 2014	12:45	4590	8	12	8	18.1

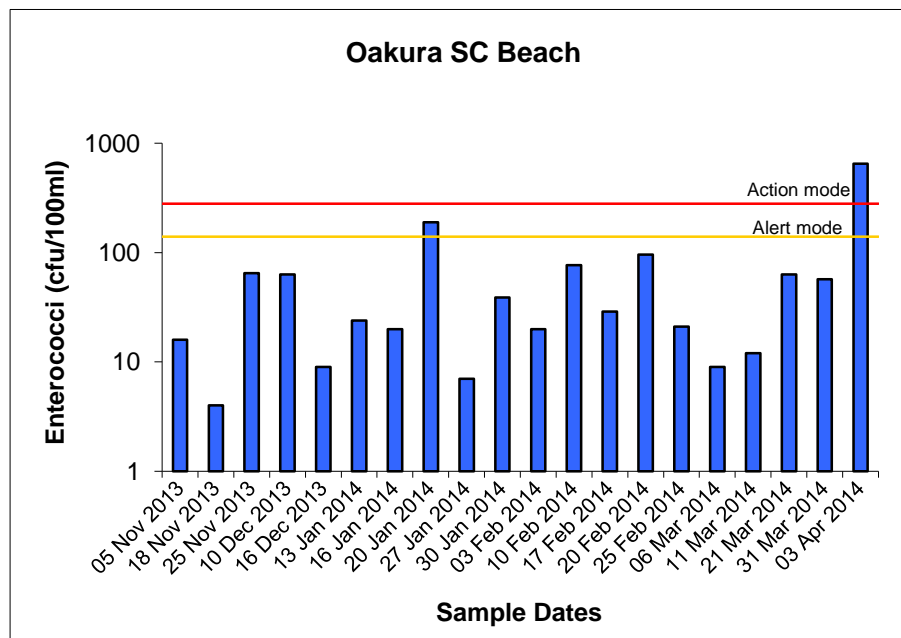


Figure 29 Enterococci numbers for the 20 sample extended survey at Oakura Beach SC

Table 52 Summary statistics for SEM and MfE samples at Oakura Beach SC

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	20	3770	4730	4630
<i>E. coli</i>	cfu/100ml	20	3	180	24
Enterococci	cfu/100ml	20	4	650	27
Faecal coliforms	cfu/100ml	20	3	180	26
Temperature	°C	19	15.9	20.9	17.9

Additional sampling had little effect on the seasonal medians for all faecal indicator bacteria (Tables 48 and 52).

4.5.9.1 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarized in Table 53. Two SEM samples (20 January and 3 April 2014) reached Alert level (>140 enterococci cfu/100ml) at this site during summer 2013-2014.

Table 53 Bacterial guidelines performance at Oakura Beach SC

Parameter	Number of exceedances of enterococci guidelines			
	ALERT Single sample 141-280/100ml		ACTION Two consecutive samples >280/100 ml	
Enterococci	2/20	10%	0/20	0%

4.10 Oakura Beach CG (opposite camp ground)

4.10.1 SEM programme

This site, situated at the west end of Oakura Beach in front of the campground, is a popular site with bathers and surfers (Photo 11).



Photo 11 Oakura Beach in front of the campground

The data for this site are presented in Table 54 and Figure 30, with a statistical summary provided in Table 55.

Table 54 Bacteriological results for Oakura Beach CG

Date	Time (NZST)	Conductivity @ 20°C (mS/m)	Bacteria			Temp (°C)
			<i>E. coli</i> (cfu/100ml)	Enterococci (cfu/100ml)	Faecal coliforms (cfu/100ml)	
05 Nov 2013	11:05	4580	19	21	25	16.2
18 Nov 2013	08:30	4660	1	4	1	16.8
16 Dec 2013	09:15	4640	8	11	9	18.7
16 Jan 2014	08:15	4720	5	5	5	16.3
20 Jan 2014	13:00	4570	16	37	16	16.4
30 Jan 2014	08:20	4760	9	5	9	15.2
03 Feb 2014	10:40	4750	<1	<1	<1	18.7
17 Feb 2014	09:15	4710	<1	3	<1	17.7
20 Feb 2014	11:25	4720	<1	<1	<1	20.5
06 Mar 2014	11:15	4740	<1	<1	<1	16.5
21 Mar 2014	11:00	4740	1	1	1	18.6
31 Mar 2014	08:35	4740	<1	3	<1	No result
03 Apr 2014	10:40	4730	<1	<1	<1	18.7

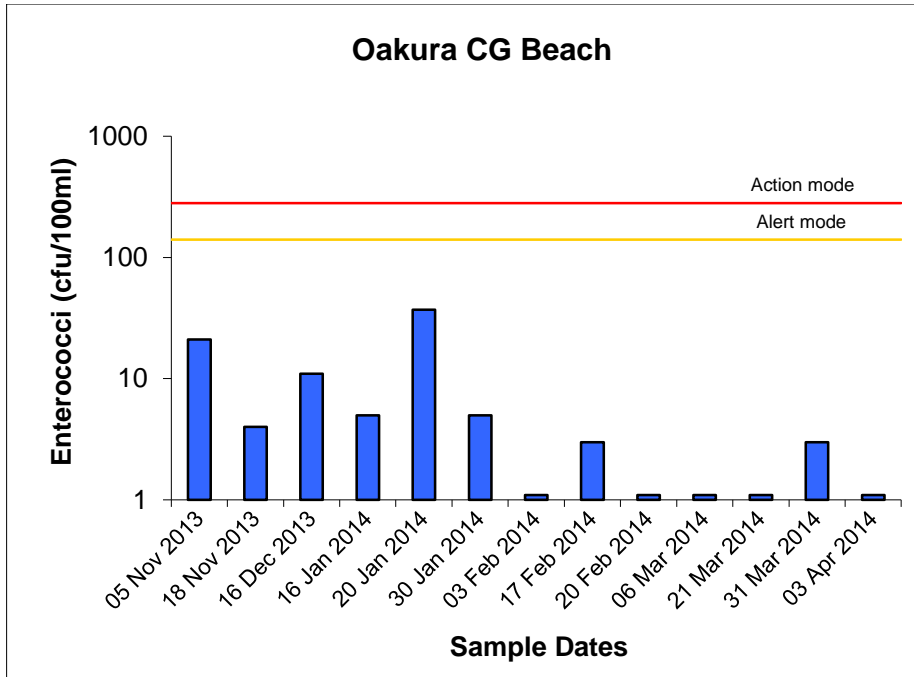


Figure 30 Enterococci counts for the 13 SEM samples taken from Oakura Beach CG

Table 55 Statistical results for Oakura Beach CG

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	4570	4760	4720
<i>E. coli</i>	cfu/100ml	13	<1	19	1
Enterococci	cfu/100ml	13	<1	37	3
Faecal coliforms	cfu/100ml	13	<1	25	1
Temperature	°C	12	15.2	20.5	17.5

Water quality was extremely good at this site with low medians for all faecal indicator bacteria (≤ 3 cfu/100ml).

4.10.2 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarized in Table 56. No sample reached Alert level (>140 enterococci cfu/100ml) at this site during summer 2013-2014.

Table 56 Bacterial guidelines performance at Oakura Beach CG

Parameter	Number of exceedances of enterococci guidelines			
	ALERT Single sample >140 cfu/100ml		ACTION Two consecutive samples $>280/100$ ml	
Enterococci	0/13	0%	0/13	0%

4.10.3 Comparison with previous summer surveys

Summary statistics for enterococci data collected at Oakura Beach opposite the campground over 19 summer surveys are presented in Table 57 and Figure 31.

Table 57 Summary enterococci data (cfu/100 ml) for summer surveys at Oakura Beach opposite the campground

Summer	1995-96	1996-97	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04	
Minimum	2	1	<1	<1	<1	<1	<1	<1	<1	
Maximum	280	150	24	16	48	240	31	17	24	
Median	9	5	2	4	3	3	7	3	3	
Summer	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14
Minimum	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Maximum	90	8	260	18	30	25	33	79	260	37
Median	6	1	3	7	6	1	<1	4	3	3

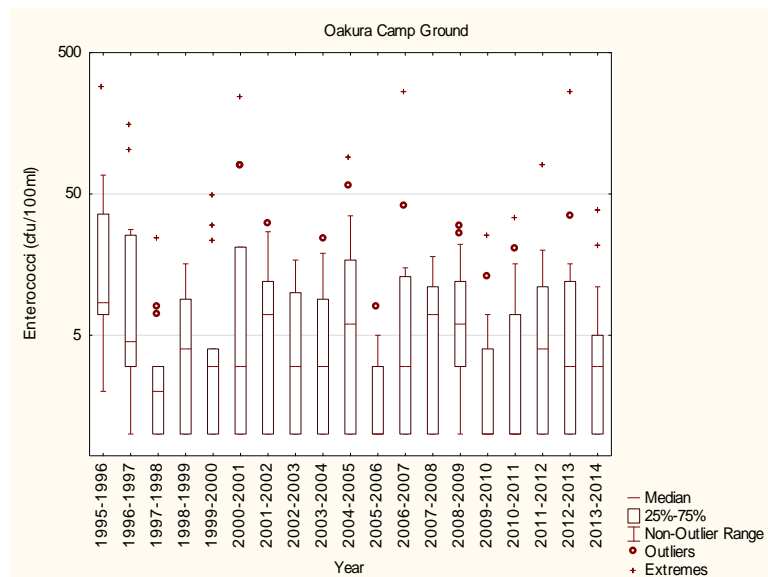


Figure 31 Box and whisker plots of enterococci for all summer SEM surveys at Oakura Beach opposite the campground

The median enterococci count for the 2013-2014 season was within the low range previously recorded at this site (3 cfu/100ml). Over the past 19 summers water quality has remained consistently high at this site (Table 57).

4.10.4 Long-term trend analysis

Trend analysis was performed by applying a LOWESS fit (tension 0.4) to a time scatterplot of the median enterococci data for 19 summer seasons (Figure 32) and testing the significance of any trend using the Mann-Kendall test at the 5% level, followed by Benjamini-Hochberg False Discovery Rate (FDR) analysis.

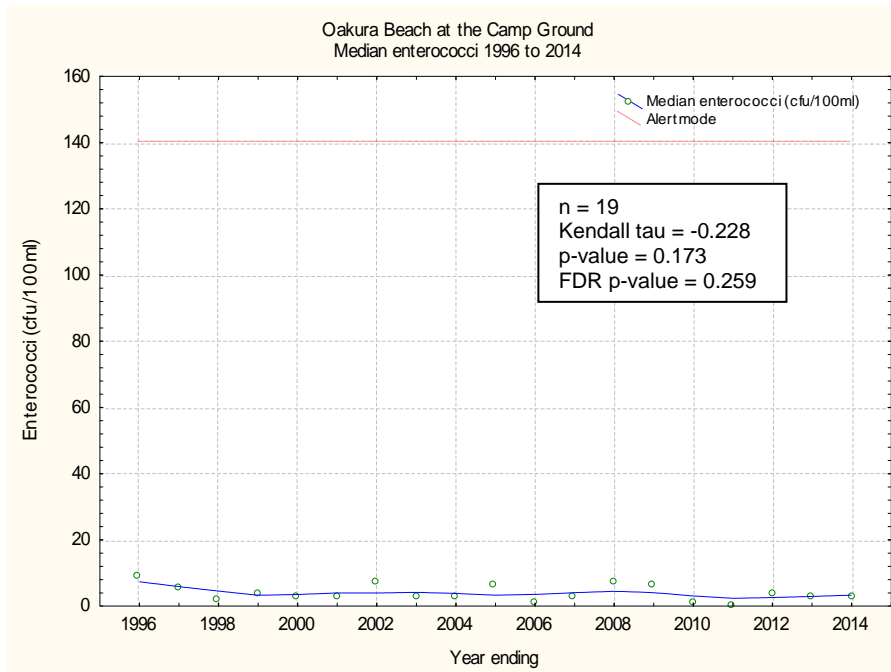


Figure 32 LOWESS trend analysis of median enterococci data at Oakura Beach Camp Ground

Over the 19 seasons monitored, there was a decreasing trend in median enterococci counts (Kendall tau = -0.228) that was not significant at the 5% level ($p = 0.173$).

4.11 Opunake Beach

4.11.1 SEM programme

Opunake Beach (Photo 12) is a very popular swimming beach in south Taranaki. There are no large rivers in the vicinity. However, the outlet of a freshwater stream from the Opunake Power Station enters at the southern end of the beach.



Photo 12 Opunake Beach and motor camp

The data for this site are presented in Table 58 and Figure 33, with a statistical summary provided in Table 59.

Table 58 Bacteriological results for Opunake Beach

Date	Time (NZST)	Conductivity @ 20°C (mS/m)	Bacteria			Temp (°C)
			<i>E. coli</i> (cfu/100ml)	Enterococci (cfu/100ml)	Faecal coliforms (cfu/100ml)	
05 Nov 2013	11:05	4640	5	1	5	16.9
18 Nov 2013	10:30	4650	12	5	12	18
16 Dec 2013	09:55	4620	1	<1	1	20.1
16 Jan 2014	10:35	4730	7	49	7	19.5
20 Jan 2014	12:10	4750	1	<1	1	17.6
30 Jan 2014	10:05	4740	<1	<1	<1	17.5
03 Feb 2014	13:15	4750	<1	<1	<1	16.7
17 Feb 2014	11:30	4730	<1	1	<1	19
20 Feb 2014	11:20	4640	<1	<1	<1	21.7
06 Mar 2014	13:25	4640	<1	1	<1	17.8
21 Mar 2014	12:35	4680	1	<1	1	18.3
31 Mar 2014	10:20	4660	4	1	4	18.7
03 Apr 2014	12:10	4680	<1	1	<1	19.3

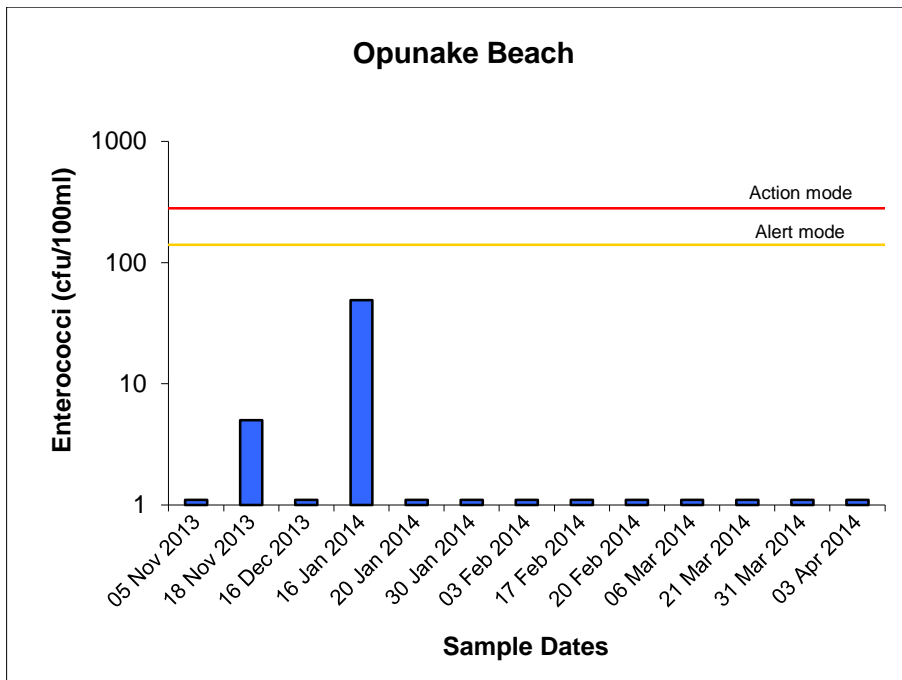


Figure 33 Enterococci numbers for the 13 SEM samples at Opunake Beach

Table 59 Statistical summary for Opunake Beach

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	4620	4750	4680
<i>E. coli</i>	cfu/100ml	13	<1	12	1
Enterococci	cfu/100ml	13	<1	49	1
Faecal coliforms	cfu/100ml	13	<1	12	1
Temperature	°C	13	16.7	21.7	18.3

Concentrations were very low for all faecal indicator bacteria, with medians of 1 cfu/100ml, indicating excellent water quality at this site.

4.11.2 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarized in Table 60. Water quality was considered suitable for contact recreation throughout the season, with all samples well below Alert guideline levels.

Table 60 Bacterial guidelines performance at Opunake Beach

Parameter	Number of exceedances of enterococci guidelines			
	ALERT Single sample >140 cfu/100ml		ACTION Two consecutive samples >280 cfu/100 ml	
Enterococci	0/13	0%	0/13	0%

4.11.3 Comparison with previous summer surveys

Summary statistics for enterococci data collected at Opunake Beach over 19 summers are presented in Table 61 and Figure 34.

Table 61 Summary enterococci data (cfu/100ml) for summer surveys at Opunake Beach

Summer	1995-96	1996-97	1999-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04	
Minimum	<1	<1	1	<1	<1	<1	<1	<1	<1	
Maximum	74	60	73	7	41	69	140	20	9	
Median	9	<1	5	<1	1	2	4	1	1	
Summer	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14
Minimum	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Maximum	10	19	8	11	25	4	100	17	7	49
Median	1	2	1	<1	2	<1	<1	3	<1	1

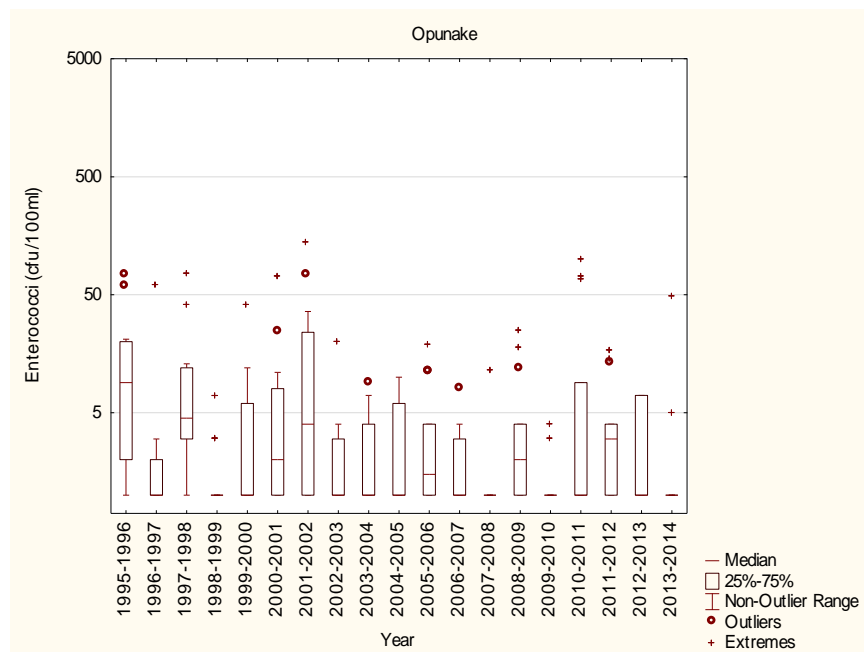


Figure 34 Box and whisker plots of enterococci for all summer SEM surveys at Opunake Beach

The low enterococci data obtained for Opunake Beach during the 2013-2014 summer continues the trend of excellent water quality at this site (Table 61, Figure 34).

4.11.4 Long-term trend analysis

Trend analysis was performed by applying a LOWESS fit (tension 0.4) to a time scatterplot of the median enterococci data for 19 summer seasons (Figure 35) and testing the significance of any trend using the Mann-Kendall test at the 5% level, followed by Benjamini-Hochberg False Discovery Rate (FDR) analysis.

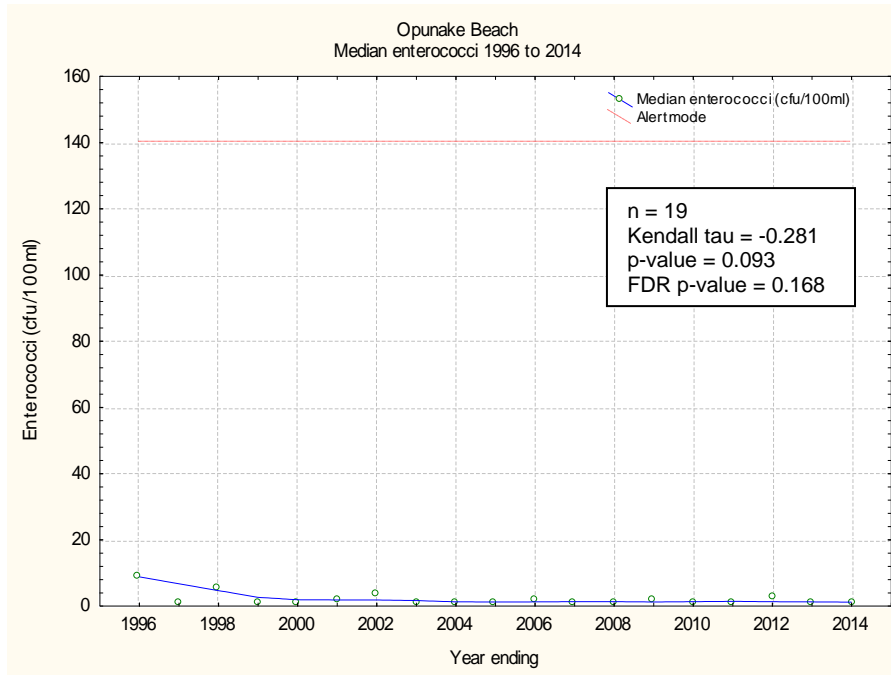


Figure 35 LOWESS trend analysis of median enterococci data at Opunake Beach

Over the 19 seasons monitored, there was a decreasing trend in median enterococci counts (Kendall tau = -0.281) that was not significant at the 5% level ($p = 0.093$).

4.11.5 MfE guidelines additional sampling

For the purpose of MfE monitoring seven additional samples were collected at regular intervals and under varying weather conditions during the survey season. All data, including additional MfE samples are presented in Table 62 and Figure 36, with a statistical summary in Table 63.

Table 62 Bacteriological results for MfE samples at Opunake Beach

Date	Time	Conductivity @ 20°C (mS/m)	Bacteria			Temperature (°C)
	(NZST)		<i>E. coli</i> (cfu/100ml)	Enterococci (cfu/100ml)	Faecal coliforms (cfu/100ml)	
25 Nov 2013	11:00	4170	<1	3	<1	21.0
10 Dec 2013	12:15	4480	11	13	11	21.1
13 Jan 2014	12:00	4690	4	1	4	19.0
27 Jan 2014	12:30	4710	4	<1	4	16.8
10 Feb 2014	12:00	4620	5	1	5	16.7
25 Feb 2014	11:25	4730	<1	<1	<1	19.6
11 Mar 2014	13:30	4740	<1	<1	<1	20.1
16 Dec 2013	09:55	4620	1	<1	1	20.1

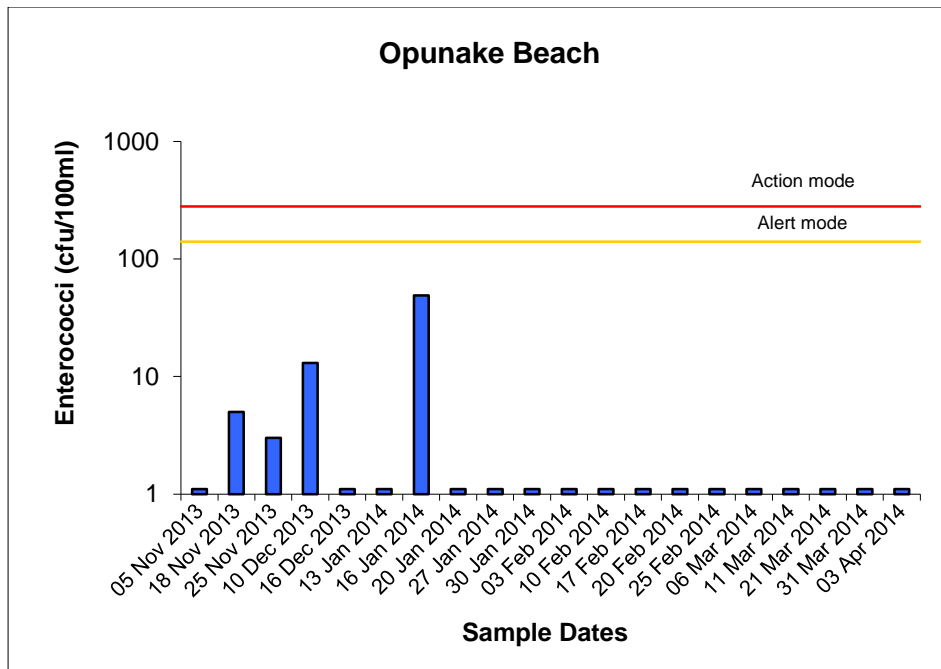


Figure 36 Enterococci numbers for the 20 sample extended survey at Opunake Beach

Table 63 Summary statistics for SEM and MfE samples at Opunake Beach

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	20	4170	4750	4680
<i>E. coli</i>	cfu/100ml	20	0.5	12	1
Enterococci	cfu/100ml	20	0.5	49	1
Faecal coliforms	cfu/100ml	20	0.5	12	1
Temperature	°C	20	16.7	21.7	18.9

The additional MfE samples made no difference to the medians for all faecal indicator bacteria, reflecting consistently high water quality at this site.

4.11.6 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarized in Table 64. No samples exceeded Alert level.

Table 64 Bacterial guidelines performance at Oakura Beach SC

Parameter	Number of exceedances of enterococci guidelines			
	ALERT Single sample >140 cfu/100ml		ACTION Two consecutive samples >280 cfu/100 ml	
Enterococci	0/20	0%	0/20	0%

4.12 Ohawe Beach

4.12.1 SEM programme

Ohawe Beach (Photo 13) is located close to the large Waingongoro River in South Taranaki. The river catchment drains highly modified agricultural land.



Photo 13 Ohawe Beach

Data from this site are presented in Table 65 and Figure 37, with a statistical summary provided in Table 66.

Table 65 Bacteriological results for Ohawe Beach

Date	Time (NZST)	Conductivity @ 20°C (mS/m)	Bacteria			Temp (°C)
			<i>E. coli</i> (cfu/100ml)	Enterococci (cfu/100ml)	Faecal coliforms (cfu/100ml)	
05 Nov 2013	09:45	4340	60	5	60	16.3
18 Nov 2013	09:05	4200	35	5	35	17.4
16 Dec 2013	09:05	4000	600	400*	600	19.6
16 Jan 2014	09:07	3360	37	43	47	17.9
20 Jan 2014	11:25	4640	12	52	12	18.7
30 Jan 2014	08:40	3570	1500	160	1500	17.8
03 Feb 2014	11:35	4530	<3	<2	<3	19
17 Feb 2014	10:05	4500	4	1	4	18.3
20 Feb 2014	12:10	4610	23	93	23	19.8
06 Mar 2014	12:00	4020	12	3	16	17.5
21 Mar 2014	11:30	4680	4	1	4	17.6
31 Mar 2014	08:45	4490	9	1	9	17.9
03 Apr 2014	10:40	4580	1	3	1	18.6

*Follow up sample taken due to count exceeding 280 cfu/100ml. Follow up result provided in Section 4.12.2

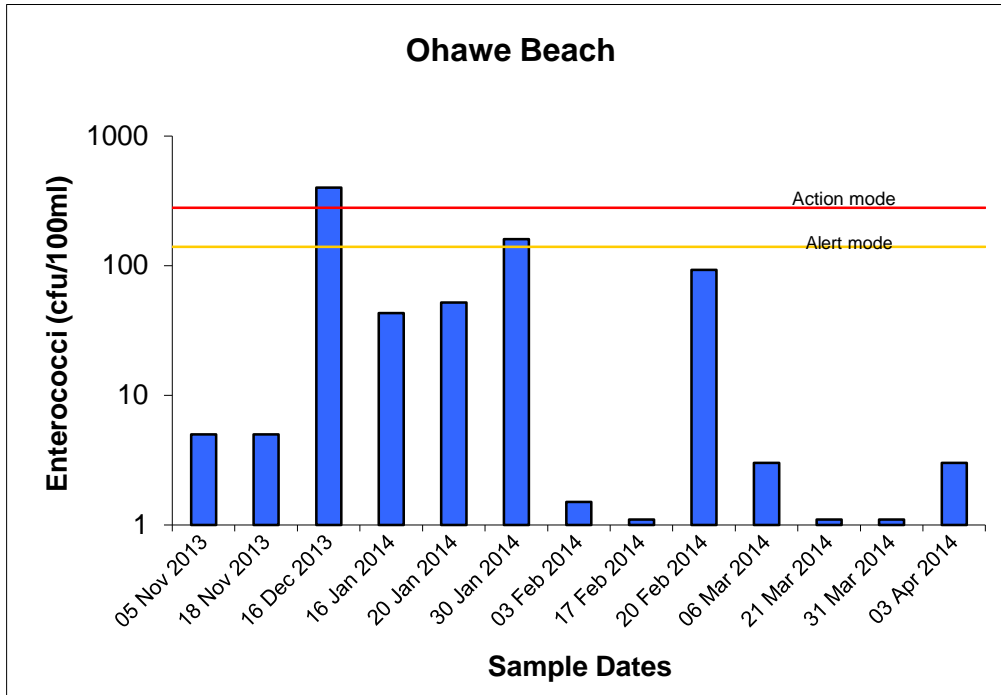


Figure 37 Enterococci numbers for the 13 SEM samples at Ohawe Beach

Table 66 Statistical summary for Ohawe Beach

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	3360	4680	4490
<i>E. coli</i>	cfu/100ml	13	1	1500	12
Enterococci	cfu/100ml	13	<1	400	5
Faecal coliforms	cfu/100ml	13	1	1500	16
Temperature	°C	13	16.3	19.8	17.9

The site can be influenced by the Waingongoro River (see low conductivities recorded throughout the season, Table 65). Microbial source tracking from samples taken at the river mouth and just upstream of the Ohawe settlement indicated that the main source of faecal contamination in the river is from ruminants and wildfowl (TRC 2013-01). Of the two 'Alert' level samples taken from the Ohawe Beach site, both showed evidence of freshwater influence (16 December 2013 and 30 January 2014, Table 65).

4.12.2 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarized in Table 67. Enterococci counts in two samples entered the Alert category (16 December 2013 and 30 January 2014). The sample collected on 16 December 2013 exceeded 280 cfu/100ml, however, Action mode did not occur because the follow up sample taken on 18 December 2013 was well below 280 enterococci cfu/100ml (37 cfu/100ml).

Table 67 Bacterial guidelines performance at Ohawe Beach

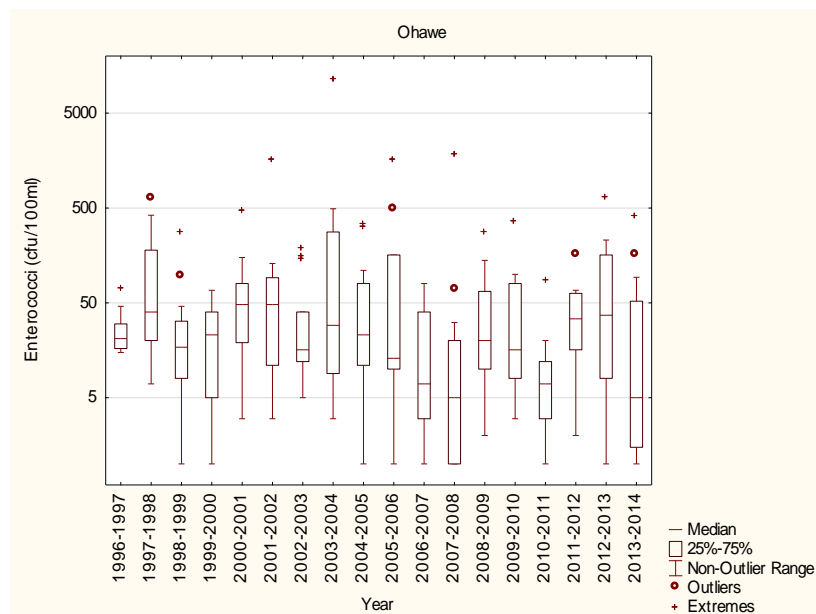
Parameter	Number of exceedances of enterococci guidelines			
	ALERT Single sample >140 cfu/100ml		ACTION Two consecutive samples >280 cfu/100ml	
Enterococci	2/13	15%	0/13	0%

4.12.3 Comparison with previous summer surveys

Summary statistics for enterococci data collected at Ohawe Beach over 18 summers are presented in Table 68 and Figure 38.

Table 68 Summary enterococci data (cfu/100ml) for summer surveys at Ohawe Beach

Summer	1996-97	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04	2004-05
Minimum	15	7	<1	1	3	3	5	3	<1
Maximum	72	650	280	68	450	1600	180	11000	330
Median	21	40	17	23	48	48	16	29	23
Summer	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14
Minimum	1	<1	<1	2	3	<1	2	<1	<1
Maximum	1600	80	1800	280	350	83	160	630	400
Median	13	7	5	20	16	7	34	37	5

**Figure 38** Box and whisker plots of enterococci for all summer surveys at Ohawe Beach

The median enterococci count (5 cfu/100ml) obtained for the 2013-2014 summer season was the equal lowest recorded at this site. The maximum count was within the range previously recorded at this site to date. Maxima and medians at this site are historically variable due to the influence of the Waingongoro River (Table 68).

4.12.4 Long-term trend analysis

Trend analysis was performed by applying a LOWESS fit (tension 0.4) to a time scatterplot of the median enterococci data for 18 summer seasons (Figure 39) and testing the significance of any trend using the Mann-Kendall test at the 5% level, followed by Benjamini-Hochberg False Discovery Rate (FDR) analysis.

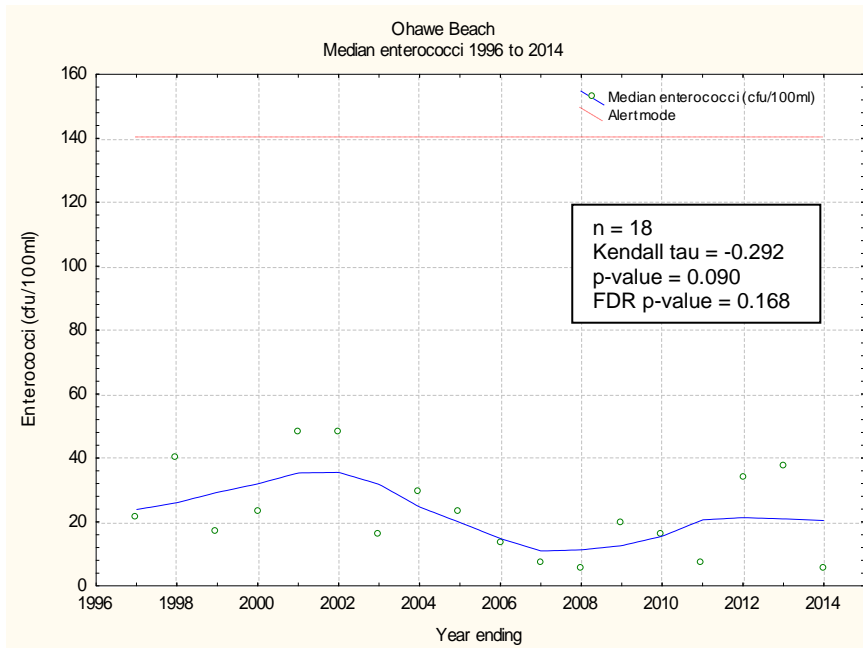


Figure 39 LOWESS trend analysis of median enterococci data at Ohawe Beach

Over the 18 seasons monitored, there was a decreasing trend in median enterococci counts (Kendall tau = -0.292) that was not significant at the 5% level ($p = 0.090$).

5. General summary

5.1 Regional overview

During the 2013-2014 summer season, microbiological water quality was generally very good across bathing beaches in the Taranaki region (Table 69). Low median enterococci values were recorded for all beaches monitored (≤ 29 enterococci cfu/100ml). Out of the 191 samples collected at 12 beach sites, 95% were below guideline Alert levels (140 enterococci cfu/100ml). No site reached Action mode (two consecutive samples >280 enterococci cfu/100ml) during the 2013-2014 season. All sites assessed obtained a Suitability for Recreation Grade of either 'good' (6/12), 'fair' (4/12) or 'poor' (2/12). These grades reflect qualitative risk grading of the catchment in addition to quantitative enterococci results (see Section 2.2).

Table 69 Summary enterococci results for the TRC beach bathing monitoring programme 2013-2014

Beach sites ¹	Enterococci median (cfu/100 ml)		Number of samples above Alert mode (>140 cfu/100ml)		Trend analysis ⁴			Suitability for recreation grade (SFRG) ⁶
	SEM ²	SEM+MfE ³	SEM ²	SEM+MfE ³	Kendall tau ⁵	Mann-Kendall p value	False Discovery Rate p value	
Fitzroy	<1	<1	0	0	-0.505	0.003	0.018	Good
Opunake	1	1	0	0	-0.281	0.093	0.168	Good
Oakura CG	3	-	0	-	-0.228	0.173	0.259	Good
East End	3	-	0	-	-	-	-	Good
Ngamotu	4	5	0	0	-0.480	0.004	0.018	Good
Onaero	5	11	0	0	0.031	0.886	0.886	Fair
Ohawe	5	-	2	-	-0.292	0.090	0.168	Fair
Waitara East	7	-	2	-	-0.152	0.388	0.485	Fair
Waitara West	8	-	0	-	-0.047	0.784	0.882	Good
Bell Block	11	-	1	-	-	-	-	Poor
Back Beach	27	-	3	-	-	-	-	Poor
Oakura SC	29	27	2	2	0.285	0.088	0.168	Fair

¹Sites ordered in ascending order of SEM median enterococci

²SEM results based on 13 samples

³SEM+MfE results based on 20 samples (MfE data available for selected sites only)

⁴Trend analysis performed on SEM data only (Section 3.4)

⁵A negative/positive Kendall tau indicates a decreasing/increasing temporal trend in median enterococci respectively

⁶The Suitability for Recreational Grade is calculated using the Microbial Assessment Category (based on five years enterococci data) and the Sanitary Inspection Category (a qualitative risk assessment based on the catchment) as explained in Section 2.2

- = insufficient data

Fitzroy Beach and Opunake Beach were the region's cleanest bathing beaches with median enterococci counts of ≤ 1 cfu/100ml and no samples reaching Alert mode throughout the 2013-2014 season (Table 69, Figure 40). Water quality at these two beaches has remained consistently high since the Taranaki Regional Council bathing beach monitoring programme began in 1995-1996 (Figure 41).

Oakura Surf Club and Back Beach recorded the highest enterococci medians of the 2013-2014 season (29 and 27 cfu/100ml respectively). Bacteriological water quality at these two sites has been historically variable due to the influence of nearby streams.

Long term trend analysis (12-19 years data) showed a significant (at the 5% level) decrease in enterococci medians at 2 of the 12 sites monitored (Fitzroy and Ngamotu) and no significant change at 10 of the 12 sites (Table 69, Kendall tau and Mann-Kendall p values). No site showed a significant increase in enterococci medians over the time period monitored i.e. deterioration in water quality.

The site at Fitzroy Beach has shown the greatest improvement in microbiological water quality since 1995 (Table 69, Kendall tau -0.505, Mann-Kendall p value 0.003). Recent improvements in water quality might have arisen due to work undertaken by the New Plymouth District Council as part of the Stormwater Upgrade Project at Fitzroy. As a result of this project there is now less flow of stormwater to the stormwater infiltration galleries located in the Fitzroy beach car park.

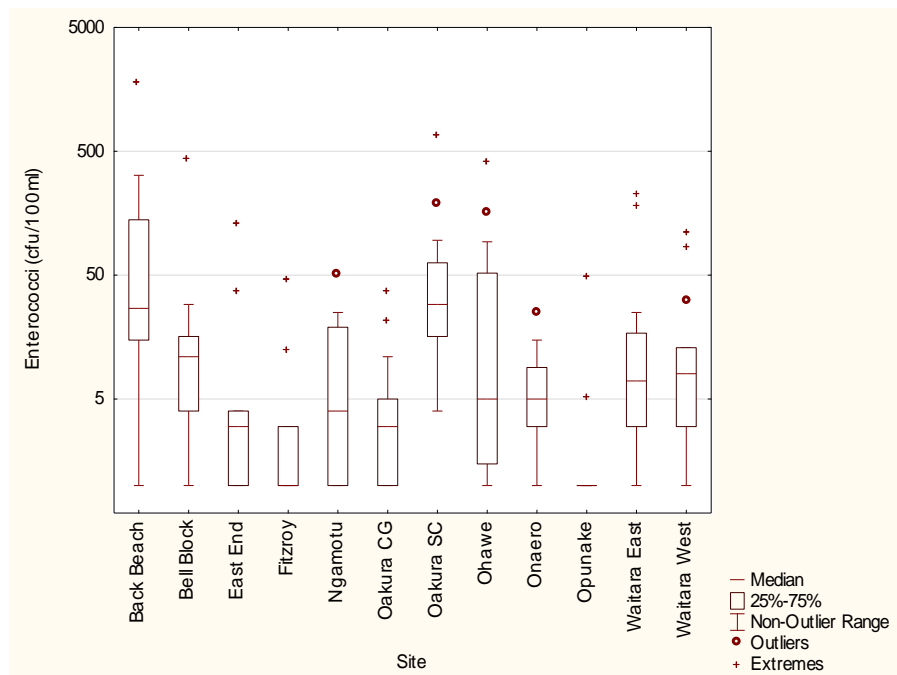


Figure 40 Box and whisker plots of enterococci at all sites during the 2013-2014 season (SEM data only)

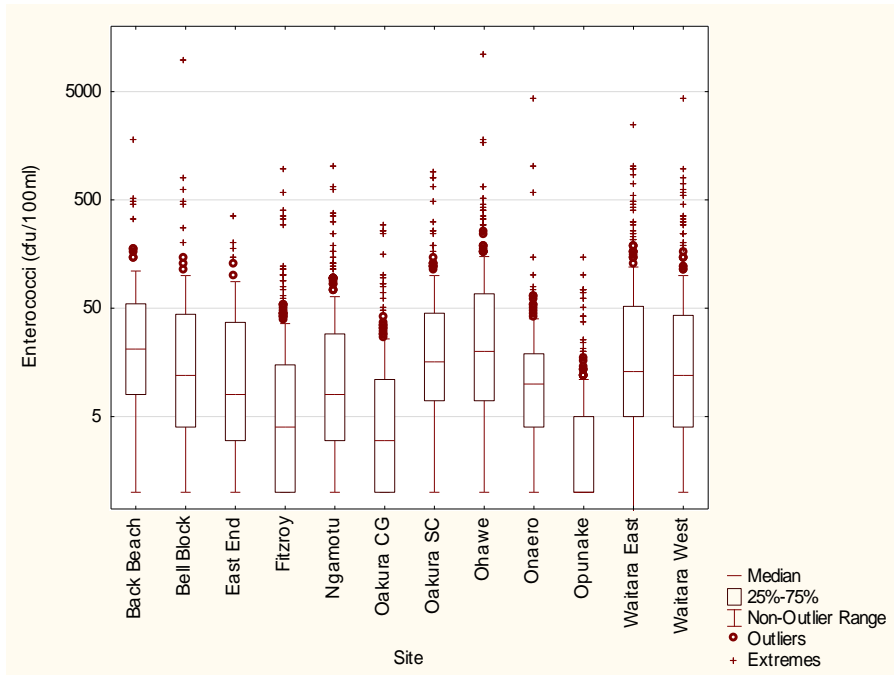


Figure 41 Box and whisker plots of long term enterococci data from 1995/implementation of monitoring to 2014 (SEM data only)

5.2 Conclusion

During the 2013-2014 summer season, water quality across the Taranaki region was generally high with 95% of samples below guideline Alert levels (<141 enterococci cfu/100ml) and no site reaching Action mode (two consecutive samples >280 enterococci cfu/100ml). At seven of the twelve sites, no sample entered the alert mode. Sites in Taranaki compared favorably to national results, with 83% of Taranaki sites considered generally satisfactory for swimming based on SFRG grades ('very good', 'good' and 'fair'). In Taranaki, of the few samples which entered the Alert category (5%) during the 2013-2014 season approximately half were associated with rainfall/freshwater influence. Many of the beach sites monitored in Taranaki are located close to stream or river mouths which can act as a source of contamination during heavy rainfall. The majority of these rivers and streams drain catchments with intensive agricultural land use, including dairying. Microbial source tracking has revealed that in addition to ruminants, birds (wildfowl and gulls) can also act as a key source of contamination in Taranaki freshwater environments (TRC 2014). In order to minimize potential health risks, the Council recommends reducing coastal recreational activities for two-three days following heavy rainfall (when other water quality parameters such as discolouration and high turbidity are not conducive to bathing in any case).

6. Recommendations

As a result of the 2013-2014 summer marine contact recreation bacteriological survey it is recommended:

1. THAT the 2014-2015 summer survey be performed at 12 sites continuing with the existing sampling protocol (annual, plus Year 3 sites).
2. THAT the 2014-2015 summer survey also includes an additional 7 samples collected at the five principal usage sites (Onaero, Fitzroy, Ngamotu, Oakura SC, and Opunake) in accordance with MfE, 2003 guidelines.
3. THAT follow-up sampling be performed as deemed necessary by Council staff. This should include follow-up samples within 24 hours of any samples exceeding 280 cfu/100ml in order to assess if Action level has been reached.
4. THAT reporting of results be performed as appropriate during the season, and in an Annual Report upon completion of the season's programme.

Glossary of common terms and abbreviations

The following abbreviations and terms are used within this report:

'Action' mode	Two consecutive single samples greater than 280 enterococci cfu/100ml
Alert mode	Single sample greater than 140 enterococci cfu/100ml
Bacteriological faecal indicators	Micro-organisms selected as indicators of faecal contamination
Bathers	Those who enter the water, and either partially or fully immerse themselves
Bathing season	Generally the bathing season extends between 1 November and 31 March
Beach	The shore or any access point to the sea
cfu	Colony forming units. A measure of the concentration of bacteria usually expressed as per 100 ml sample
Condy	Conductivity, an indication of the level of dissolved salts in a sample, usually measured at 20°C and expressed in mS/m
Contact recreation	Recreation activities that bring people physically in contact with water, involving a risk of involuntary ingestion or inhalation of water
E.coli	Escherichia coli, member of the Enterobacteriaceae, an indicator of the possible presence of faecal material and pathological micro-organisms. Usually expressed as colony forming units per 100 millilitre sample
Enterococci	Members of the Streptococcus group of bacteria characterised as faecal in origin. Enterococci provide an indicator of the possible presence of faecal material and pathological micro-organisms. Usually expressed as colony forming units per 100 ml of sample
Faecal coliform	An indicator of the possible presence of faecal material and pathological micro-organisms. Usually expressed as colony forming units per 100 ml sample
False Discovery Rate (FDR)	The expected proportion of true hypothesis rejected out of the total number of rejections
Follow-up sample	Second sample taken to confirm an initial high result; usually within 24-72 hours depending on accessibility/sample turnaround time, etc.
Median	Central value when values are arranged in order of magnitude
Microbiological Assessment RMA	A measurement of water quality over time as provided by historical (five years) microbiological results – A, B, C or D Category (MAC) Resource Management Act 1991 and subsequent amendments
Sanitary Inspection Category (SIC)	A measure of the susceptibility of a water body to faecal contamination – Very High, High, Moderate, Low or Very Low
Suitability for Recreation Grade (SFRG)	A combination of Sanitary Inspection Category (SIC) and Microbiological Assessment Category (MAC), describes the general condition of a site at any given time, based on both risk and indicator bacteria counts
Temp	Temperature, measured in °C (degrees Celsius)
Water quality	The bacteriological condition of a water body as it relates to human health, measured using indicator bacteria

For further information on analytical methods, contact the Council's laboratory

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Appendix I

High tide times

High tide times (NZST) at New Plymouth for 2013-2014 sampling dates

Date		Time of HT
Tuesday	5 November 2013	1033
Monday	18 November 2013	0958
Monday	16 December 2013	0902
Thursday	16 January 2014	0958
Monday	20 January 2014	1209
Thursday	30 January 2014	0903
Monday	3 February 2014	1213
Monday	17 February 2014	1111
Thursday	20 February 2014	1255
Thursday	6 March 2014	1315
Friday	21 March 2014	1234
Monday	31 March 2014	0959
Thursday	3 April 2014	1204

Appendix II

MAC assessments 2009-2014

Onaero Beach

Marine MAC Assessment

Import MAC Data
Press "Import Data" to retrieve a new MAC data set

Site Name
Name of site from the MAC file: Onaero Beach

MAC Data Summary

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedances (Enterococci / 100 mL)		Days in Compliance (%days < 280 / year)
			140 to 280	>280	
2013	20	10.5	0	0	100 %
2012	20	7.5	0	1	95 %
2011	20	14.5	2	2	90 %
2010	20	14.0	1	1	95 %
2009	20	15.5	1	0	100 %
Total	100	13.0	4	4	96 %

Calculate MAC
Press "Calculate MAC" to determine a MAC assessment

MAC Results
MAC category: C 95%ile (/100 mL): 240.0
Interim Result? Complete Data Set (5 years with at least 100 samples)

Save MAC Assessment
Press "Save MAC Report" to save this MAC assessment.

Marine Suitability for Recreational Grade

MAC Assessment Results
MAC Assessment: C
Interim Assessment? Complete Data Set (5 years with at least 100 samples)

SIC Assessment Results
SIC Assessment: Moderate
Primary SIC Impact: 13: River - agricultural activities/birds/teral animals

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment
Reassessment of the MAC and / or SIC is required or press "Irreconcilable Followup" to assign a conservative grade.

SFRG Assessment Results
Site name: Onaero Beach
SFRG Assessment: Fair

Save this SFRG Assessment to a Single Summary File
Press "Save as a Single Entry File" to save the SFRG, MAC, and SIC assessments and the MAC and SIC data in one file.

Save SFRG Assessment to a Multiple Summary File
Press "Save to a Database Format File" to save summary data as one row in a comma-delimited file.
 Print the column labels to the file "ColumnLabelsMarine.txt".

Waitara East

Marine MAC Assessment

Import MAC Data
Press "Import Data" to retrieve a new MAC data set

Site Name
Name of site from the MAC file: Waitara East Beach

MAC Data Summary

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedances (Enterococci / 100 mL)		Days in Compliance (%days < 280 / year)
			140 to 280	>280	
2013	13	7.0	2	0	100 %
2012	13	37.0	0	2	84 %
2011	13	6.0	1	0	100 %
2010	13	3.0	1	2	84 %
2009	13	15.0	2	0	100 %
Total	65	8.0	6	4	93 %

Calculate MAC
Press "Calculate MAC" to determine a MAC assessment

MAC Results
MAC category: C 95%ile (/100 mL): 332.5
Interim Result? Interim Data Set (< 5 years, or < 100 samples used)

Save MAC Assessment
Press "Save MAC Report" to save this MAC assessment.

Marine Suitability for Recreational Grade

MAC Assessment Results
MAC Assessment: C
Interim Assessment? Interim Data Set (< 5 years, or < 100 samples used)

SIC Assessment Results
SIC Assessment: Moderate
Primary SIC Impact: 13: River - agricultural activities/birds/teral animals

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment
Reassessment of the MAC and / or SIC is required or press "Irreconcilable Followup" to assign a conservative grade.

SFRG Assessment Results
Site name: Waitara East Beach
SFRG Assessment: Fair

Save this SFRG Assessment to a Single Summary File
Press "Save as a Single Entry File" to save the SFRG, MAC, and SIC assessments and the MAC and SIC data in one file.

Save SFRG Assessment to a Multiple Summary File
Press "Save to a Database Format File" to save summary data as one row in a comma-delimited file.
 Print the column labels to the file "ColumnLabelsMarine.txt".

Waitara West

Marine MAC Assessment

Import MAC Data
Press "Import Data" to retrieve a new MAC data set Import data

Site Name
Name of site from the MAC file: Waitara West Beach

MAC Data Summary

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedances (Enterococci / 100 mL)		Days in Compliance (%days < 280 / year)
			140 to 280	>280	
2013	13	8.0	0	0	100 %
2012	13	8.0	0	0	100 %
2011	13	13.0	1	0	100 %
2010	13	20.0	0	2	84 %
2009	13	12.0	0	0	100 %
Total	65	11.0	1	2	96 %

Calculate MAC
Press "Calculate MAC" to determine a MAC assessment Calculate MAC

MAC Results
MAC category: B 95%ile (/100 mL): 145.0
Interim Result?: Interim Data Set (< 5 years, or < 100 samples used)

Save MAC Assessment
Press "Save MAC Report" to save this MAC assessment. Save MAC Report

OK

Marine Suitability for Recreational Grade

MAC Assessment Results
MAC Assessment: B
Interim Assessment?: Interim Data Set (< 5 years, or < 100 samples used)

SIC Assessment Results
SIC Assessment: Moderate
Primary SIC Impact: 13: River - agricultural activities/birds/teral animals

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment Calculate SFRG
Reassessment of the MAC and / or SIC is required or press "Irreconcilable Followup" to assign a conservative grade Irreconcilable Followup

SFRG Assessment Results
Site name: Waitara West Beach
SFRG Assessment: Good

Save this SFRG Assessment to a Single Summary File
Press "Save as a Single Entry File" to save the SFRG, MAC, and SIC assessments and the MAC and SIC data in one file. Save as a Single Entry File

Save SFRG Assessment to a Multiple Summary File
Press "Save to a Database Format File" to save summary data as one row in a comma-delimited file. Save to a Database Format File
 Print the column labels to the file "ColumnLabelsMarine.txt".

OK

Bell Block

Marine MAC Assessment

Import MAC Data
Press "Import Data" to retrieve a new MAC data set Import data

Site Name
Name of site from the MAC file: Bell Block

MAC Data Summary

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedances (Enterococci / 100 mL)		Days in Compliance (%days < 280 / year)
			140 to 280	>280	
2013	13	11.0	0	1	92 %
2012	17	13.0	0	2	88 %
2011	0	0.0	0	0	0 %
2010	13	5.0	1	1	92 %
2009	0	0.0	0	0	0 %
Total	43	11.0	1	4	90 %

Calculate MAC
Press "Calculate MAC" to determine a MAC assessment Calculate MAC

MAC Results
MAC category: D 95%ile (/100 mL): 647.5
Interim Result?: Interim Data Set (< 5 years, or < 100 samples used)

Save MAC Assessment
Press "Save MAC Report" to save this MAC assessment. Save MAC Report

OK

Marine Suitability for Recreational Grade

MAC Assessment Results
MAC Assessment: D
Interim Assessment?: Interim Data Set (< 5 years, or < 100 samples used)

SIC Assessment Results
SIC Assessment: Moderate
Primary SIC Impact: 3: Urban stormwater

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment Calculate SFRG
Reassessment of the MAC and / or SIC is required or press "Irreconcilable Followup" to assign a conservative grade Irreconcilable Followup

SFRG Assessment Results
Site name: Bell Block
SFRG Assessment: Poor

Save this SFRG Assessment to a Single Summary File
Press "Save as a Single Entry File" to save the SFRG, MAC, and SIC assessments and the MAC and SIC data in one file. Save as a Single Entry File

Save SFRG Assessment to a Multiple Summary File
Press "Save to a Database Format File" to save summary data as one row in a comma-delimited file. Save to a Database Format File
 Print the column labels to the file "ColumnLabelsMarine.txt".

OK

Fitzroy

Marine MAC Assessment

Import MAC Data
Press "Import Data" to retrieve a new MAC data set

Site Name
Name of site from the MAC file: Fitzroy Beach

MAC Data Summary

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedances (Enterococci / 100 mL)		Days in Compliance (%days < 280 / year)
			140 to 280	>280	
2013	20	1.0	0	0	100 %
2012	20	3.0	0	0	100 %
2011	21	3.0	0	1	95 %
2010	21	1.0	0	0	100 %
2009	20	4.5	0	0	100 %
Total	102	1.0	0	1	99 %

Calculate MAC
Press "Calculate MAC" to determine a MAC assessment

MAC Results
MAC category: B 95%ile (/100 mL): 44.4
Interim Result?: Complete Data Set (5 years with at least 100 samples)

Save MAC Assessment
Press "Save MAC Report" to save this MAC assessment.

Marine Suitability for Recreational Grade

MAC Assessment Results
MAC Assessment: B
Interim Assessment?: Complete Data Set (5 years with at least 100 samples)

SIC Assessment Results
SIC Assessment: Moderate
Primary SIC Impact: 3: Urban stormwater

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment
Reassessment of the MAC and / or SIC is required or press "Inconceivable Followup" to assign a conservative grade

SFRG Assessment Results
Site name: Fitzroy Beach
SFRG Assessment: Good

Save this SFRG Assessment to a Single Summary File
Press "Save as a Single Entry File" to save the SFRG, MAC, and SIC assessments and the MAC and SIC data in one file.

Save SFRG Assessment to a Multiple Summary File
Press "Save to a Database Format File" to save summary data as one row in a comma-delimited file.
 Print the column labels to the file "ColumnLabelsMarine.txt".

East End

Marine MAC Assessment

Import MAC Data
Press "Import Data" to retrieve a new MAC data set

Site Name
Name of site from the MAC file: East End Beach

MAC Data Summary

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedances (Enterococci / 100 mL)		Days in Compliance (%days < 280 / year)
			140 to 280	>280	
2013	13	3.0	0	0	100 %
2012	20	9.5	1	0	100 %
2011	21	13.0	1	1	95 %
2010	21	8.0	0	0	100 %
2009	21	9.0	1	1	95 %
Total	96	8.0	3	2	97 %

Calculate MAC
Press "Calculate MAC" to determine a MAC assessment

MAC Results
MAC category: B 95%ile (/100 mL): 144.0
Interim Result?: Interim Data Set (< 5 years, or < 100 samples used)

Save MAC Assessment
Press "Save MAC Report" to save this MAC assessment.

Marine Suitability for Recreational Grade

MAC Assessment Results
MAC Assessment: B
Interim Assessment?: Interim Data Set (< 5 years, or < 100 samples used)

SIC Assessment Results
SIC Assessment: Moderate
Primary SIC Impact: 3: Urban stormwater

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment
Reassessment of the MAC and / or SIC is required or press "Inconceivable Followup" to assign a conservative grade

SFRG Assessment Results
Site name: East End Beach
SFRG Assessment: Good

Save this SFRG Assessment to a Single Summary File
Press "Save as a Single Entry File" to save the SFRG, MAC, and SIC assessments and the MAC and SIC data in one file.

Save SFRG Assessment to a Multiple Summary File
Press "Save to a Database Format File" to save summary data as one row in a comma-delimited file.
 Print the column labels to the file "ColumnLabelsMarine.txt".

Ngamotu

Marine MAC Assessment

Import MAC Data
Press "Import Data" to retrieve a new MAC data set

Site Name
Name of site from the MAC file: Ngamotu Beach

MAC Data Summary

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedances (Enterococci / 100 mL)		Days in Compliance (%days < 280 / year)
			140 to 280	>280	
2013	20	4.5	0	0	100 %
2012	20	4.0	0	0	100 %
2011	21	8.0	0	1	95 %
2010	20	8.0	1	1	95 %
2009	20	4.0	0	0	100 %
Total	101	5.0	1	2	98 %

Calculate MAC
Press "Calculate MAC" to determine a MAC assessment

MAC Results
MAC category: B 95%ile (/100 mL) 78.1
Interim Result? Complete Data Set (5 years with at least 100 samples)

Save MAC Assessment
Press "Save MAC Report" to save this MAC assessment.

Marine Suitability for Recreational Grade

MAC Assessment Results
MAC Assessment: B
Interim Assessment? Complete Data Set (5 years with at least 100 samples)

SIC Assessment Results
SIC Assessment: Moderate
Primary SIC Impact: 3: Urban stormwater

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment
Reassessment of the MAC and / or SIC is required or press "Irreconcilable Followup" to assign a conservative grade

SFRG Assessment Results
Site name: Ngamotu Beach
SFRG Assessment: Good

Save this SFRG Assessment to a Single Summary File
Press "Save as a Single Entry File" to save the SFRG, MAC, and SIC assessments and the MAC and SIC data in one file.

Save SFRG Assessment to a Multiple Summary File
Press "Save to a Database Format File" to save summary data as one row in a comma-delimited file.
 Print the column labels to the file "ColumnLabelsMarine.txt".

Back

Marine MAC Assessment

Import MAC Data
Press "Import Data" to retrieve a new MAC data set

Site Name
Name of site from the MAC file: Back Beach

MAC Data Summary

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedances (Enterococci / 100 mL)		Days in Compliance (%days < 280 / year)
			140 to 280	>280	
2013	13	27.0	1	2	84 %
2012	0	0.0	0	0	0 %
2011	0	0.0	0	0	0 %
2010	13	32.0	1	0	100 %
2009	0	0.0	0	0	0 %
Total	26	31.5	2	2	92 %

Calculate MAC
Press "Calculate MAC" to determine a MAC assessment

MAC Results
MAC category: D 95%ile (/100 mL) 616.0
Interim Result? Interim Data Set (< 5 years, or < 100 samples used)

Save MAC Assessment
Press "Save MAC Report" to save this MAC assessment.

Marine Suitability for Recreational Grade

MAC Assessment Results
MAC Assessment: D
Interim Assessment? Interim Data Set (< 5 years, or < 100 samples used)

SIC Assessment Results
SIC Assessment: Low
Primary SIC Impact: 14: River - focal points of drainage

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment
Reassessment of the MAC and / or SIC is required or press "Irreconcilable Followup" to assign a conservative grade

SFRG Assessment Results
Site name: Back Beach
SFRG Assessment: Poor

Save this SFRG Assessment to a Single Summary File
Press "Save as a Single Entry File" to save the SFRG, MAC, and SIC assessments and the MAC and SIC data in one file.

Save SFRG Assessment to a Multiple Summary File
Press "Save to a Database Format File" to save summary data as one row in a comma-delimited file.
 Print the column labels to the file "ColumnLabelsMarine.txt".

Oakura SC

Marine MAC Assessment

Import MAC Data
Press "Import Data" to retrieve a new MAC data set Import data

Site Name
Name of site from the MAC file: Oakura SC Beach

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedances (Enterococci / 100 mL)		Days in Compliance (%days < 280 / year)
			140 to 280	>280	
2013	20	26.5	1	1	95 %
2012	20	18.5	0	1	95 %
2011	20	36.5	1	1	95 %
2010	20	18.5	0	1	95 %
2009	21	45.0	3	1	95 %
Total	101	28.0	5	5	95 %

Calculate MAC
Press "Calculate MAC" to determine a MAC assessment Calculate MAC

MAC Results
MAC category: C 95%ile (/100 mL): 286.0
Interim Result?: Complete Data Set (5 years with at least 100 samples)

Save MAC Assessment
Press "Save MAC Report" to save this MAC assessment. Save MAC Report

OK

Marine Suitability for Recreational Grade

MAC Assessment Results
MAC Assessment: C
Interim Assessment?: Complete Data Set (5 years with at least 100 samples)

SIC Assessment Results
SIC Assessment: Moderate
Primary SIC Impact: 13: River - agricultural activities/birds/teral animals

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment Calculate SFRG
Reassessment of the MAC and / or SIC is required or press "Irreconcilable Followup" to assign a conservative grade Irreconcilable Followup

SFRG Assessment Results
Site name: Oakura SC Beach
SFRG Assessment: Fair

Save this SFRG Assessment to a Single Summary File
Press "Save as a Single Entry File" to save the SFRG, MAC, and SIC assessments and the MAC and SIC data in one file. Save as a Single Entry File

Save SFRG Assessment to a Multiple Summary File
Press "Save to a Database Format File" to save summary data as one row in a comma-delimited file. Save to a Database Format File
 Print the column labels to the file "ColumnLabelsMarine.txt".

OK

Oakura CG

Marine MAC Assessment

Import MAC Data
Press "Import Data" to retrieve a new MAC data set Import data

Site Name
Name of site from the MAC file: Oakura CG Beach

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedances (Enterococci / 100 mL)		Days in Compliance (%days < 280 / year)
			140 to 280	>280	
2013	13	3.0	0	0	100 %
2012	13	3.0	1	0	100 %
2011	15	4.0	0	0	100 %
2010	13	1.0	0	0	100 %
2009	13	1.0	0	0	100 %
Total	67	3.0	1	0	100 %

Calculate MAC
Press "Calculate MAC" to determine a MAC assessment Calculate MAC

MAC Results
MAC category: B 95%ile (/100 mL): 43.3
Interim Result?: Interim Data Set (< 5 years, or < 100 samples used)

Save MAC Assessment
Press "Save MAC Report" to save this MAC assessment. Save MAC Report

OK

Marine Suitability for Recreational Grade

MAC Assessment Results
MAC Assessment: B
Interim Assessment?: Interim Data Set (< 5 years, or < 100 samples used)

SIC Assessment Results
SIC Assessment: Moderate
Primary SIC Impact: 13: River - agricultural activities/birds/teral animals

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment Calculate SFRG
Reassessment of the MAC and / or SIC is required or press "Irreconcilable Followup" to assign a conservative grade Irreconcilable Followup

SFRG Assessment Results
Site name: Oakura CG Beach
SFRG Assessment: Good

Save this SFRG Assessment to a Single Summary File
Press "Save as a Single Entry File" to save the SFRG, MAC, and SIC assessments and the MAC and SIC data in one file. Save as a Single Entry File

Save SFRG Assessment to a Multiple Summary File
Press "Save to a Database Format File" to save summary data as one row in a comma-delimited file. Save to a Database Format File
 Print the column labels to the file "ColumnLabelsMarine.txt".

OK

Opunake

Marine MAC Assessment

Import MAC Data
Press "Import Data" to retrieve a new MAC data set

Site Name
Name of site from the MAC file: Opunake Beach

MAC Data Summary

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedances (Enterococci / 100 mL)		Days in Compliance (%days < 280 / year)
			140 to 280	>280	
2013	20	1.0	0	0	100 %
2012	20	1.0	0	0	100 %
2011	20	1.0	0	0	100 %
2010	20	1.0	0	0	100 %
2009	20	1.0	0	0	100 %
Total	100	1.0	0	0	100 %

Calculate MAC
Press "Calculate MAC" to determine a MAC assessment

MAC Results
MAC category: A 95%ile (/100 mL): 33.0
Interim Result?: Complete Data Set (5 years with at least 100 samples)

Save MAC Assessment
Press "Save MAC Report" to save this MAC assessment.

Marine Suitability for Recreational Grade

MAC Assessment Results
MAC Assessment: A
Interim Assessment?: Complete Data Set (5 years with at least 100 samples)

SIC Assessment Results
SIC Assessment: Moderate
Primary SIC Impact: 3: Urban stormwater

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment
Reassessment of the MAC and / or SIC is required or press "Irreconcilable Followup" to assign a conservative grade

SFRG Assessment Results
Site name: Opunake Beach
SFRG Assessment: Good

Save this SFRG Assessment to a Single Summary File
Press "Save as a Single Entry File" to save the SFRG, MAC, and SIC assessments and the MAC and SIC data in one file.

Save SFRG Assessment to a Multiple Summary File
Press "Save to a Database Format File" to save summary data as one row in a comma-delimited file.
 Print the column labels to the file "ColumnLabelsMarine.txt".

Ohawe

Marine MAC Assessment

Import MAC Data
Press "Import Data" to retrieve a new MAC data set

Site Name
Name of site from the MAC file: Ohawe Beach

MAC Data Summary

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedances (Enterococci / 100 mL)		Days in Compliance (%days < 280 / year)
			140 to 280	>280	
2013	13	5.0	1	1	92 %
2012	13	37.0	3	1	92 %
2011	13	34.0	1	0	100 %
2010	13	7.0	0	0	100 %
2009	13	16.0	0	1	92 %
Total	65	15.0	5	3	95 %

Calculate MAC
Press "Calculate MAC" to determine a MAC assessment

MAC Results
MAC category: C 95%ile (/100 mL): 260.0
Interim Result?: Interim Data Set (< 5 years, or < 100 samples used)

Save MAC Assessment
Press "Save MAC Report" to save this MAC assessment.

Marine Suitability for Recreational Grade

MAC Assessment Results
MAC Assessment: C
Interim Assessment?: Interim Data Set (< 5 years, or < 100 samples used)

SIC Assessment Results
SIC Assessment: Moderate
Primary SIC Impact: 13: River - agricultural activities/birds/teral animals

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment
Reassessment of the MAC and / or SIC is required or press "Irreconcilable Followup" to assign a conservative grade

SFRG Assessment Results
Site name: Ohawe Beach
SFRG Assessment: Fair

Save this SFRG Assessment to a Single Summary File
Press "Save as a Single Entry File" to save the SFRG, MAC, and SIC assessments and the MAC and SIC data in one file.

Save SFRG Assessment to a Multiple Summary File
Press "Save to a Database Format File" to save summary data as one row in a comma-delimited file.
 Print the column labels to the file "ColumnLabelsMarine.txt".

Patea (Mana Bay)

Marine MAC Assessment

Import MAC Data
Press "Import Data" to retrieve a new MAC data set

Site Name
Name of site from the MAC file: Patea (Mana Bay)

MAC Data Summary

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedances (Enterococci / 100 mL)		Days in Compliance (%days < 280 / year)
			140 to 280	>280	
2012	13	2.0	0	0	100 %
2011	13	5.0	0	0	100 %
2010	19	3.0	0	0	100 %
2009	13	3.0	0	0	100 %
2008	0	0.0	0	0	0 %
Total	58	3.5	0	0	100 %

Calculate MAC
Press "Calculate MAC" to determine a MAC assessment

MAC Results
MAC category: A 95%ile (/100 mL): 40.0
Interim Result?: Interim Data Set (< 5 years, or < 100 samples used)

Save MAC Assessment
Press "Save MAC Report" to save this MAC assessment.

Marine Suitability for Recreational Grade

MAC Assessment Results
MAC Assessment: A
Interim Assessment?: Interim Data Set (< 5 years, or < 100 samples used)

SIC Assessment Results
SIC Assessment: Moderate
Primary SIC Impact: 13: River - agricultural activities/birds/feral animals

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment
Reassessment of the MAC and / or SIC is required or press "Irreconcilable Followup" to assign a conservative grade.

SFRG Assessment Results
Site name: Patea (Mana Bay)
SFRG Assessment: Good

Save this SFRG Assessment to a Single Summary File
Press "Save as a Single Entry File" to save the SFRG, MAC, and SIC assessments and the MAC and SIC data in one file.

Save SFRG Assessment to a Multiple Summary File
Press "Save to a Database Format File" to save summary data as one row in a comma-delimited file.
 Print the column labels to the file "ColumnLabelsMarine.txt".

Patea

Marine MAC Assessment

Import MAC Data
Press "Import Data" to retrieve a new MAC data set

Site Name
Name of site from the MAC file: Patea Beach

MAC Data Summary

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedances (Enterococci / 100 mL)		Days in Compliance (%days < 280 / year)
			140 to 280	>280	
2012	13	2.0	0	0	100 %
2011	0	0.0	0	0	0 %
2010	0	0.0	0	0	0 %
2009	13	3.0	1	0	100 %
2008	0	0.0	0	0	0 %
Total	26	3.0	1	0	100 %

Calculate MAC
Press "Calculate MAC" to determine a MAC assessment

MAC Results
MAC category: B 95%ile (/100 mL): 79.2
Interim Result?: Interim Data Set (< 5 years, or < 100 samples used)

Save MAC Assessment
Press "Save MAC Report" to save this MAC assessment.

Marine Suitability for Recreational Grade

MAC Assessment Results
MAC Assessment: B
Interim Assessment?: Interim Data Set (< 5 years, or < 100 samples used)

SIC Assessment Results
SIC Assessment: Moderate
Primary SIC Impact: 13: River - agricultural activities/birds/feral animals

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment
Reassessment of the MAC and / or SIC is required or press "Irreconcilable Followup" to assign a conservative grade.

SFRG Assessment Results
Site name: Patea Beach
SFRG Assessment: Good

Save this SFRG Assessment to a Single Summary File
Press "Save as a Single Entry File" to save the SFRG, MAC, and SIC assessments and the MAC and SIC data in one file.

Save SFRG Assessment to a Multiple Summary File
Press "Save to a Database Format File" to save summary data as one row in a comma-delimited file.
 Print the column labels to the file "ColumnLabelsMarine.txt".

Waverley

Marine MAC Assessment

Import MAC Data
Press "Import Data" to retrieve a new MAC data set

Site Name
Name of site from the MAC file: Waverley

MAC Data Summary

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedances (Enterococci / 100 mL)		Days in Compliance (%days < 280 / year)
			140 to 280	>280	
2012	13	3.0	0	0	100 %
2011	0	0.0	0	0	0 %
2010	0	0.0	0	0	0 %
2009	13	4.0	0	0	100 %
2008	0	0.0	0	0	0 %
Total	26	3.0	0	0	100 %

Calculate MAC
Press "Calculate MAC" to determine a MAC assessment

MAC Results
MAC category: A 95%ile (/100 mL): 11.0
Interim Result?: Interim Data Set (< 5 years, or < 100 samples used)

Save MAC Assessment
Press "Save MAC Report" to save this MAC assessment.

Marine Suitability for Recreational Grade

MAC Assessment Results
MAC Assessment: A
Interim Assessment?: Interim Data Set (< 5 years, or < 100 samples used)

SIC Assessment Results
SIC Assessment: Moderate
Primary SIC Impact: 13: River - agricultural activities/birds/feral animals

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment
Reassessment of the MAC and / or SIC is required or press "Irreconcilable Followup" to assign a conservative grade

SFRG Assessment Results
Site name: Waverley
SFRG Assessment: Good

Save this SFRG Assessment to a Single Summary File
Press "Save as a Single Entry File" to save the SFRG, MAC, and SIC assessments and the MAC and SIC data in one file.

Save SFRG Assessment to a Multiple Summary File
Press "Save to a Database Format File" to save summary data as one row in a comma-delimited file.
 Print the column labels to the file "ColumnLabelsMarine.txt".

Wai-inu

Marine MAC Assessment

Import MAC Data
Press "Import Data" to retrieve a new MAC data set

Site Name
Name of site from the MAC file: Wai-inu

MAC Data Summary

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedances (Enterococci / 100 mL)		Days in Compliance (%days < 280 / year)
			140 to 280	>280	
2012	13	2.0	0	0	100 %
2011	0	0.0	0	0	0 %
2010	0	0.0	0	0	0 %
2009	13	2.0	0	0	100 %
2008	0	0.0	0	0	0 %
Total	26	2.0	0	0	100 %

Calculate MAC
Press "Calculate MAC" to determine a MAC assessment

MAC Results
MAC category: A 95%ile (/100 mL): 15.2
Interim Result?: Interim Data Set (< 5 years, or < 100 samples used)

Save MAC Assessment
Press "Save MAC Report" to save this MAC assessment.

Marine Suitability for Recreational Grade

MAC Assessment Results
MAC Assessment: A
Interim Assessment?: Interim Data Set (< 5 years, or < 100 samples used)

SIC Assessment Results
SIC Assessment: Moderate
Primary SIC Impact: 13: River - agricultural activities/birds/feral animals

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment
Reassessment of the MAC and / or SIC is required or press "Irreconcilable Followup" to assign a conservative grade

SFRG Assessment Results
Site name: Wai-inu
SFRG Assessment: Good

Save this SFRG Assessment to a Single Summary File
Press "Save as a Single Entry File" to save the SFRG, MAC, and SIC assessments and the MAC and SIC data in one file.

Save SFRG Assessment to a Multiple Summary File
Press "Save to a Database Format File" to save summary data as one row in a comma-delimited file.
 Print the column labels to the file "ColumnLabelsMarine.txt".