Bathing Beach Recreational Water Quality State of the Environment Annual Report 2017-2018

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Executive summary

This report provides an assessment of microbial water quality at 13 bathing beach sites in the Taranaki region, based on summer monitoring of faecal indicator bacteria conducted by the Council between 7 November 2017 and 9 April 2018. The report focusses on enterococci results, as this indicator is considered by health authorities 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, except when it was unsafe to do so. At eight of the ten coastal sites monitored every year, up to an extra 11 samples were collected to satisfy MfE requirements for the number of seasonal samples to be used for grading purposes and to provide more timely results during the holiday periods. Follow up samples were often collected following instances where enterococci counts exceeded 140 cfu/100 ml.

During the 2017-2018 summer season, 89% of the 245 scheduled samples remained within surveillance mode. January, February and March were the months where the highest proportions of samples exceeded the MfE guidelines. These three months also received considerably higher levels of rainfall than normal. Four of the five highest enterococci counts recorded this season were likely due to the exceptionally turbulent conditions resulting from Cyclone Fehi, at the beginning of February. Median enterococci counts recorded in the SEM programme were lower at four sites, higher at seven sites and even at two sites, when compared with their respective historic medians.

The guideline MfE Action mode is reached when enterococci counts in two consecutive samples exceed 280 enterococci cfu/100 ml. In the summer under review, Action mode was reached once during follow up sampling.

Mann-Kendall tests were performed in order to assess long term trends in microbiological water quality. One site, Fitzroy Beach, showed a significant decrease in median enterococci counts (improving quality) over the 23 years it has been monitored, indicating an overall improvement in microbiological water quality. No site showed a significant increase in enterococci medians over the time period monitored i.e. deterioration in water quality.

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 2017-2018.

Through the Council's Long Term Plan (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 annual monitoring sites from the 2003-2004 summer that are compliant with the contact recreational guidelines (MfE, 2003). In the 2003-2004 summer, seven of the nine coastal bathing sites were compliant with the guidelines (Action levels). In the season under review, all sample results at the same nine beaches were compliant with this guideline. The LTP target was therefore met.

Continuation of the Bathing Beach Recreational Water Quality Programme in the 2018-2019 year is recommended.

Table of contents

List of tables

List of figures

List of photos

1 Introduction

1.1 General

The Resource Management Act 1991 (RMA) established new requirements for local authorities to undertake environmental monitoring. Section 35 of the RMA requires local authorities to monitor, among other matters, the state of the environment of their region or district, to the extent that is appropriate to enable them to effectively carry out their functions under the Act.

To this effect, the Taranaki Regional Council ('the Council') has established a state of the environment monitoring (SEM) programme for the region. This programme is outlined in the Council's 'State of the Environment Monitoring Procedures Document', which was prepared in 1997. The monitoring programme is based on the significant resource management issues that were identified in the Council's Regional Policy Statement for Taranaki (1994).

The SEM programme is made up of a number of individual monitoring activities, many of which are undertaken and managed on an annual basis (from 1 July to 30 June). For these annual monitoring activities, summary reports are produced following the end of each monitoring year (i.e., after 30 June). Where possible, individual consent monitoring programmes have been integrated within the SEM programme to save duplication of effort and minimise costs. The purpose of annual SEM reports is to summarise regional environmental monitoring activity results for the year, and provide an interpretation of these results, together with an update of trends in the data.

Annual SEM reports act as 'building blocks' towards the preparation of the regional state of the environment report every five years. The Council's first, or baseline, state of the environment report was prepared in 1996 (TRC, 1996b), summarising the region's progress in improving environmental quality in Taranaki over the past two decades. The second report (for the period 1995-2000) was published in 2003 (TRC, 2003). Data spanning the ten year period 1995 to 2005 have been used in the preparation of a trend report (TRC, 2006). The third State of the Environment report (for the period 1995 to 2007) was published (TRC, 2009a) and included trend reporting, and the fourth report (for the 1995 to 2014 period) has been published (TRC, 2015a). The provision of appropriate computer software statistical procedures allows regular reporting on trends in the environmental quality over time, in relation to Council's ongoing monitoring activities, now that there has been an accumulation of a comprehensive dataset of sufficient duration to permit a meaningful analysis of trends (i.e. minimum of 10 years).

This report summarises the results for the sites surveyed in the Bathing Beach Recreational Water Quality SEM programme over the 2017-2018 monitoring year, the 23rd year of the programme.

1.2 Background

In coastal waters, faecal indicator bacteria (enterococci, *E. coli* and faecal coliforms) can be monitored to assess contamination from human or animal excreta. Levels of these faecal indicators are of particular interest where the coast is 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 has been implemented from the 1995-1996 summer as an on-going component of the SEM programme for the Taranaki region.

The Bathing Beach Recreational 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 Standards and guidelines

2.1 Microbiological water quality guidelines

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 Section 3.2).

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).

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
Recommended procedure	• Continue routine monitoring	• Increase sample to daily ('Follow up sampling') • Undertake sanitary survey • Identify sources of contamination • Consult CAC to assist in identifying possible source	• 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

It should be noted that in 'Alert' mode, the beach is still considered suitable for swimming, but monitoring becomes more focused.

Over the 2017-2018 summer season, warning signs were erected in response to one sample reaching 280 cfu/100 ml, rather than two consecutive samples. Also, daily follow up sampling was often not practicable or appropriate (see Section 3.1.3 for more information on follow up sampling).

2.2 Suitability for recreational grading (SFRG) of sites

The 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 4. 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, which 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 (Table 2). 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 ≤ 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 and interpreted 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.

Of the 19 total coastal sites monitored by the Council, 16 had sufficient data available to calculate SFRG grades for the period spanning November 2012 to April 2017. Of these 16 sites, 12 were graded 'good', 3 were graded 'fair' and 1 was 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 actual 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: The grades presented in Table 3 take into account all routine sampling results; comprising SEM and extended monitoring results (see Section 3).

Table 3 Suitability for recreation grade for the period November 2012 to April 2017

Site	Sanitary Inspection Category	MAC			SFRG Grade	%of all inspection in compliance
		95%ile	No of samples	Category		
Onaero (SC)	Moderate 13	241.0	104	C	Fair	95
Waitara (East)	Moderate 13	292.0	76	C	Fair	94
Waitara (West)	Moderate 13	180.0	76	B	Good	97
Fitzroy	Moderate 3	41.5	104	B	Good	99
East End	Moderate 3	101.8	65	B	Good	100
Ngamotu	Moderate 3	119.0	104	B	Good	99
Oakura (SC)	Moderate 13	190.0	104	B	Good	96
Oakura (CG)	Moderate 13	41.5	65	B	Good	100
Opunake	Moderate 3	21.6	104	A	Good	100
Ohawe	Moderate 13	361.0	76	C	Fair	94
Patea (Mana Bay)	Moderate 13	45.5	39	B	Good	97
Patea	Moderate 13	28.6	26	A	Good	100
Waverley	Moderate 13	27.4	26	A	Good	100
Wai-inu	Moderate 13	41.6	26	B	Good	100
Back	Low 14	896.0	26	D	Poor	88
Bell Block	Moderate 3	162.4	26	B	Good	96
Wai-iti	Moderate 13	Insufficient data (triennial)				
Urenui	Moderate 13	Insufficient data (triennial)				
Onaero Settlement	Low 14	Insufficient data (triennial)				

13 = River - agricultural activities/birds/feral animal

14 = River - focal points of discharge

3 = Urban stormwater

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

3 Monitoring methodology

3.1 Program design

The Council's Bathing Beach Recreational Water Quality programme consists of two primary components: State of the Environment monitoring and extended monitoring.

The SEM component involves ten annual sampling sites and nine rotational sites (Figure 1). The rotational sites are sampled on a three year rotation, with Year 3 beaches sampled during the 2017-2018 monitoring programme (Table 4). Thirteen samples are collected per site for the SEM component.

The extended monitoring component has been included in order to meet requirements of the revised guidelines for microbiological water quality of marine recreational areas (MfE, 2003). Since the 2016-2017 bathing season, additional samples are collected at eight SEM sites as part of the extended monitoring component (Figure 1). Approximately ten samples are collected during the extended monitoring regime.

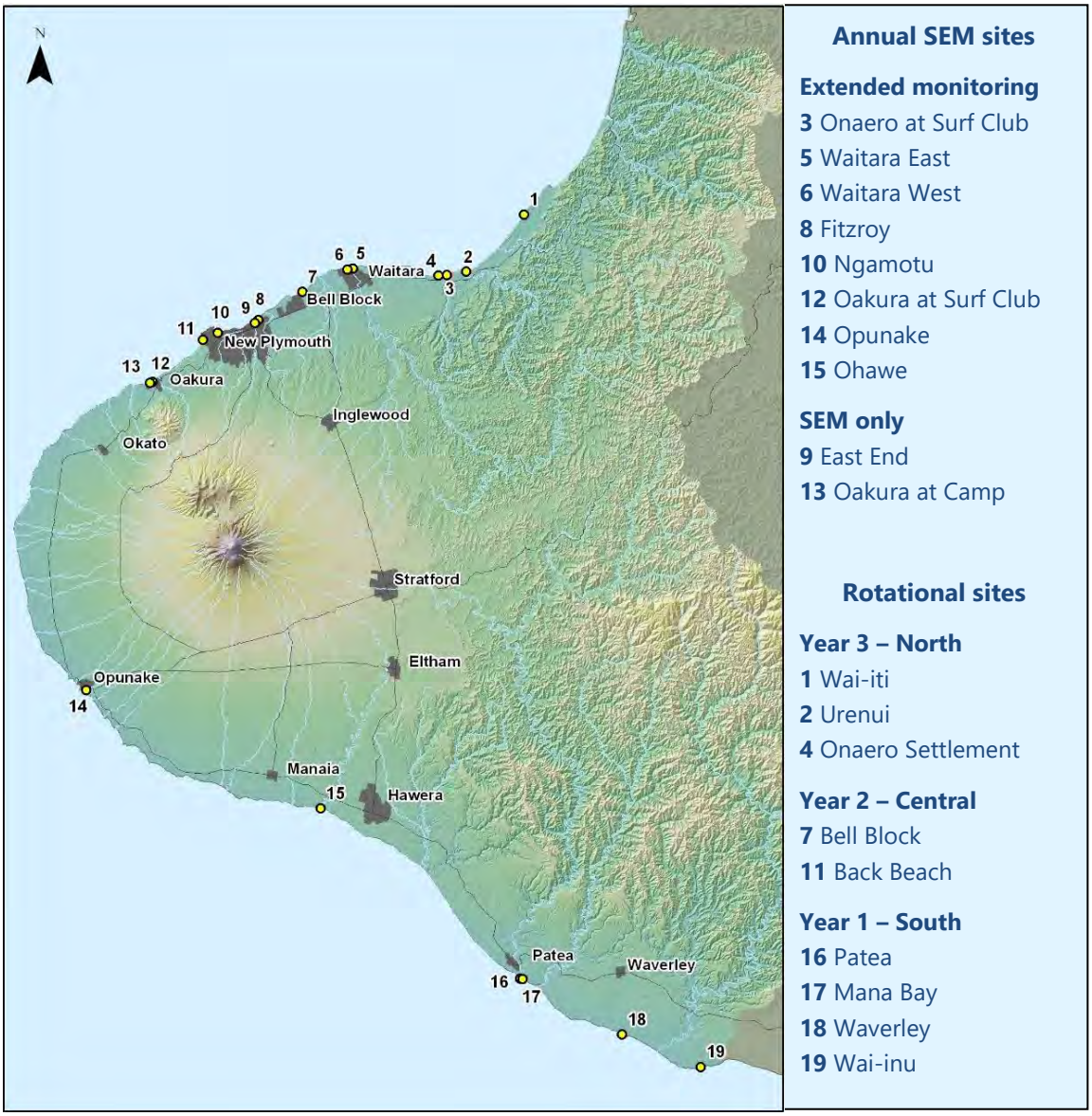


Figure 1 Bathing beach monitoring sites

The thirteen beaches that were sampled during the 2017-2018 bathing season are specified in Table 4.

Table 4 Beach sites sampled during the 2017-2018 bathing season

Beach	Location	GPS	Site code
Wai-iti	75 m N of Wai-iti Stream	1727667-5690609	SEA900060
Urenui	East of Urenui River mouth	1720582-5683563	SEA900072
Onaero	Opposite surf lifesaving club	2628254-6244898	SEA900085
Onaero	Settlement beach	1717129-5683099	SEA900087
Waitara	East Beach	1706602-5683915	SEA901033
Waitara	West Beach	1705951-5683802	SEA901037
Fitzroy	Opposite surf lifesaving club	2605036-6239351	SEA902025
East End	Opposite surf lifesaving club	2604605-6239000	SEA902035
Ngamotu	Centre of beach	2600022-6237765	SEA902062
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

The purpose of each monitoring component, and their respective sampling protocols, are discussed in sections 3.1.1 and 3.1.2.

3.1.1 State of the Environment monitoring

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 localized influence of diffuse sources (i.e. streams and rivers) on adjacent coastal water quality. For these reasons the following criteria have been adopted for this SEM protocol:

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) to ensure, as far as practicable, consistent environmental factors. Bathing water samples were taken between the hours of 0900 and 1800 hours (NZDT) to reflect the most likely period for swimming. 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.

In the 2017-2018 summer period, 13 SEM surveys were undertaken. However, due to adverse weather and unsafe sampling conditions, not all sites were sampled on every occasion.

3.1.2 Extended monitoring

The revised guidelines for microbiological water quality of marine recreational areas (MfE, 2003) envisaged 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. This number of samples each season is regarded as providing the most robust dataset for site categorisation purposes. In the 2002-2003 summer period,

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). 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.

In the 2016-2017 summer period, monitoring frequency was increased to at least weekly between December and February at eight of the most popular coastal recreational sites (Onaero, Waitara West, Waitara East, Fitzroy, Ngamotu, Oakura Surf Club, Opunake and Ohawe Beaches), to align fully with the MfE guidelines and the reporting protocols for the Land, Air, Water Aotearoa (LAWA) website. When possible, the SEM protocol of dry weather monitoring was followed. In weeks when weather or tide did not meet the SEM protocol, sampling occurred no later than Thursday to allow public posting of results before the weekend.

In the 2017-2018 summer period, an additional 11 samples were collected at the eight sites listed above, following the extended monitoring protocol. In the discussion that follows, these samples are described as 'extended' or 'MfE' samples.

3.1.3 Follow up monitoring

As recommended by the national guidelines (MfE, 2003), a follow up sample may be collected when a routine monitoring sample reaches 'Alert' mode (see Section 2.1). Follow up samples can be useful in determining the source of a high enterococci count, the longevity of the event, and for updating the site's suitability for bathing. These samples are generally collected as soon as reasonably practicable in the days following the high result, though follow ups may be deemed inappropriate under certain circumstances. For example, if wet weather ensues, a follow up sample may not be collected due to contamination from nearby freshwater inputs masking the source in question. In some instances, when routine surveys are scheduled within close succession, the subsequent survey may substitute a dedicated follow up survey.

3.2 Analysis

3.2.1 Sample analysis

Historically, samples were analysed 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).

In the 2017-2018 summer period, it was decided to stop analysing for *E.coli* and faecal coliforms, in order to optimise the efficiency of the laboratory; given the increase in overall sampling intensity in recent years. *E.coli* and faecal coliforms are inferior indicators of faecal contamination in marine waters, when compared with enterococci (see Section 3.1). Follow up enterococci samples were quantified using the Enterolert (IDEXX) Quanti-Tray system (see Section 3.1 for an explanation of when follow up samples are required).

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.

Once verified, all results were posted on the Taranaki Regional Council website (www.trc.govt.nz).

3.2.2 Data analysis

Long term trend analysis is only carried out with the results from samples collected within the SEM schedule of the complete programme, in order to determine the trends of recreational water quality around Taranaki

under dry weather conditions (i.e. samples collected under reproducible conditions). 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 ($p < 0.05$ = 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).

4 Results

During the 2017-2018 bathing season, sampling was generally confined to weekdays, with no statutory holidays included. For these reasons, recreational usage of the waters at the time 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.

Whenever possible, no sampling for SEM purposes was undertaken within three days following significant river freshes. However, it is recognised that water conditions at the time of sampling was occasionally affected by localized rainfall and elevated river flows. The extended ('MfE') monitoring was preferentially, but not exclusively, undertaken during fine weather. Given these sampling criteria, the results presented here generally reflect coastal water quality under fine weather conditions (that is, conditions where bathing would be typically most popular).

All results (SEM, MfE and follow up monitoring), from the 2017-2018 bathing season are presented and discussed on a site by site basis in this report. The statistical analyses do not include follow-up sampling results, as they're collected in response to particular events (resulting in high enterococci counts) and are therefore not random, and potentially not representative of typical bathing conditions.

Supplementary data and observations are presented in the appendices.

4.1 Wai-iti Beach

Wai-iti Beach (Photo 1), located in North Taranaki, is a popular bathing beach over the summer period, particularly for occupants of the adjacent baches and camp ground. The relatively small Wai-iti Stream drains onto the southern end of the beach.

Photo 1 Wai-iti Beach

All enterococci data for this site, from the 2017-2018 summer period, is presented in Figure 2. The complete survey results are presented in Appendix I. Fifteen samples were collected at the site across the summer, including 13 scheduled SEM samples and two follow up samples.

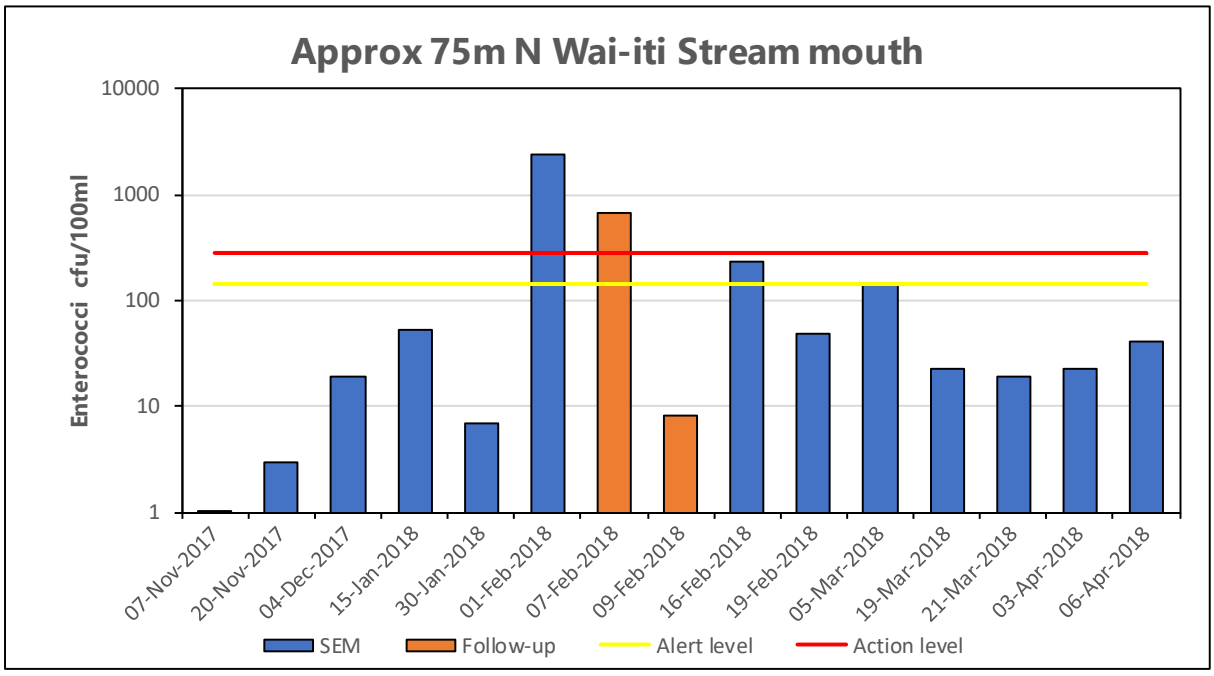


Figure 2 Enterococci results for Wai-iti Beach.

The monitoring data is summarized in Table 5.

Table 5 Statistical summary for Wai-iti Beach

Parameter	Units	Number of samples	Minimum	Maximum	Median
Conductivity	mS/m@20°C	13	4390	4820	4690
Enterococci	cfu/100 ml	13	1	2400	23
Temperature	°C	13	17.1	24.2	20.6

4.1.1 Comparison with guidelines

Enterococci counts from Wai-iti Beach over the 2017-2018 summer are summarized against the guidelines in Table 6. Of the 13 scheduled SEM samples collected during the season, two samples reached the 'Alert' mode. 'Action' mode was reached once after a high count in a follow up sample.

The first exceedance (2400 cfu/100 ml), on 1 February, was likely due to the resuspension of benthic sediments (and associated enterococci) in the turbulent seas caused by Cyclone Fehi. Elevated enterococci counts were recorded at all sites that were sampled in North Taranaki on this day (see Section 5.1 for further discussion). Due to adverse weather and sea conditions following this event, a follow-up sample could not be collected until six days later on 7 February. However, the enterococci count in this sample was also elevated (670 cfu/100 ml). Despite the amount of time that had lapsed between the initial exceedance and the follow up, this sample was collected as soon as practicable and therefore an 'Action' categorisation for this event was still warranted under the guidelines, given it was the second consecutive sample above the 'Action' trigger threshold (280 cfu/100 ml). The site returned to 'Surveillance' mode on 9 February after recording a low enterococci count in the second follow up sample (8 cfu/100 ml). 'Alert' mode was triggered again on 16 February due to another count reaching that threshold (230 cfu/100 ml). It should be noted that gulls were recorded on the beach in the vicinity of the sampling location on several occasions, potentially contributing faecal contaminants to the shoreline waters.

Table 6 Performance against guidelines at Wai-iti Beach

Parameter	Number of exceedances of enterococci guidelines	
	ALERT Single sample >140/100 ml	ACTION Two consecutive single samples >280/100 ml
SEM samples	2 [15%]	0 [0%]*

* Action mode was reached once due to a follow up sample result

4.1.2 Comparison with previous summer surveys

Summary statistics for SEM enterococci data collected at Wai-iti Beach over eight summers are presented in Figure 3. The overall distribution of enterococci counts recorded during the 2017-2018 summer was the highest ever recorded at this site, with the lower quartile, median and upper quartile counts all higher than those from previous summers. The two highest counts from any of the eight monitored summers were recorded in 2017-2018. Despite the distribution of results being higher than those previously, the difference is marginal; the median count in 2017-2018 (23 cfu/100 ml) was only slightly greater than that recorded in the 2008-2009 summer (21 cfu/100 ml).

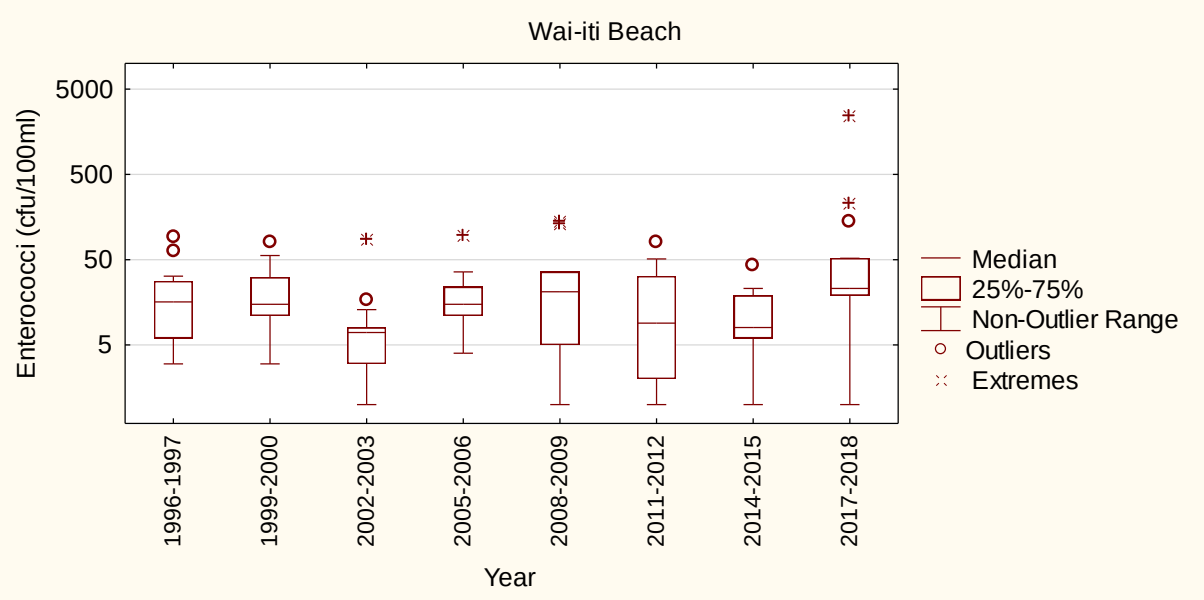


Figure 3 Box and whisker plots of enterococci for all summer SEM surveys at Wai-iti Beach

4.1.3 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).

4.2 Urenui Beach

Urenui Beach (Photo 2), in North Taranaki, is a relatively popular bathing beach, especially over the Christmas holiday period. Draining through predominantly agricultural land, the Urenui River enters at the western end of the beach and makes a significant contribution to bacteria counts subsequent to rainfall events.

Photo 2 Urenui beach (at low tide with river cutting though beach)

All enterococci data for this site, from the 2017-2018 summer period, is presented in Figure 4. The complete survey results are presented in Appendix I. Due to unsafe sampling conditions, Urenui Beach could only be sampled on nine of the 13 scheduled SEM surveys.

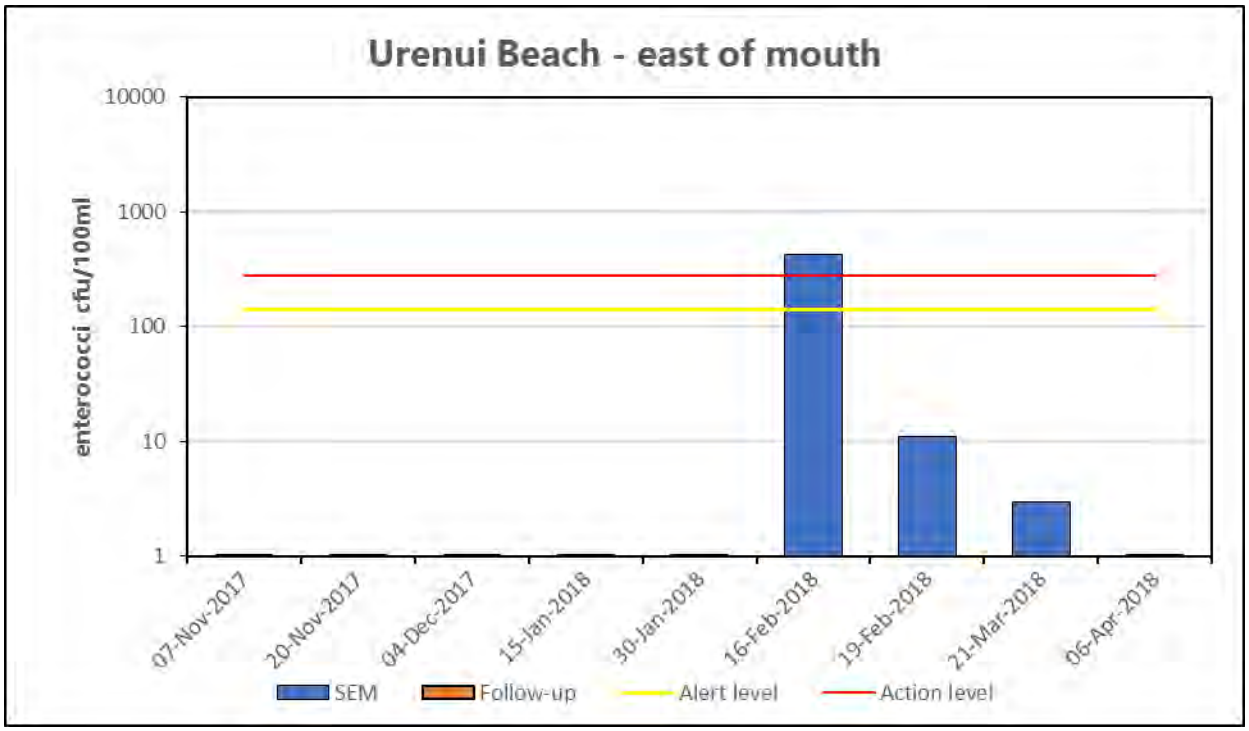


Figure 4 Enterococci results for Urenui Beach.

The monitoring data is summarized in Table 7.

Table 7 Statistical summary for Urenui Beach

Parameter	Units	Number of samples	Minimum	Maximum	Median
Conductivity	mS/m@20°C	9	4630	4810	4730
Enterococci	cfu/100 ml	9	<1	420	1
Temperature	°C	8	17.3	23.6	20.1

4.2.1 Comparison with guidelines

Enterococci counts from Urenui Beach over the 2017-2018 summer are summarized against the guidelines in Table 8. Alert mode was reached once on 16 February 2018 (420 cfu/100 ml). The associated conductivity result (4730 mS/m@20°C; Appendix I) was not low enough to suggest an obvious freshwater influence, nor was any wildlife was observed in the vicinity of the sampling site.

Table 8 Performance against guidelines at Urenui Beach

Parameter	Number of exceedances of enterococci guidelines	
	ALERT Single sample >140/100 ml	ACTION Two consecutive single samples >280/100 ml
SEM samples	1 [11%]	0 [0]

4.2.2 Comparison with previous summer surveys

Summary statistics for SEM enterococci data collected at Urenui Beach over eight summers are presented in Figure 5. Despite recording the highest ever individual result for this site, the upper quartile and median enterococci counts in the 2017-2018 summer were the lowest to date. However, it should be noted that this year's results are confounded by the small sample size.

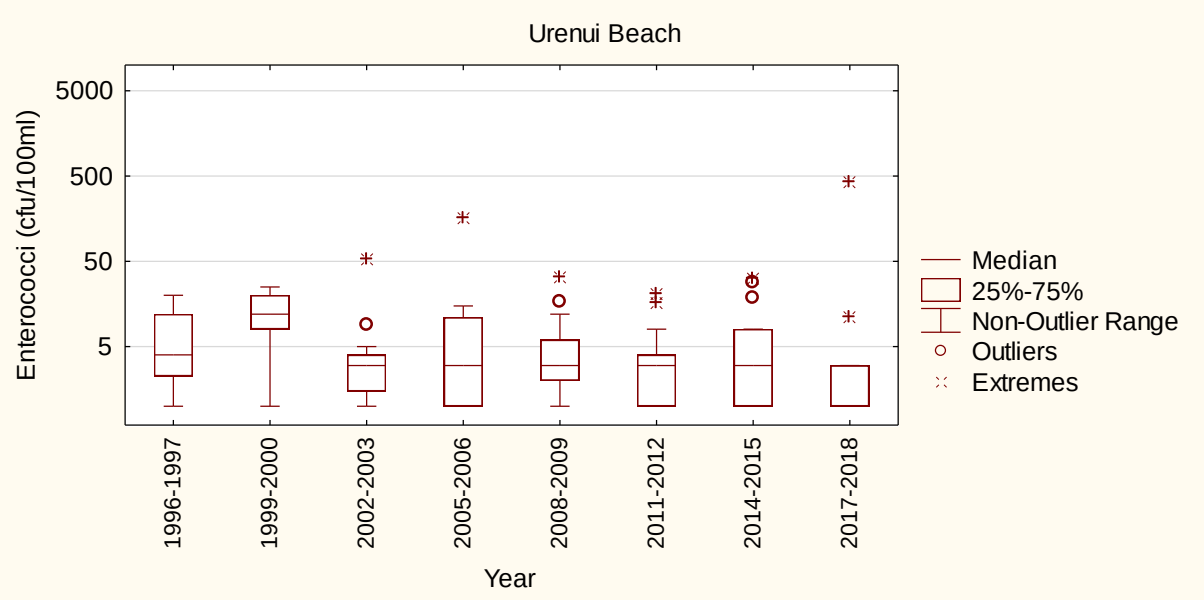


Figure 5 Box and whisker plots of enterococci for all summer SEM surveys at Urenui Beach

4.2.3 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).

4.3 Onaero Beach (Surf Club)

Onaero Beach (Photo 3), 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 3 Onaero Beach

All enterococci data for this site, from the 2017-2018 summer period, is presented in Figure 6. The complete survey results are presented in Appendix I. A total of 25 samples were collected at this site across the summer. All 13 scheduled SEM samples were collected, as well as 11 extended monitoring samples and one follow up.

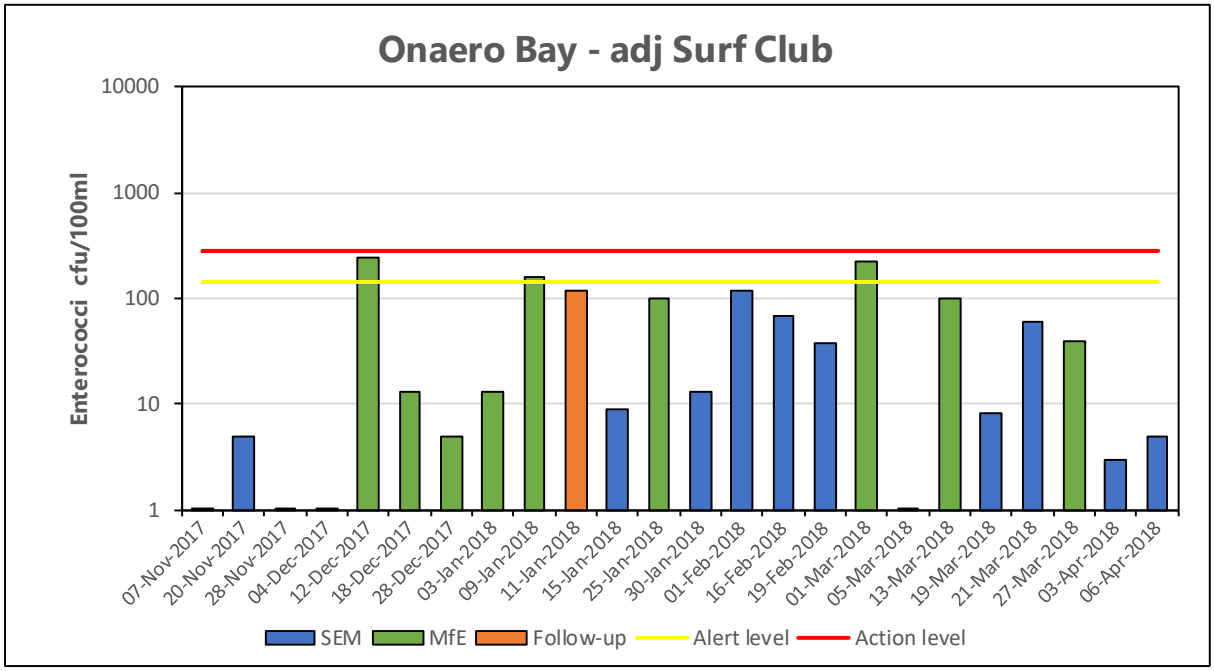


Figure 6 Enterococci results for Onaero Beach at the Surf Club.

The monitoring data is summarized in Table 9.

Table 9 Statistical summary for Onaero Beach at the Surf Club

Parameter		Units	Number of samples	Minimum	Maximum	Median
SEM samples	Conductivity	mS/m@20°C	13	4550	4820	4740
	Enterococci	cfu/100 ml	13	<1	120	8
	Temperature	°C	13	17.5	24.1	20.6
SEM + MfE samples	Conductivity	mS/m@20°C	24	1951	4820	4725
	Enterococci	cfu/100 ml	24	<1	240	13
	Temperature	°C	24	17.5	24.1	20.4

4.3.1 Comparison with guidelines

Enterococci counts from Onaero Beach at the Surf Club over the 2017-2018 summer are summarized against the guidelines in Table 10. 'Alert' mode was reached on three occasions across the summer; 12 December, 9 January and 1 March (240, 160 and 220 cfu/100 ml, respectively). All three samples were collected during extended monitoring surveys. The first and last of these three occasions coincided with relatively low conductivities; indicating a freshwater influence (see Appendix I). The remaining samples collected over the summer were within 'Surveillance' mode.

Table 10 Performance against guidelines at Onaero Beach (at the Surf Club)

Parameter	Number of exceedances of enterococci guidelines	
	ALERT Single sample >140/100 ml	ACTION Two consecutive single samples >280/100 ml
SEM samples	0 [0%]	0 [0]
SEM + MfE samples	3 [13%]	0 [0]

4.3.2 Comparison with previous summer surveys

Summary statistics for the SEM enterococci data collected at Onaero Beach over 19 summers are presented in Figure 7. The results from the 2017-2018 summer period were comparable with previous summers.

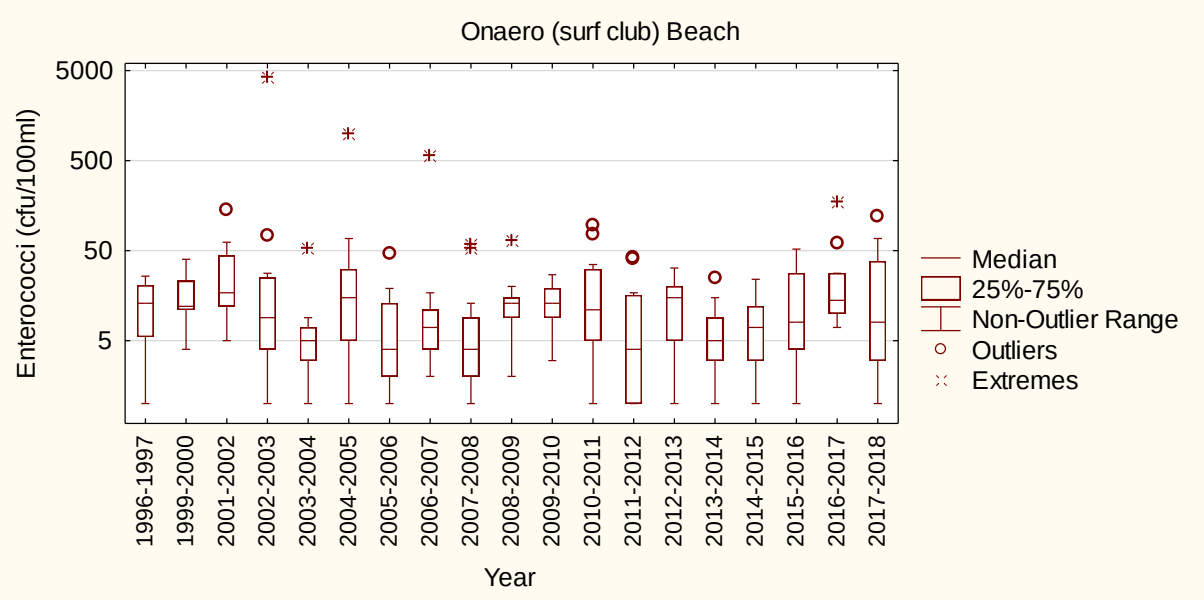


Figure 7 Box and whisker plots of enterococci for all summer SEM surveys at Onaero Beach

4.3.3 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 16 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.

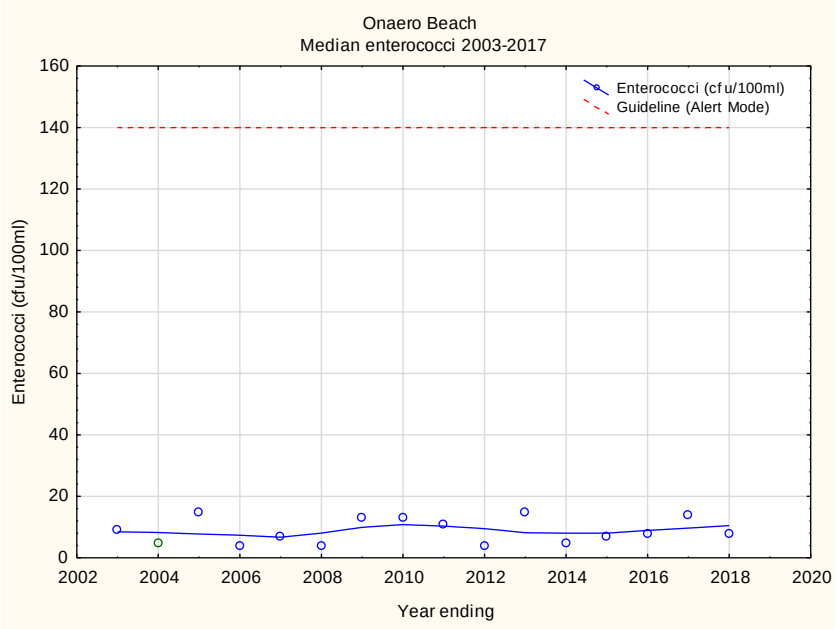


Figure 8 LOWESS trend analysis of median enterococci data at Onaero Beach

Over the 16 seasons monitored, there was a positive trend (i.e. an increase) in median enterococci counts (Kendall tau = 0.104) that was not significant at the 5% level (p = 0.576).

4.4 Onaero Beach Settlement

Onaero Beach Settlement (Photo 4) is located approximately 1 km west of the Onaero River.

Photo 4 Onaero Beach Settlement

All data for this site, from the 2017-2018 summer period, is presented in Figure 9. The complete survey results are presented in Appendix I. Due to unsafe sampling conditions, this site was only sampled on seven out of 13 scheduled SEM surveys.

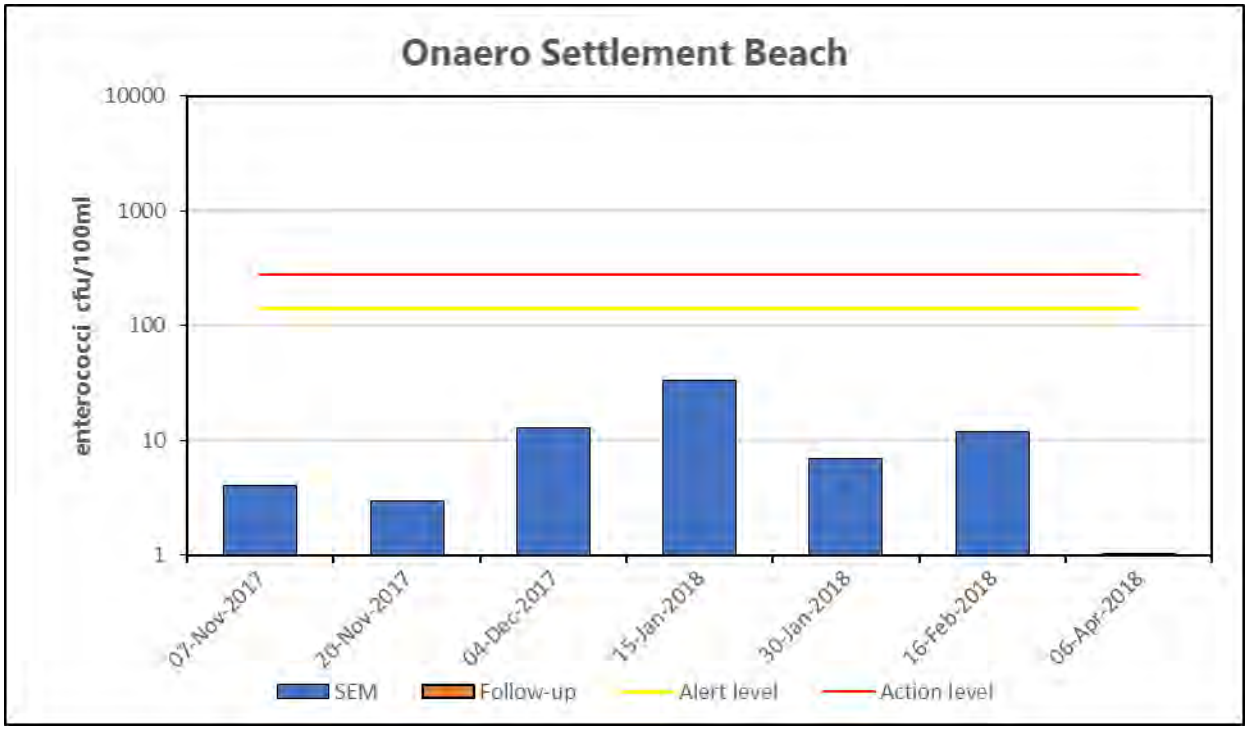


Figure 9 Enterococci results for Onaero Beach Settlement.

The monitoring data is summarized in Table 11.

Table 11 Statistical summary for Onaero Beach Settlement

Parameter	Units	Number of samples	Minimum	Maximum	Median
Conductivity	mS/m@20°C	7	4680	4800	4750
Enterococci	cfu/100 ml	7	<1	33	7
Temperature	°C	7	16.8	22.6	20.5

4.4.1 Comparison with guidelines

Enterococci counts from Onaero Beach Settlement over the 2017-2018 summer are summarized against the guidelines in Table 12. Enterococci counts remained within 'Surveillance' mode throughout the summer period.

Table 12 Performance against guidelines at Onaero Beach Settlement

Parameter	Number of exceedances of enterococci guidelines	
	ALERT Single sample >140/100 ml	ACTION Two consecutive single samples >280/100 ml
SEM samples	0 [0]	0 [0]

4.4.2 Comparison with previous summer surveys

Summary statistics for SEM enterococci data collected at Onaero Beach Settlement over eight summers are presented in Figure 10. The results from the 2017-2018 summer period were comparable with previous summers. However, it should be noted that this year's results are confounded by the small sample size.

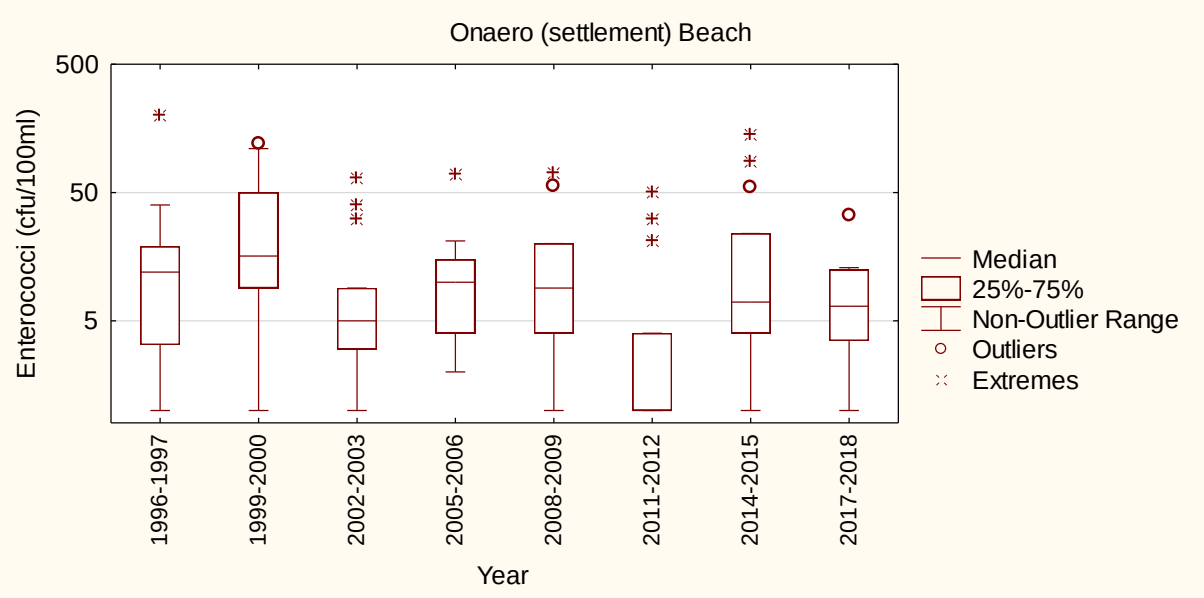


Figure 10 Box and whisker plots of enterococci for all summer SEM surveys at Onaero Beach Settlement

4.4.3 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 Waitara East Beach

Waitara East Beach is located to the east of the Waitara River mouth (Photo 5). Results at this site are influenced by the Waitara River which drains a large agricultural catchment and often contains high levels of bacteria.

Prior to October 2014, municipal wastewater from the Waitara township was discharged through the Waitara Marine Outfall approximately 1.8 km out to sea. Since October 2014, New Plymouth District Council has pumped municipal wastewater from the Waitara township to the New Plymouth Wastewater Treatment Plant and sewage is no longer discharged through the Waitara Marine Outfall during normal operation of the wastewater system.

Photo 5 Waitara East Beach

All data for this site, from the 2017-2018 summer period, is presented in Figure 11. The complete survey results are presented in Appendix I. Due to unsafe sampling conditions, one of the 13 scheduled SEM samples could not be collected. In addition to the SEM samples, 11 extended monitoring samples and one follow up sample were also collected (24 in total).

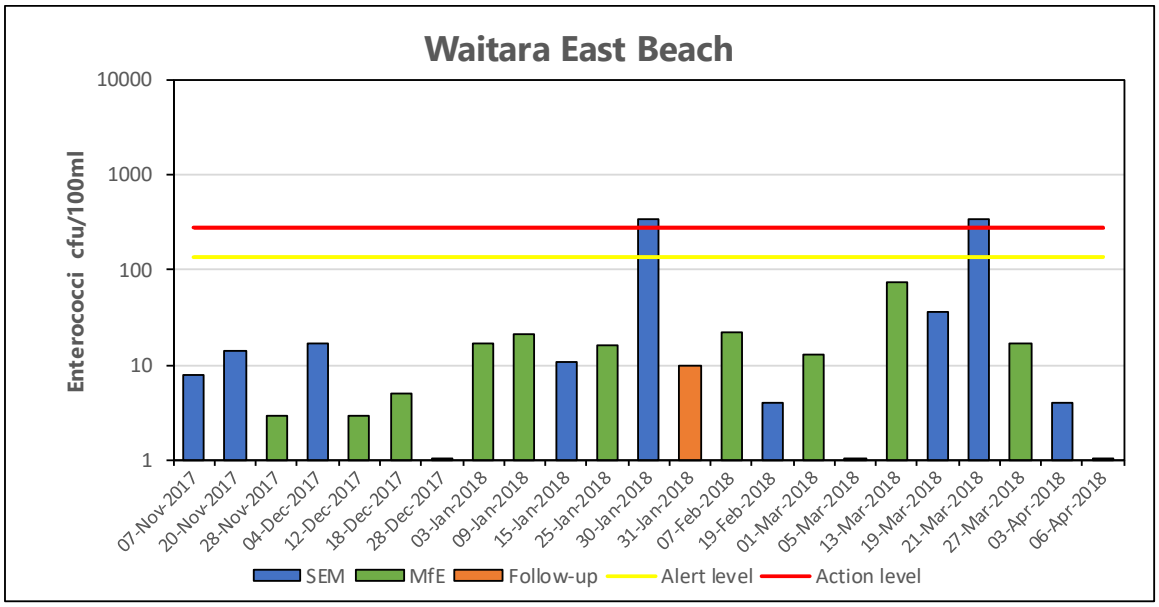


Figure 11 Enterococci results for Waitara East Beach

The monitoring data is summarized in Table 13.

Table 13 Statistical summary for Waitara East Beach

Parameter		Units	Number of samples	Minimum	Maximum	Median
SEM samples	Conductivity	mS/m@20°C	12	4120	4700	4585
	Enterococci	cfu/100 ml	12	1	340	12
	Temperature	°C	12	16.9	23.9	20.0
MfE + SEM samples	Conductivity	mS/m@20°C	23	2410	4760	4520
	Enterococci	cfu/100 ml	23	1	340	14
	Temperature	°C	23	16.9	23.9	20.0

4.5.1 Comparison with guidelines

Enterococci counts from Waitara East over the 2017-2018 summer are summarized against the guidelines in Table 14. 'Alert' mode was reached on two occasions following high counts (340 cfu/100 ml on 30 January, and 340 cfu/100 ml on 21 March). Both samples were collected during SEM surveys. The remaining samples were within 'Surveillance' mode.

Table 14 Performance against guidelines at Waitara East Beach

Parameter	Number of exceedances of enterococci guidelines	
	ALERT Single sample >140/100 ml	ACTION Two consecutive single samples >280/100 ml
SEM samples	2 [17%]	0 [0]
SEM + MfE samples	2 [9%]	0 [0]

4.5.2 Comparison with previous summer surveys

Summary statistics for SEM enterococci data collected at Waitara East Beach over 23 summers are presented in Figure 12. The results from the 2017-2018 summer period were comparable with previous summers.

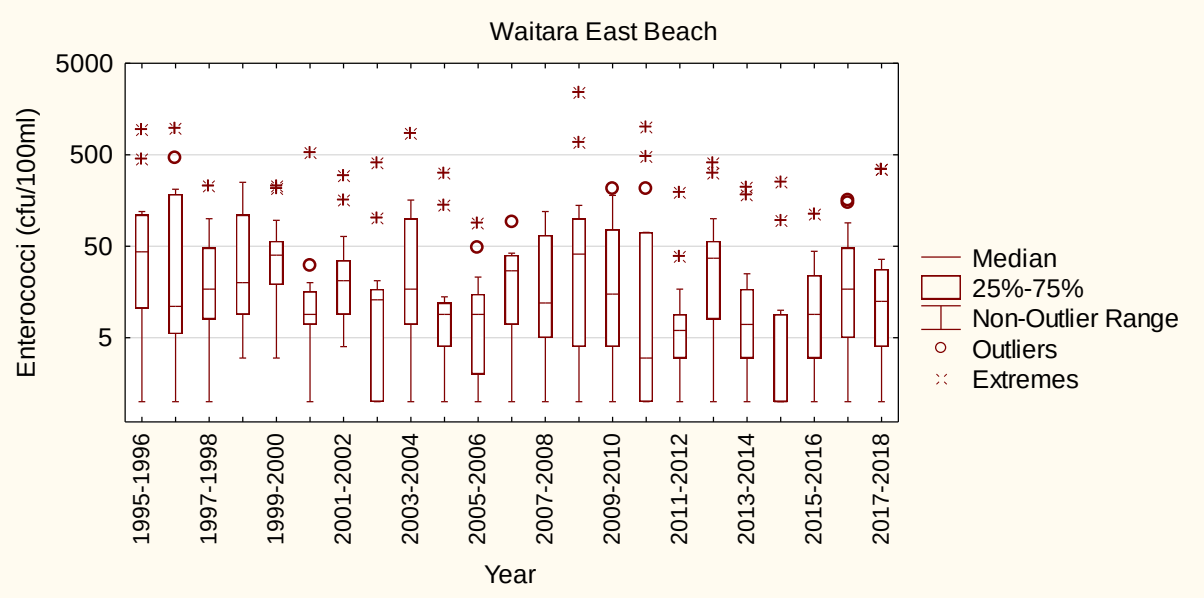


Figure 12 Box and whisker plots of enterococci for all summer SEM surveys at Waitara East Beach

4.5.3 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 23 summer seasons (Figure 13) 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.

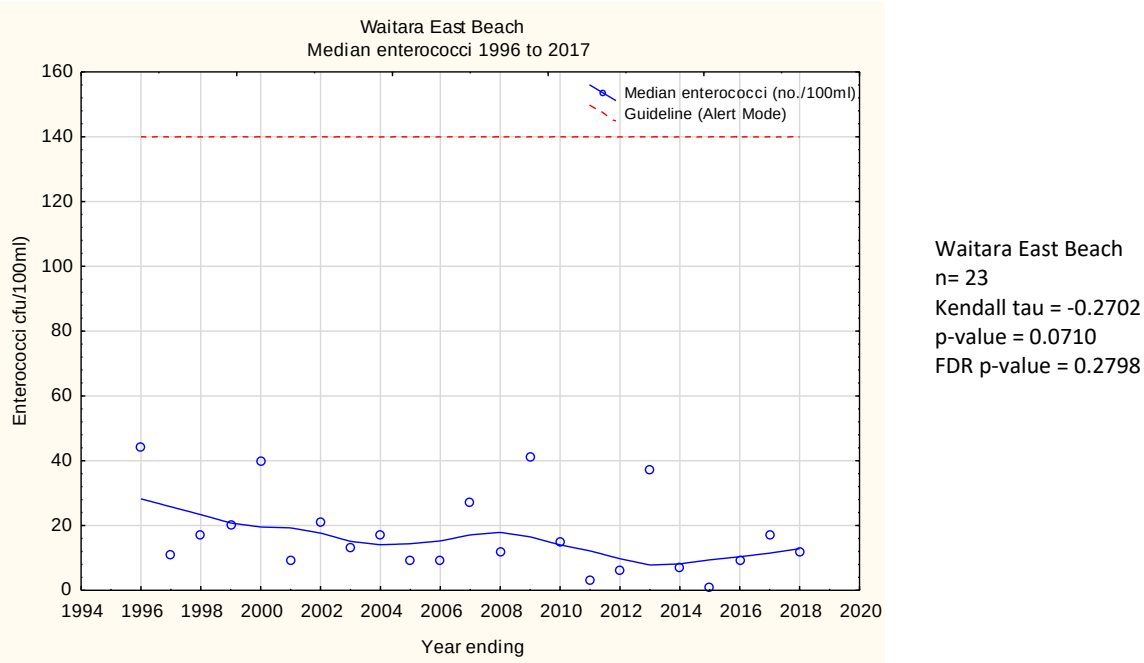


Figure 13 LOWESS trend analysis of median enterococci data at Waitara East Beach

Over 23 seasons, there was a negative trend (i.e. a decrease) in median enterococci counts (Kendall tau = -0.2702) that was not significant at the 5% level (p = 0.071).

4.6 Waitara West Beach

Waitara West Beach is located to the west of the Waitara River mouth (Photo 6). As with Waitara East Beach, the results at this site can be influenced by the Waitara River.

Since October 2014, municipal wastewater from the Waitara Township has been directed to the New Plymouth Wastewater Treatment Plant and is no longer discharged through the Waitara Marine Outfall during normal operation of the wastewater system.

Photo 6 Waitara West Beach

All data for this site, from the 2017-2018 summer period, is presented in Figure 14. The complete survey results are presented in Appendix I. Due to unsafe sampling conditions, one of the 13 scheduled SEM samples could not be collected. In addition to the SEM samples, 11 extended monitoring samples and one follow up sample were also collected (24 in total).

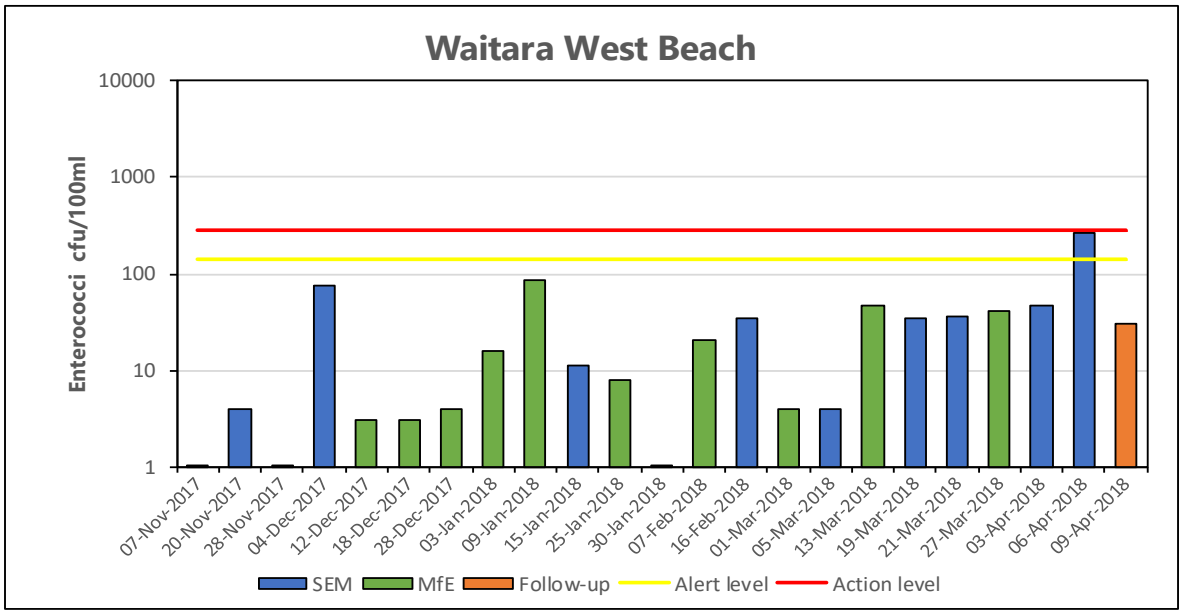


Figure 14 Enterococci results for Waitara West Beach

The monitoring data is summarized in Table 15.

Table 15 Statistical summary for Waitara West Beach

Parameter		Units	Number of samples	Minimum	Maximum	Median
SEM samples	Conductivity	mS/m@20°C	12	4220	4820	4675
	Enterococci	cfu/100 ml	12	<1	271	22
	Temperature	°C	12	16.9	23.6	20.4
SEM + MfE samples	Conductivity	mS/m@20°C	23	2650	4820	4620
	Enterococci	cfu/100 ml	23	<1	271	11
	Temperature	°C	23	16.9	23.6	20.6

4.6.1 Comparison with guidelines

Enterococci counts from Waitara West over the 2017-2018 summer are summarized against the guidelines in Table 16. 'Alert' mode was prompted once following a high count from an SEM sample on 6 April (271 cfu/100 ml). The remaining samples were within 'Surveillance' mode limits.

Table 16 Performance against guidelines at Waitara West Beach

Parameter	Number of exceedances of enterococci guidelines	
	ALERT Single sample >140/100 ml	ACTION Two consecutive single samples >280/100 ml
SEM samples	1 [8%]	0 [0]
SEM + MfE samples	1 [4%]	0 [0]

4.6.2 Comparison with previous summer surveys

Summary statistics for SEM enterococci data collected at Waitara East Beach over 23 summers are presented in Figure 15. The distribution of counts from the 2017-2018 summer period was comparable with previous summers, though the median was relatively high (22 cfu/100 ml).

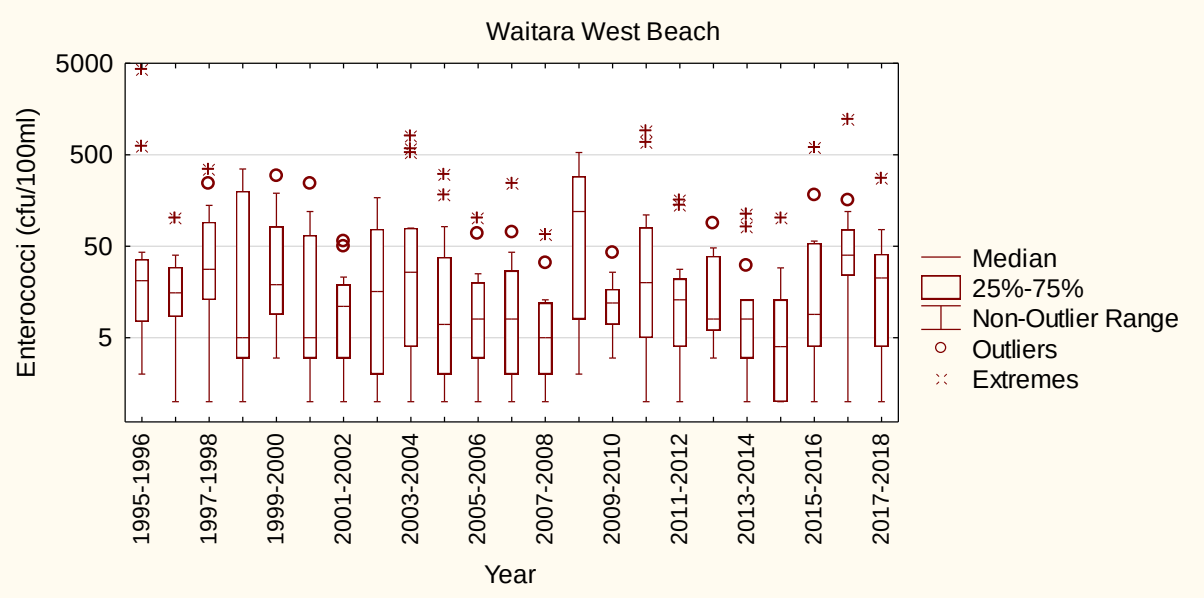


Figure 15 Box and whisker plots of enterococci for all summer SEM surveys at Waitara West Beach

4.6.3 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 23 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.

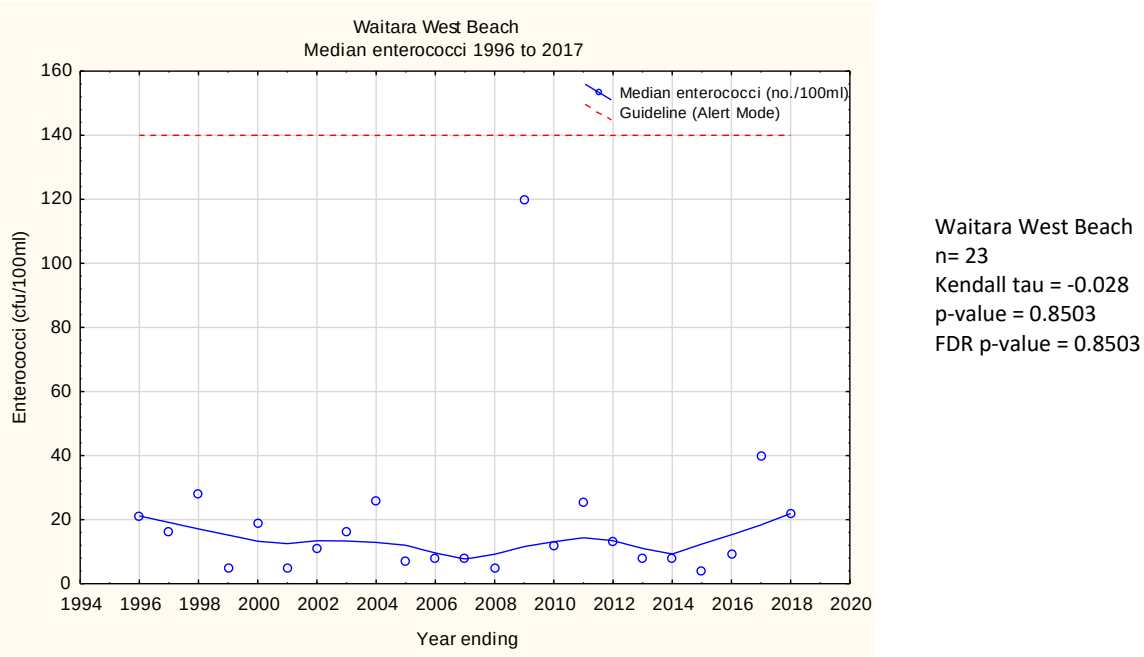


Figure 16 LOWESS trend analysis of median enterococci data at Waitara West Beach

Over 23 seasons, there was a negative trend (i.e. decrease) in median enterococci counts (Kendall tau = -0.028) that was not significant at the 5% level (p = 0.8503).

4.7 Fitzroy Beach

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 7).

The mouth of the Waiwhakaiho River enters the sea at the eastern end of the beach, approximately 800 m from the sample site, which 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 7 Fitzroy Beach

All data for this site, from the 2017-2018 summer period, is presented in Figure 17. The complete survey results are presented in Appendix I. A total of 25 samples were collected, comprising 13 SEM samples, 11 extended monitoring samples and one follow up sample.

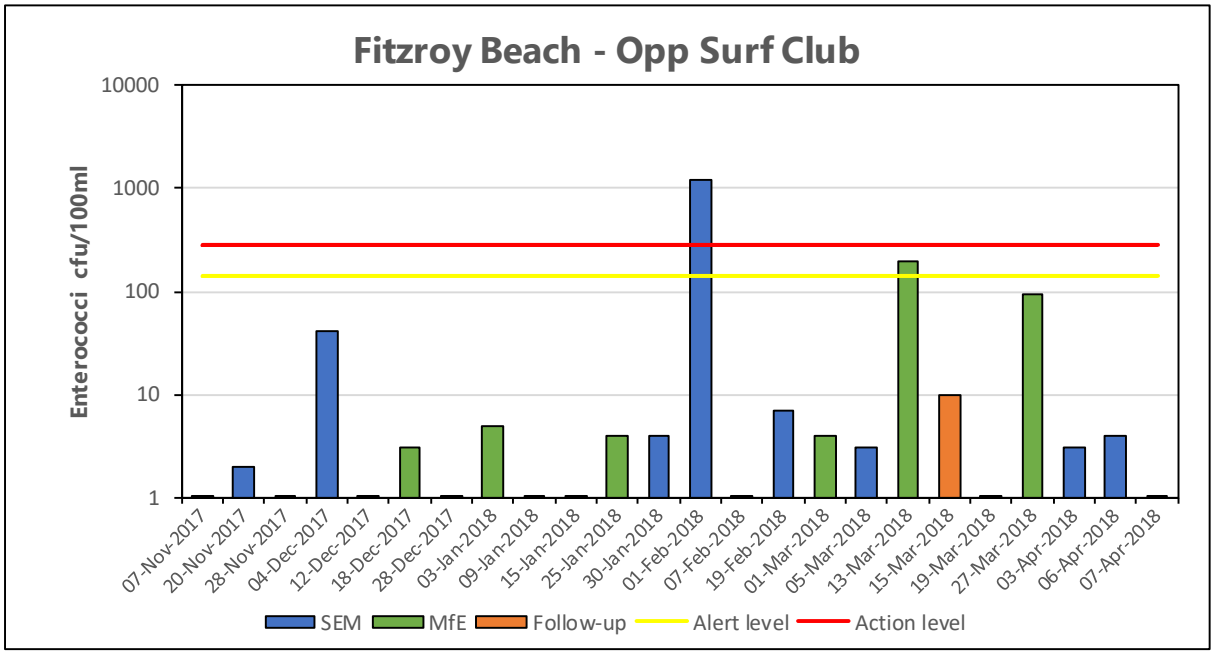


Figure 17 Enterococci results for Fitzroy Beach.

The monitoring data is summarized in Table 17.

Table 17 Statistical summary for Fitzroy Beach

Parameter		Units	Number of samples	Minimum	Maximum	Median
SEM samples	Conductivity	mS/m@20°C	13	4540	4820	4770
	Enterococci	cfu/100 ml	13	<1	1200	3
	Temperature	°C	13	14.4	23.7	20.2
SEM + MfE samples	Conductivity	mS/m@20°C	24	4200	4820	4760
	Enterococci	cfu/100 ml	24	<1	1200	3
	Temperature	°C	24	14.4	23.7	20.2

4.7.1 Comparison with guidelines

Enterococci counts from Fitzroy Beach over the 2017-2018 summer are summarized against the guidelines in Table 18. 'Alert' mode was reached on two occasions; 1 February and 13 March (1200 and 200 cfu/100 ml, respectively). The first exceedance coincided with Cyclone Fehi. The remaining samples were within the 'Surveillance' limits.

Table 18 Performance against guidelines at Fitzroy Beach

Parameter	Number of exceedances of enterococci guidelines	
	ALERT Single sample >140/100 ml	ACTION Two consecutive single samples >280/100 ml
SEM samples	1 [8%]	0 [0]
SEM + MfE samples	2 [8%]	0 [0]

4.7.2 Comparison with previous summer surveys

Summary statistics for SEM enterococci data collected at Fitzroy Beach over 23 summers are presented in Figure 18. The distribution of results from the 2017-2018 summer period was relatively low compared with previous summers; despite recording the single highest count to date.

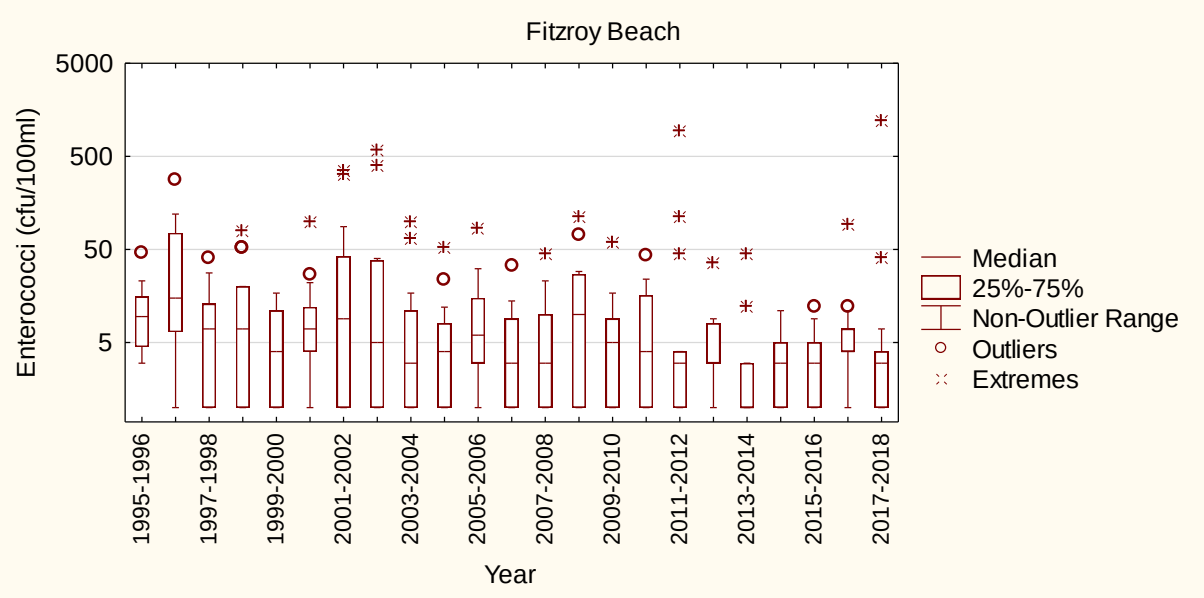


Figure 18 Box and whisker plots of enterococci for all summer SEM surveys at Fitzroy Beach

4.7.3 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 23 summer seasons (Figure 19) 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.

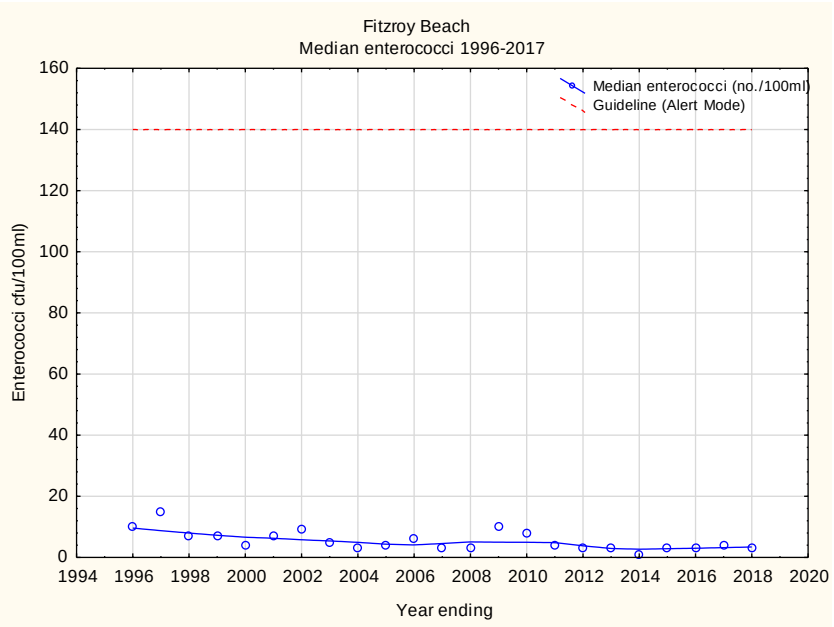


Figure 19 LOWESS trend analysis of median enterococci data at Fitzroy Beach

Over the 23 seasons monitored, there was a decrease in median enterococci counts (Kendall tau = -0.5188). This negative trend was significant using the Mann-Kendall test (p = 0.0005) and after FDR application (p = 0.0053).

4.8 East End Beach

East End Beach is situated approximately 500m south-west of Fitzroy Beach in New Plymouth (Photo 8). This beach is popular with summer bathers and has its own Surf Life-saving Club. The Te Henui Stream enters the sea approximately 200 m to the south-west of the sample site, which can result in high freshwater inputs during significant rainfall events.

Photo 8 East End Beach

All data for this site, from the 2017-2018 summer period, is presented in Figure 20. The complete survey results are presented in Appendix I. Two follow up samples were collected in addition to the 13 SEM samples (15 samples total).

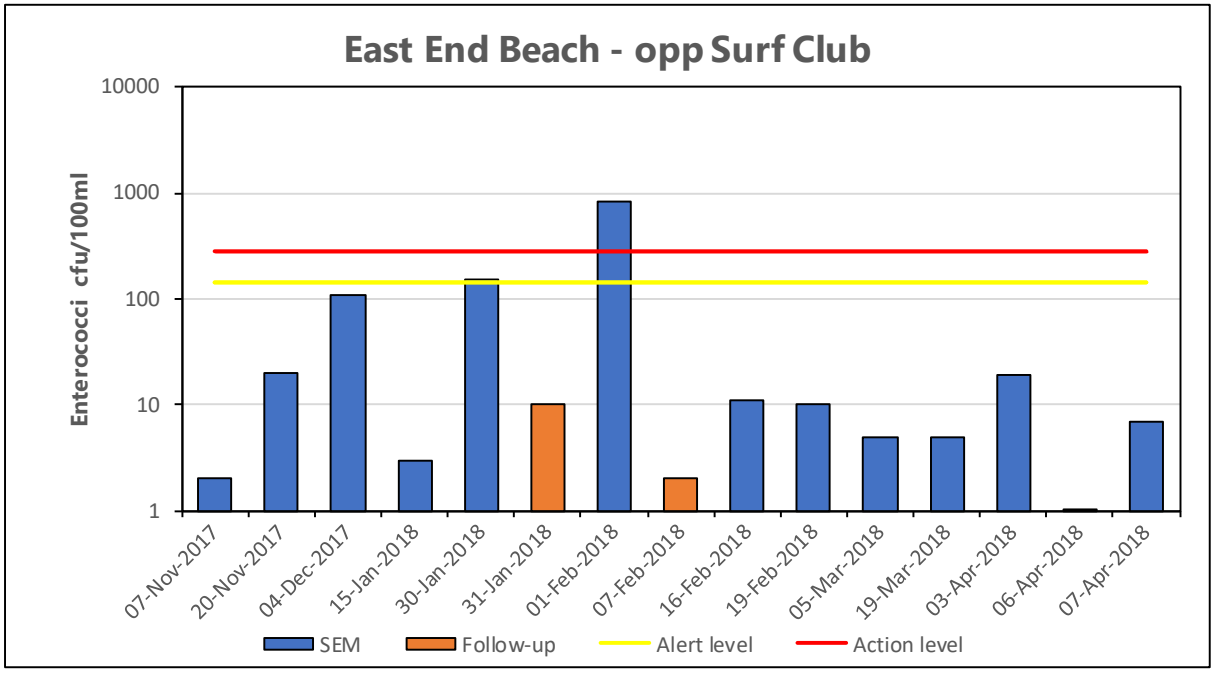


Figure 20 Enterococci results for East End Beach.

The monitoring results are summarized in Table 19.

Table 19 Statistical summary for East End Beach

Parameter	Units	Number of samples	Minimum	Maximum	Median
Conductivity	mS/m@20°C	13	4490	4830	4770
Enterococci	cfu/100 ml	13	<1	820	10
Temperature	°C	13	15.5	23.8	20.4

4.8.1 Comparison with guidelines

Enterococci counts from East End Beach over the 2017-2018 summer are summarized against the guidelines in Table 20. 'Alert' mode was reached on two occasions; 30 January and 1 February (150 and 820 cfu/100 ml, respectively). The second exceedance coincided with Cyclone Fehi. The remaining samples were within the 'Surveillance' limits.

Table 20 Performance against guidelines at East End Beach

Monitoring regime	Number of exceedances of enterococci guidelines	
	ALERT Single sample >140/100 ml	ACTION Two consecutive single samples >280/100 ml
SEM samples	2 [15%]	0 [0]

4.8.2 Comparison with previous summer surveys

Summary statistics for SEM enterococci data collected at East End Beach over 15 summers are presented in Figure 21. The results from the 2017-2018 summer period were comparable with previous summers; despite recording the single highest count to date.

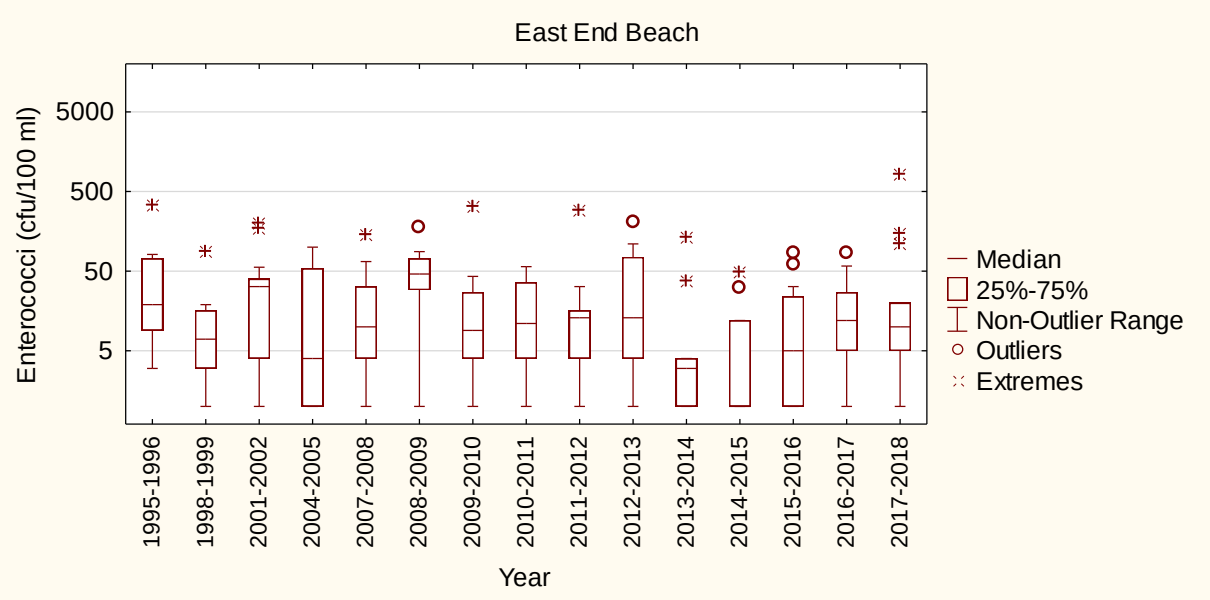
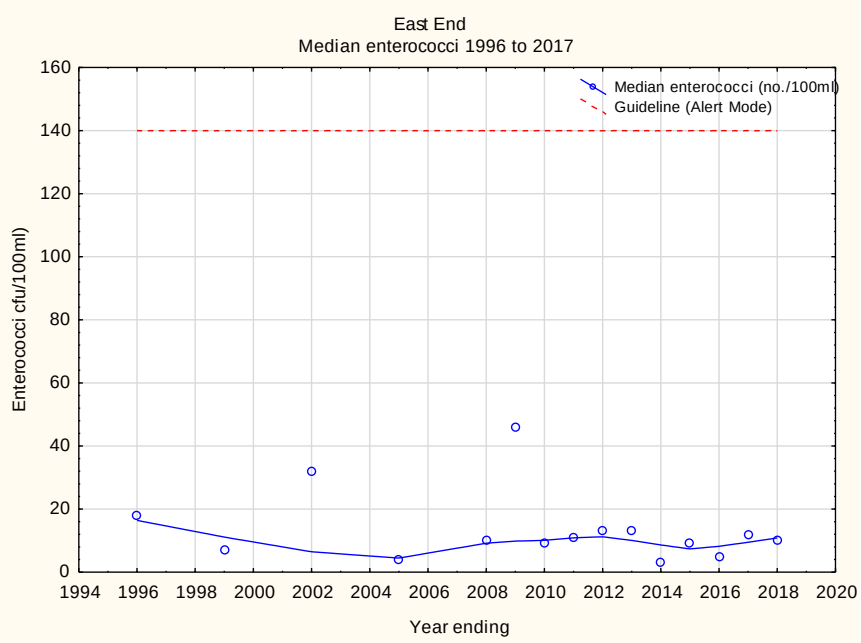


Figure 21 Box and whisker plots of enterococci for all summer SEM surveys at East End Beach

4.8.3 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 15 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.



East End Beach
n= 15
Kendall tau = -0.1353
p-value = 0.4821
FDR p-value = 0.8085

Figure 22 LOWESS trend analysis of median enterococci data at East End Beach

Over the 15 seasons monitored, there was a decreasing trend in median enterococci counts (Kendall tau = -0.135) that was not significant at the 5% level (p = 0.482).

4.9 Ngamotu Beach

Ngamotu Beach (Photo 9) 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 9 Ngamotu Beach

All data for this site, from the 2017-2018 summer period, is presented in Figure 23. The complete survey results are presented in Appendix I. Ngamotu Beach was sampled on 26 occasions throughout the summer; comprising 13 SEM samples, 11 extended monitoring samples and two follow up samples.

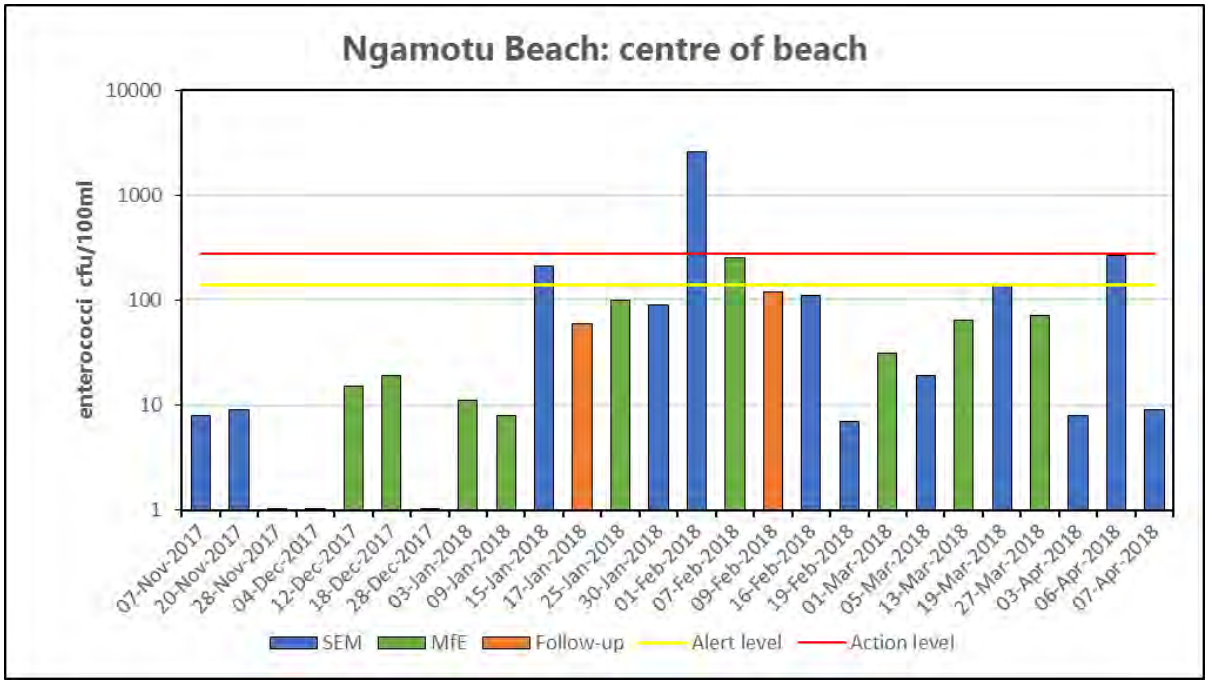


Figure 23 Enterococci results for Ngamotu Beach.

The monitoring results are summarised in Table 21.

Table 21 Statistical summary for Ngamotu Beach

Parameter		Units	Number of samples	Minimum	Maximum	Median
SEM samples	Conductivity	mS/m@20°C	13	4660	4820	4760
	Enterococci	cfu/100 ml	13	1	2600	19
	Temperature	°C	13	17.3	25.1	20.9
SEM + MfE samples	Conductivity	mS/m@20°C	24	4470	4850	4740
	Enterococci	cfu/100 ml	24	<1	2600	19
	Temperature	°C	24	17.3	25.1	21.2

4.9.1 Comparison with guidelines

Enterococci counts from Ngamotu Beach over the 2017-2018 summer are summarized against the guidelines in Table 22. 'Alert' mode was prompted on four occasions; 15 January, 1 February, 7 February and 6 April (210, 2600, 250 and 269 cfu/100 ml, respectively). The high enterococci count recorded on 1 February coincided with Cyclone Fehi. A large number of gulls were observed in the vicinity of the sampling site on 7 February, potentially influencing water quality at that time. Gulls were also abundant at Ngamotu Beach when the final high count was recorded on 6 April. Gull excrement was observed on the beach when this sample was collected.

Table 22 Performance against guidelines at Ngamotu Beach

Parameter	Number of exceedances of enterococci guidelines	
	ALERT Single sample >140/100 ml	ACTION Two consecutive single samples >280/100 ml
SEM samples	3 [23%]	0 [0]
SEM + MfE samples	4 [17%]	0 [0]

4.9.2 Comparison with previous summer surveys

Summary statistics for SEM enterococci data collected at Ngamotu Beach over 23 summers is presented in Figure 24. The distribution of counts recorded over the 2017-2018 summer was high compared with previous years. The maximum count from this summer was the highest ever recorded.

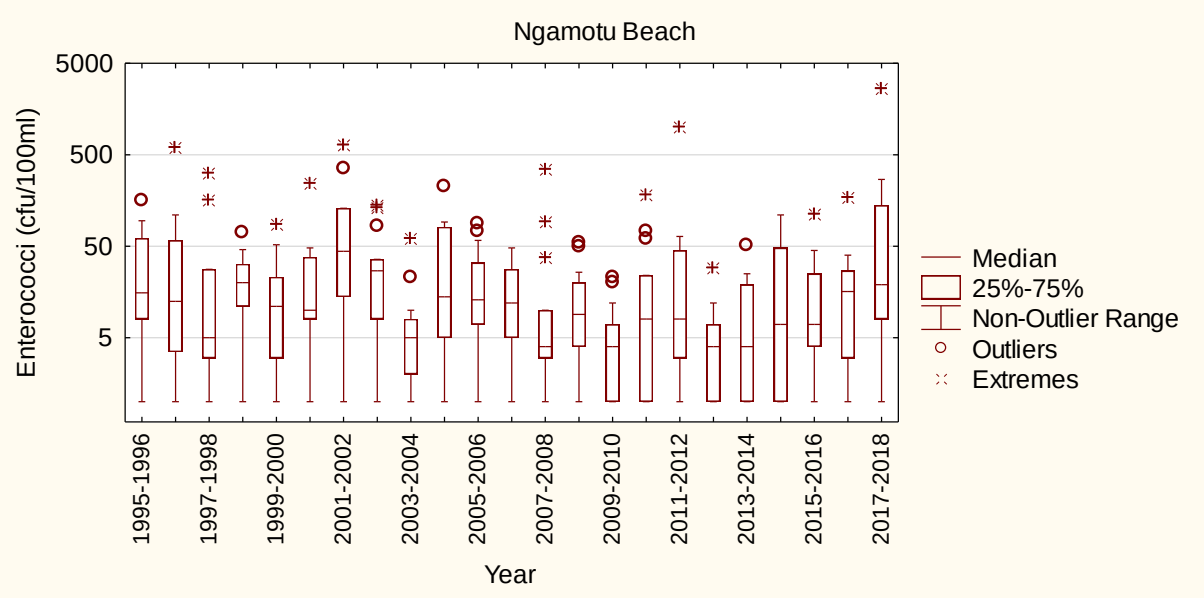


Figure 24 Box and whisker plots of enterococci for all summer SEM surveys at Ngamotu Beach

4.9.3 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 23 summer seasons (Figure 25) 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.

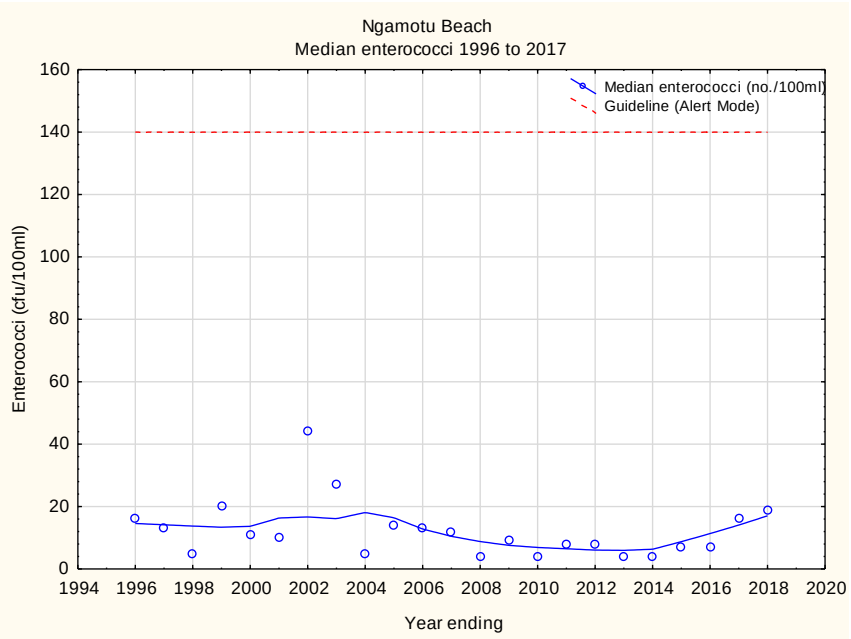


Figure 25 LOWESS trend analysis of median enterococci data at Ngamotu Beach

Over the 23 seasons monitored, there was a decreasing trend in median enterococci counts (Kendall tau = -0.259) that was not significant at the 5% level (p = 0.084).

4.10 Oakura Beach (Surf Club)

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 at Surf Club

All enterococci data for this site, from the 2017-2018 summer period, is presented in Figure 26. The complete survey results are presented in Appendix 1. This beach was sampled on 25 occasions throughout the summer; comprising 13 SEM samples, 11 extended monitoring samples and one follow up sample.

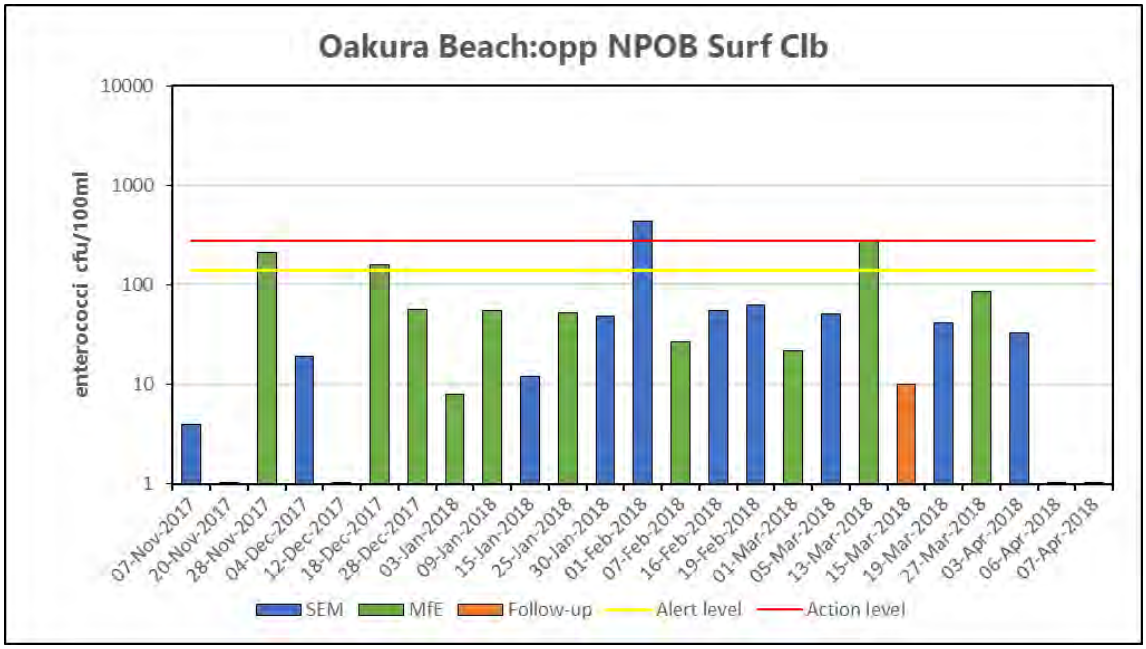


Figure 26 Enterococci results for the Surf Club at Oakura Beach.

The monitoring results are summarised in Table 23.

Table 23 Statistical summary for Oakura Beach (Surf Club)

Parameter		Units	Number of samples	Minimum	Maximum	Median
SEM samples	Conductivity	mS/m@20°C	13	4590	4830	4720
	Enterococci	cfu/100 ml	13	<1	440	33
	Temperature	°C	13	16.0	24.1	20.4
SEM + MfE samples	Conductivity	mS/m@20°C	24	3960	4830	4715
	Enterococci	cfu/100 ml	24	<1	440	44
	Temperature	°C	24	16.0	24.1	20.2

4.10.1 Comparison with guidelines

Enterococci counts from the Surf Club at Oakura Beach over the 2017-2018 summer are summarized against the guidelines in Table 24. 'Alert' mode was reached on four occasions; 28 November, 18 December, 1 February and 13 March (210, 160, 440 and 280 cfu/100 ml, respectively). It is worth noting that preceding wet weather may have contributed to the elevated count on 18 December, and the high enterococci count recorded on 1 February coincided with Cyclone Fehi.

Table 24 Performance against guidelines at Oakura Beach (Surf Club)

Parameter	Number of exceedances of enterococci guidelines	
	ALERT Single sample >140/100 ml	ACTION Two consecutive single samples >280/100 ml
SEM samples	1 [8%]	0 [0]
SEM + MfE samples	4 [17%]	0 [0]

4.10.2 Comparison with previous summer surveys

Summary statistics for SEM enterococci data collected from Oakura Beach at the Surf Club over 23 summers are presented in Figure 27. The distribution of results from the 2017-2018 summer period were comparable with previous summers; though the median count (33 cfu/100 ml) was relatively high.

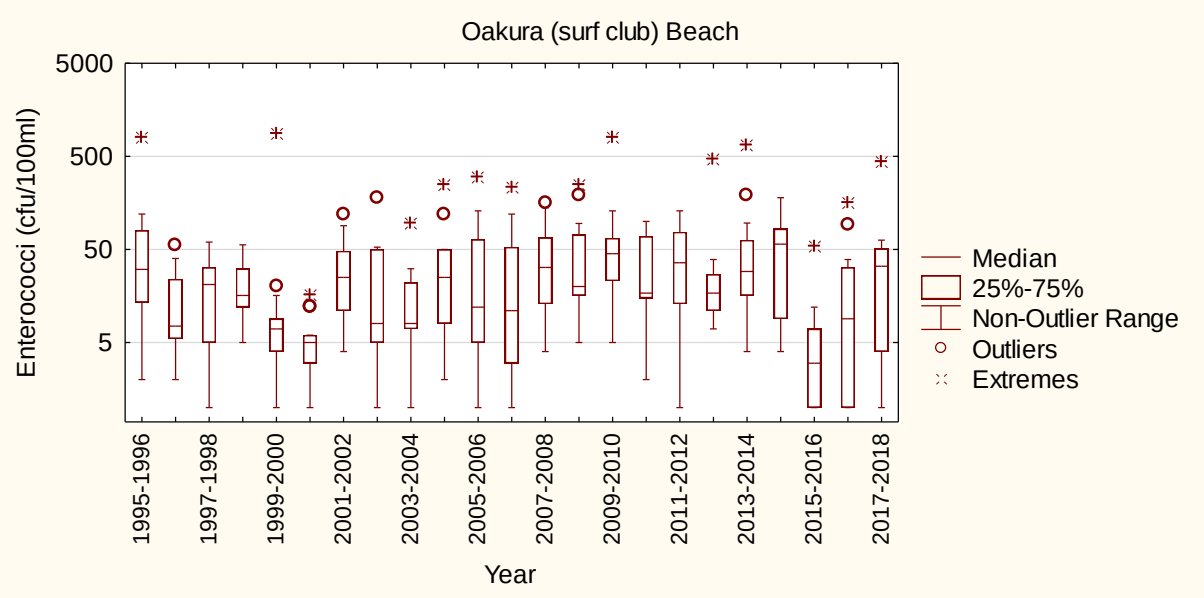


Figure 27 Box and whisker plots of enterococci for all summer SEM surveys at Oakura Beach at the Surf Club

4.10.3 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 23 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.

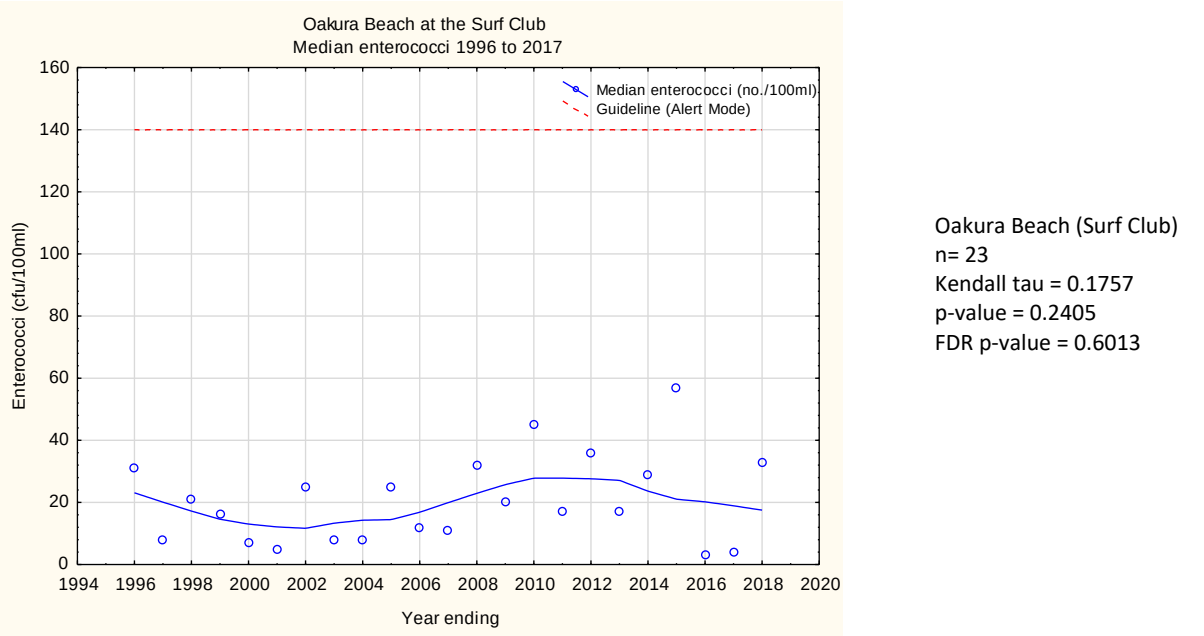


Figure 28 LOWESS trend analysis of median enterococci data at Oakura Beach (Surf Club)

Over the 23 seasons monitored, there was a positive trend (i.e. an increase) in median enterococci counts (Kendall tau = 0.176) that was not significant at the 5% level (p = 0.241).

4.11 Oakura Beach (Camp Ground)

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, opposite the Camp Ground

All enterococci data for this site, from the 2017-2018 summer period, is presented in Figure 29. The complete survey results are presented in Appendix I. In addition to the 13 SEM samples, one follow up sample was collected.

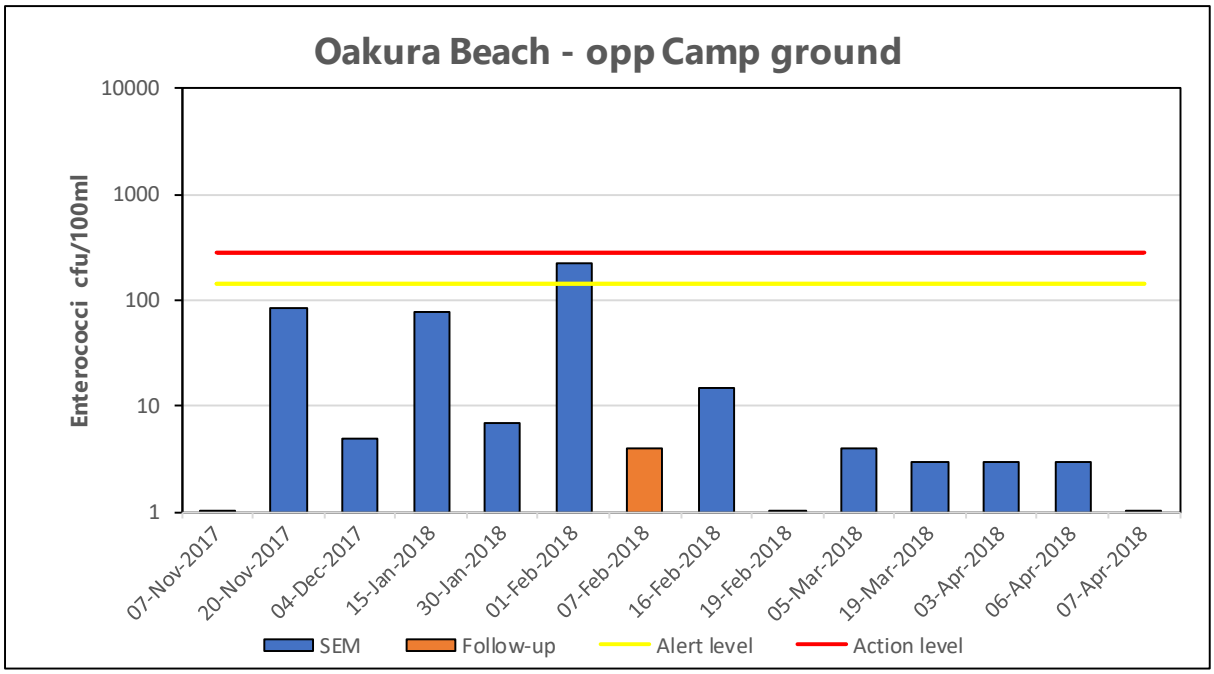


Figure 29 Enterococci results (presented on a logarithmic scale) for Oakura Beach at the Camp Ground.

The monitoring results are summarized in Table 25.

Table 25 Statistical summary for Oakura Beach (Camp Ground)

Parameter	Units	Number of samples	Minimum	Maximum	Median
Conductivity	mS/m@20°C	13	4630	4820	4760
Enterococci	cfu/100 ml	13	<1	220	4
Temperature	°C	13	15.8	23.9	20.7

4.11.1 Comparison with guidelines

Enterococci counts from Oakura Beach at the Camp Ground over the 2017-2018 summer are summarized against the guidelines in Table 26. The highest count (220 cfu/100 ml; Figure 29; Table 26), recorded on the 1 February, coincided with Cyclone Fehi and reached 'Alert' mode. The remaining 13 samples were within the 'Surveillance' limits.

Table 26 Bacterial guidelines performance at Oakura Beach (Camp Ground)

Parameter	Number of exceedances of enterococci guidelines	
	ALERT Single sample >140/100 ml	ACTION Two consecutive single samples >280/100 ml
SEM samples	1 [8%]	0 [0]

4.11.2 Comparison with previous summer surveys

Summary statistics for SEM enterococci data collected at East End Beach over 23 summers are presented in Figure 30. The results from the 2017-2018 summer period were comparable with previous summers.

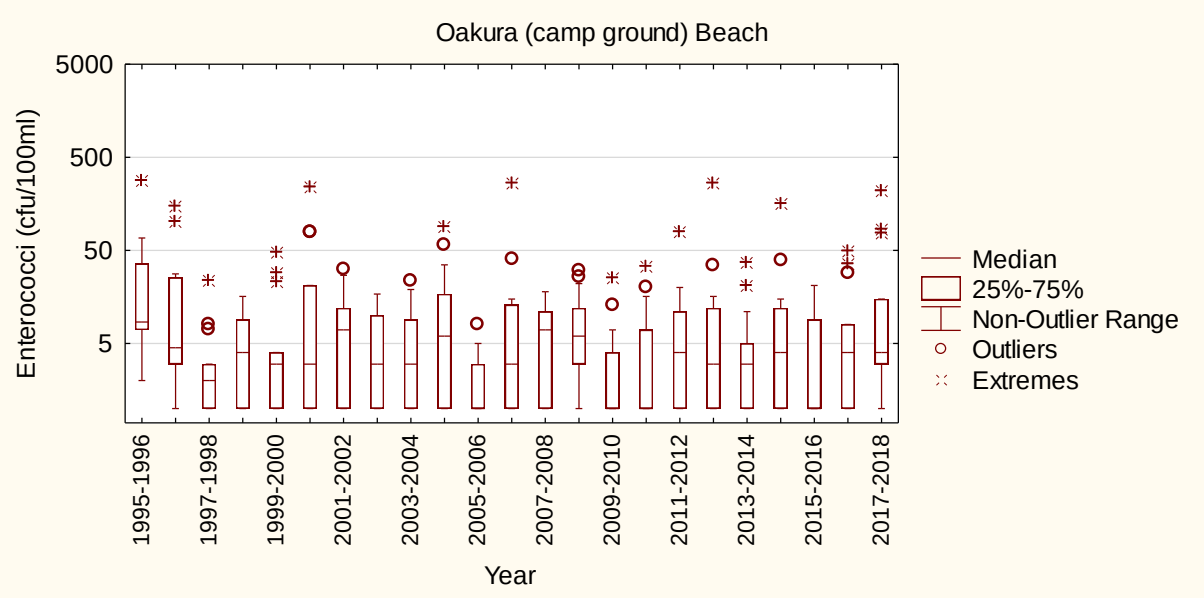
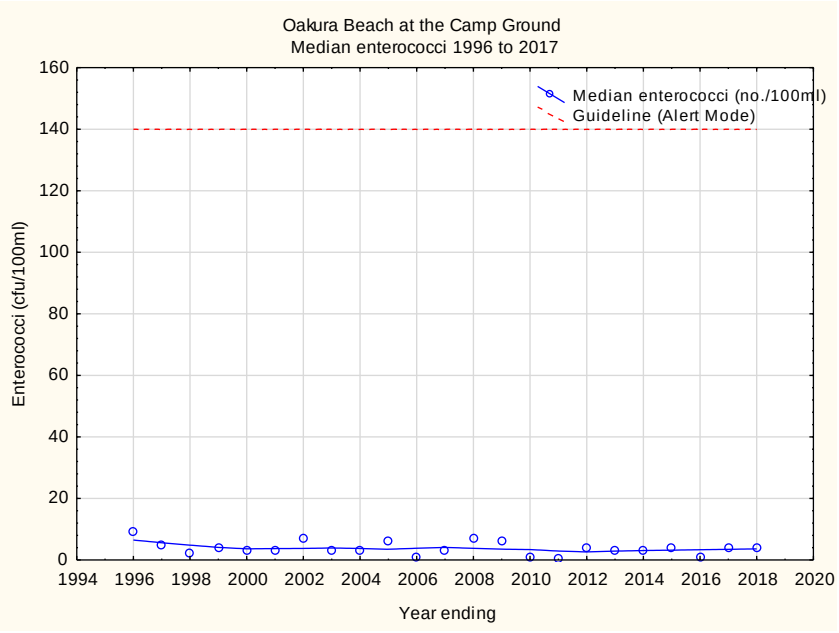


Figure 30 Box and whisker plots of enterococci for all summer SEM surveys at Oakura Beach opposite the Camp Ground

4.11.3 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 23 summer seasons (Figure 31) 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.



Oakura Beach
(Camp Ground)
n= 23
Kendall tau = -0.1494
p-value = 0.3182
FDR p-value = 0.6365

Figure 31 LOWESS trend analysis of median enterococci data at Oakura Beach (Camp Ground)

Over the 23 seasons monitored, there was a negative trend (i.e. a decrease) in median enterococci counts (Kendall tau = -0.149) that was not significant at the 5% level (p = 0.318).

4.12 Opunake Beach

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

All data for this site, from the 2017-2018 summer period, is presented in Figure 32. The complete survey results are presented in Appendix I. This beach was sampled on 25 occasions throughout the summer; comprising 13 SEM samples, 11 extended monitoring samples and one follow up sample.

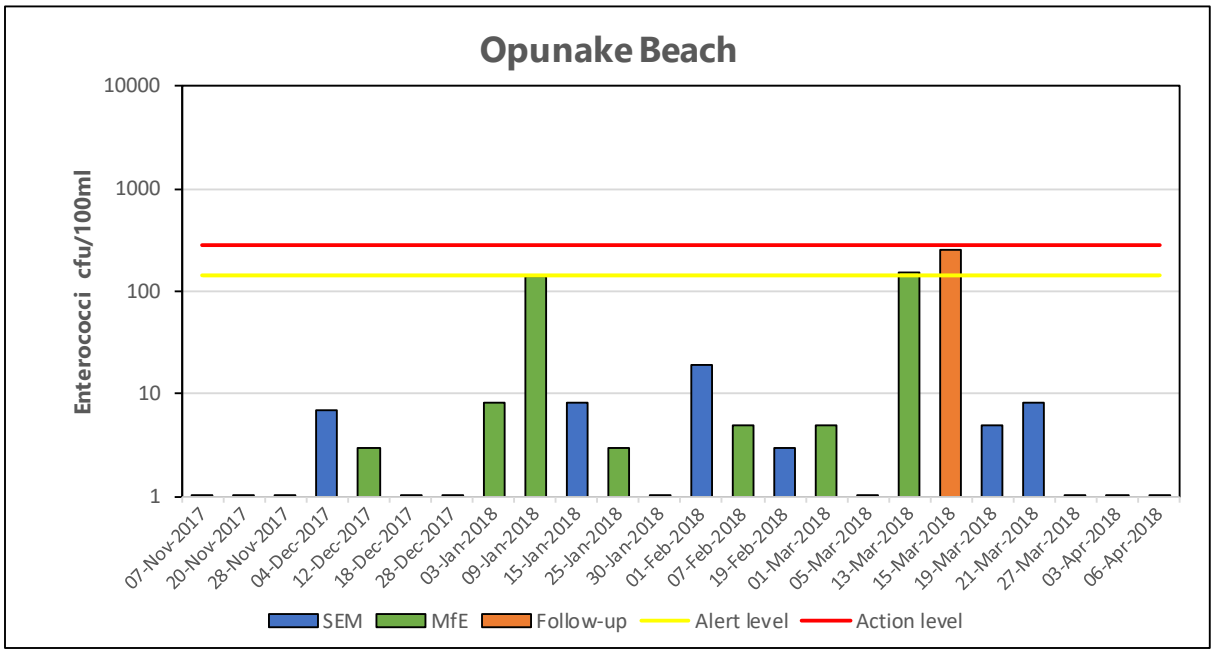


Figure 32 Enterococci results for the Surf Club at Opunake Beach.

The monitoring results are summarized in Table 27.

Table 27 Statistical summary for Opunake Beach

Parameter		Units	Number of samples	Minimum	Maximum	Median
SEM samples	Conductivity	mS/m@20°C	13	4560	4860	4760
	Enterococci	cfu/100 ml	13	<1	19	3
	Temperature	°C	13	16.5	23.3	21.1
SEM + MfE samples	Conductivity	mS/m@20°C	24	3440	4860	4740
	Enterococci	cfu/100 ml	24	<1	150	3
	Temperature	°C	24	16.3	24.1	20.8

4.12.1 Comparison with guidelines

Enterococci counts from the Opunake Beach over the 2017-2018 summer are summarized against the guidelines in Table 28. Over the season, 'Alert' mode was reached twice during routine monitoring and once from follow up sampling. The remaining samples were within 'Surveillance' mode. The MfE sample that was collected on 13 March (150 cfu/100 ml) had a clear freshwater influence (4010 mS/m@20°C; Appendix I) and there was an abundance of birds in the vicinty of the sampling site.

Table 28 Performance against guidelines at Opunake Beach

Parameter	Number of exceedances of enterococci guidelines	
	ALERT Single sample >140/100 ml	ACTION Two consecutive single samples >280/100 ml
SEM samples	0 [0]	0 [0]
SEM + MfE samples	2 [8%]*	0 [0]

* Alert mode was also reached once due to a follow up sample result

4.12.2 Comparison with previous summer surveys

Summary statistics for SEM enterococci data collected at Opunake Beach over 23 summers are presented in Figure 33. The results from the 2017-2018 summer period were comparable with previous summers.

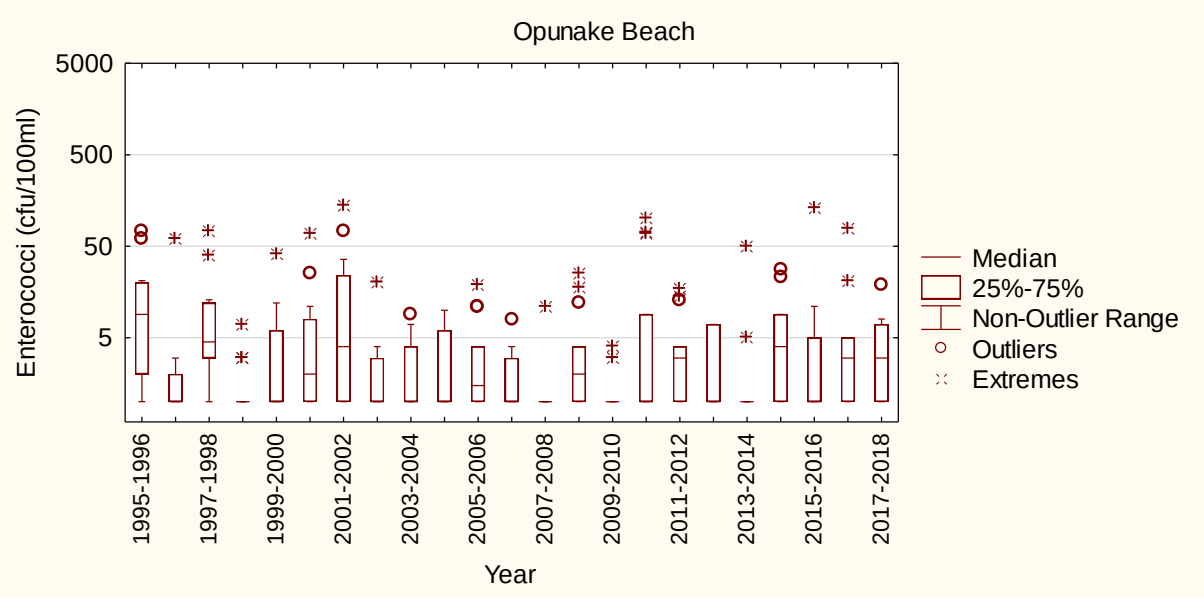


Figure 33 Box and whisker plots of enterococci for all summer SEM surveys at Opunake Beach

4.12.3 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 23 summer seasons (Figure 34) 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.

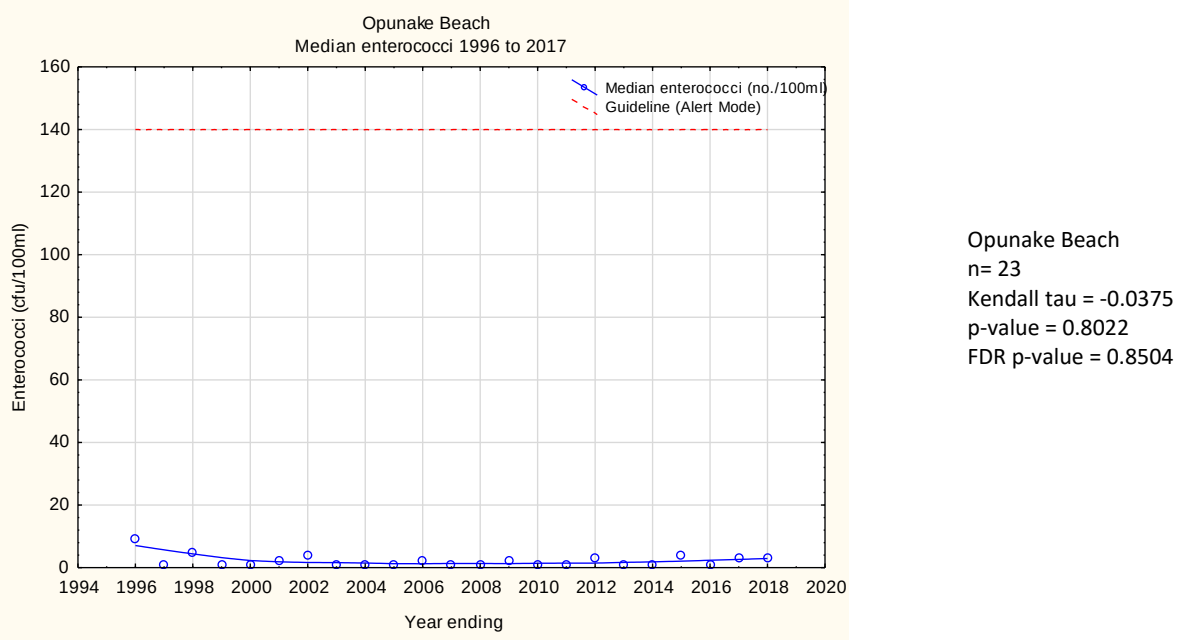


Figure 34 LOWESS trend analysis of median enterococci data at Opunake Beach

Over the 23 seasons monitored, there was a negative trend (i.e. a decrease) in median enterococci counts (Kendall tau = -0.038) that was not significant at the 5% level (p = 0.802).

4.13 Ohawe Beach

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

All data for this site, from the 2017-2018 summer period, is presented in Figure 35. The complete survey results are presented in Appendix I. This beach was sampled on 26 occasions throughout the summer; comprising 13 SEM samples, 11 extended monitoring samples and two follow up samples.

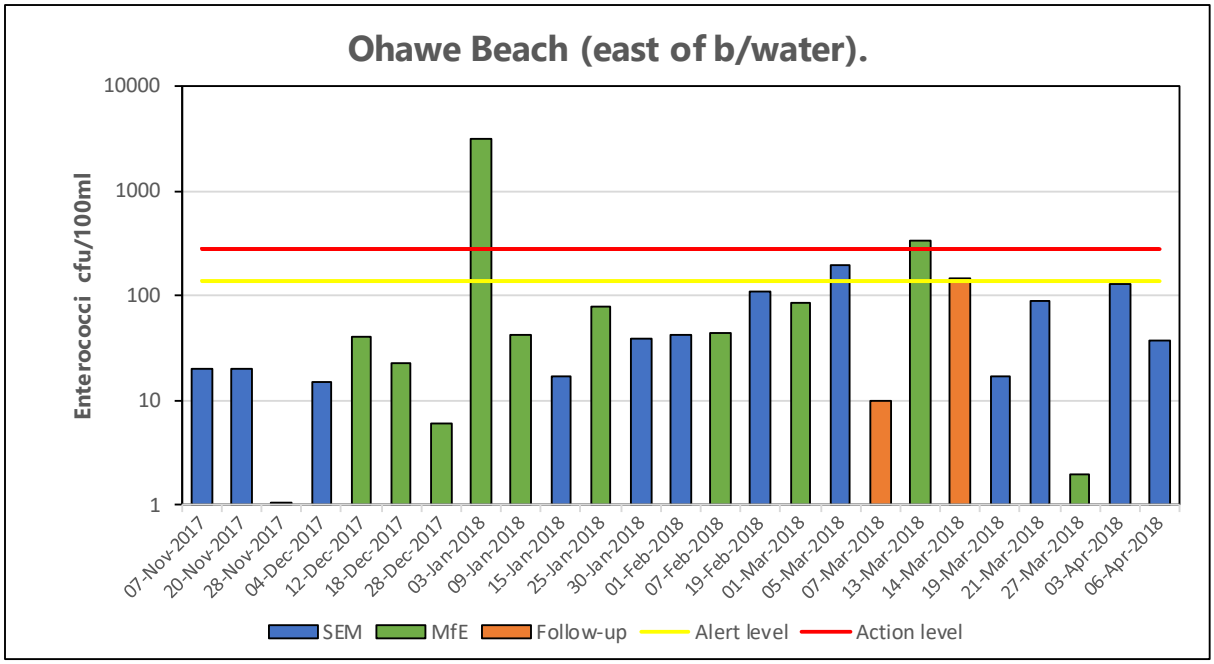


Figure 35 Enterococci results for the Surf Club at Opunake Beach.

The monitoring results are summarized in Table 29.

Table 29 Statistical summary for Ohawe Beach

Parameter		Units	Number of samples	Minimum	Maximum	Median
SEM samples	Conductivity	mS/m@20°C	13	3800	4810	4360
	Enterococci	cfu/100 ml	13	15	200	39
	Temperature	°C	13	16.4	23.6	19.9
SEM + MfE samples	Conductivity	mS/m@20°C	24	2780	4810	4090
	Enterococci	cfu/100 ml	24	<1	3100	42
	Temperature	°C	24	16.4	23.6	20.6

4.13.1 Comparison with guidelines

Enterococci counts from the Ohawe Beach over the 2017-2018 summer are summarized against the guidelines in Table 31. 'Alert' mode was prompted on three occasions during routine monitoring; 3 January, 5 March, and 13 March (3100, 200 and 330 cfu/100 ml, respectively). 'Alert' mode was also reached after a high follow up sample result on 14 March (146 cfu/100 ml). The remaining counts were within 'Surveillance' limits. Wet weather preceded the sampling on 3 January and was reflected in the associated conductivity sample (3540 mS/m@20°C). A considerable freshwater influence was also evident on 13 March (3330 mS/m@20°C).

Table 30 Performance against guidelines at Ohawe Beach

Parameter	Number of exceedances of enterococci guidelines	
	ALERT Single sample >140/100 ml	ACTION Two consecutive single samples >280/100 ml
SEM samples	1 [8%]	0 [0]
SEM + MfE samples	3 [13%]*	0 [0]

* Alert mode was also reached once due to a follow up sample result

4.13.2 Comparison with previous summer surveys

Summary statistics for SEM enterococci data collected at Ohawe Beach over 22 summers are presented in Figure 36. The results from the 2017-2018 summer period were comparable with previous summers; though the median count (39 cfu/100 ml) was relatively high.

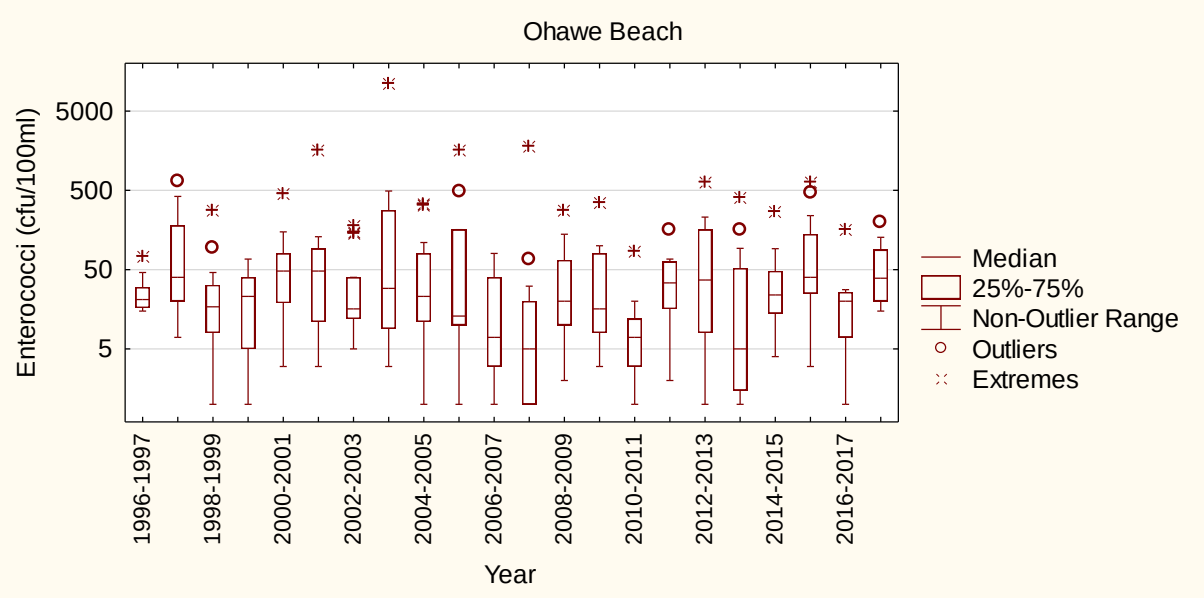


Figure 36 Box and whisker plots of enterococci for all summer SEM surveys at Ohawe Beach

4.13.3 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 22 summer seasons (Figure 37) 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.

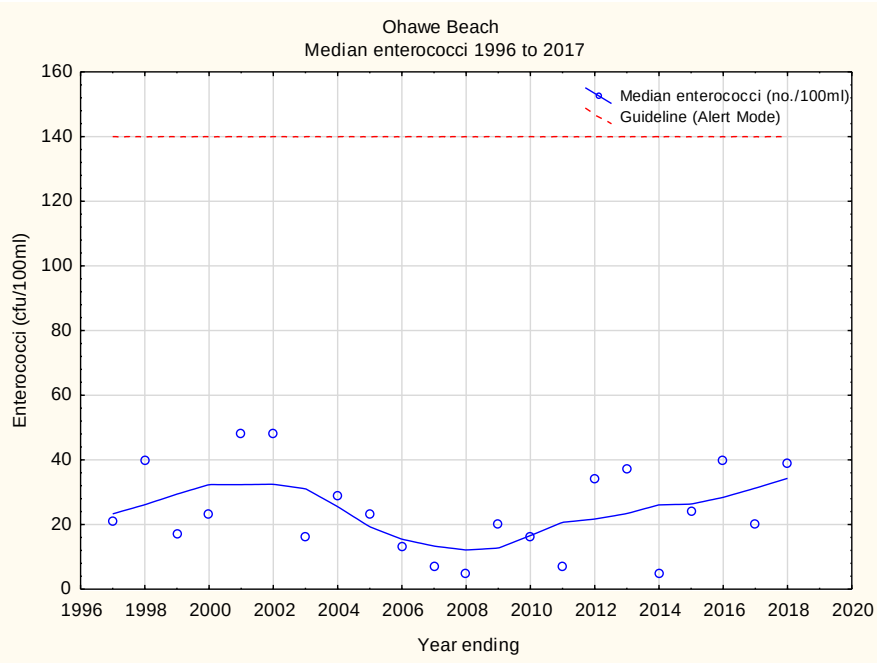


Figure 37 LOWESS trend analysis of median enterococci data at Ohawe Beach

Over the 22 seasons monitored, there was a decreasing trend in median enterococci counts (Kendall tau = -0.062) that was not significant at the 5% level (p = 0.689).

5 Discussion

5.1 Regional overview

Given the influence of faecal contaminants of terrestrial origin on recreational water quality, it is necessary to consider rainfall when interpreting results. When examining the entire summer period (November 2017 to April 2018), rainfall levels across Taranaki were fairly typical based on historical results (Figure 38). However, these values are the averages of two contrasting periods of weather. The months of November and December were significantly drier across the region, compared with historical averages. This dry spell didn't last, however, with January, February and March seeing levels of rainfall well above typical levels. Rainfall in April was only marginally higher than in past years (see Appendix III for a detailed summary). These contrasting periods of rainfall were somewhat reflected in the distribution of guideline exceedances over the summer. November and December had the lowest proportion of samples exceeding the guidelines (3% and 5%, respectively), whereas the proportion of exceedances were considerably higher in January, February and March (10%, 21% and 13%, respectively). Guideline exceedances decreased again in April (7% of samples). February had a considerably higher proportion of samples exceeding the guidelines compared with other months. However, over half of these counts were likely attributed to a specific event.

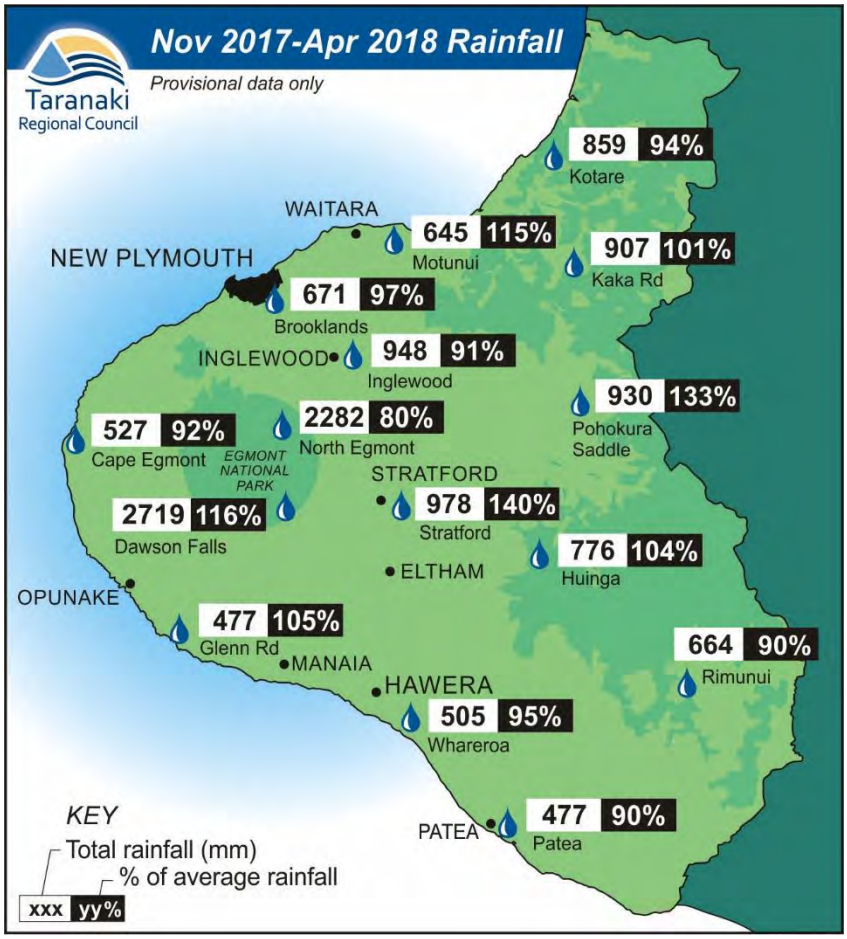


Figure 38 Average rainfall data for Taranaki, November 2017 to April 2018

On 1 February 2018, Cyclone Fehi and a king tide aligned to produce exceptional coastal conditions. Most relevant, when discussing coastal water quality, were the effects of the cyclone in terms of wind and swell. The turbulent seas that resulted on this day had a far greater potential to mix the coastal waters and stir up benthic sediments, compared with typical conditions. Given the high abundance of faecal indicator bacteria in benthic sediments (e.g. Hartz et al. 2009), their reintroduction to the water column through vigorous

mixing can lead to significant decreases in coastal water quality. Although this process may regularly occur through wave action at the shoreline, the exceptional turbulence on this occasion likely suspended a greater area of the seafloor by stirring up sediments from deeper waters. Enterococci counts were elevated, some considerably so, at the seven North Taranaki sites that were sampled during Cyclone Fehi. The four remaining North Taranaki sites were unable to be sampled due to unsafe conditions. For two of these sites, reoccurring safety issues limited the number of samples that could be collected over the summer.

Sampling at two of the rotational sites, Onaero Beach Settlement and Urenui Beach, was considerably reduced during the 2017-2018 summer season due to unsafe conditions. At both locations, samples are collected from seawall access ramps, which can be exposed to unpredictable and dangerous waves at high tide. The ongoing inclusion of these sites in the monitoring programme is now subject to review. It should also be noted that the reduced sampling effort at the Onaero and Urenui sites (9/13 and 7/13 samples, respectively), constrains the rigour of the results. When fewer samples are collected, less of the natural variation is captured, and a less accurate representation of water quality is portrayed.

5.2 Guidelines and grades

A summary of results for all bathing beach sites monitored over the 2017-2018 summer period is presented in Table 31, in ascending order of median count. In this table, the performance of each site is summarised in terms of the MfE Guidelines and the Suitability for Recreation Grades (2013/14 - 2017/18), based on routine samples collected over the summer (SEM and extended monitoring).

Table 31 Summary of bathing beach performance against relevant guidelines and grades

Beach	Median	Number of samples	Number of samples reaching Alert mode [% of samples]	Number of samples reaching Action mode [% of samples]	Suitability for Recreation Grade (SFRG)
Urenui	1	9	1 [11%]	0 [0%]	Good
Opunake	3	24	1 [4%]*	0 [0%]	Good
Fitzroy	3	24	2 [8%]	0 [0%]	Good
Oakura (Camp Ground)	4	13	1 [8%]	0 [0%]	Good
Onaero (Settlement)	7	7	0 [0%]	0 [0%]	Good
East End	10	13	2 [13%]	0 [0%]	Good
Waitara West	11	23	1 [4%]	0 [0%]	Good
Onaero (Surf Club)	13	24	3 [13%]	0 [0%]	Fair
Waitara East	14	23	2 [8%]	0 [0%]	Fair
Ngamotu	19	24	4 [17%]	0 [0%]	Good
Wai-iti	23	13	2 [15%]	0 [0%]*	Poor
Ohawe	42	24	3 [13%]*	0 [0%]	Fair
Oakura (Surf Club)	44	24	4 [17%]	0 [0%]	Fair

*Single guideline exceedance also occurred due to a follow up sample result

During the 2017-2018 summer period, a total of 245 routine samples were collected across 13 sites. Of these, 219 samples (89.4%) remained in Surveillance mode (≤140 cu/100 ml) and 26 samples (10.6%) reached Alert mode (>140 cfu/100 ml). Action mode (2x >280 cfu/100 ml) was not reached during routine sampling. The proportion of these samples which exceeded the surveillance threshold was slightly higher

than in the previous bathing season (9.4% of routine samples exceeded 140 cfu/100 ml in 2016-2017). Follow up samples prompted Alert mode twice and Action mode once in the summer under review.

Although correlation cannot directly infer causation, it is worth noting that wet weather and/or low sample conductivity was associated with six of the guideline exceedances, the presence of birds in the vicinity of the sampling site was associated with five exceedances, and turbulent shoreline conditions caused by Cyclone Fehi coincided with six exceedances. Four of the five highest enterococci counts recorded over the summer period came from samples collected during Cyclone Fehi.

Sites that were monitored during the 2017-2018 summer were also assigned a Suitability for Recreation Grade, which reflects a qualitative risk grading of the catchment in addition to quantitative enterococci results since the 2013-2014 summer (see Section 3.2). The majority of sites (8/13) were graded 'good', while four sites were graded 'fair' and one site was graded 'poor'. No sites were graded 'very poor'. These grades are similar to those following the 2016-2017 bathing season, where 8/12 sites were graded 'good', 3/12 were 'fair' and 1/12 was 'poor'. The grading for Oakura at the Surf Club has decreased from good to fair in light of the most recent results. Complete grading results are presented in Appendix IV.

Following the 2017-2018 bathing season, Wai-iti Beach received the lowest SFRG grade out of all sites, despite two other beaches having a higher proportion of samples exceeding the MfE guidelines. It should be noted that because this site is sampled on a rotational frequency, fewer samples collected over the five year SFRG assessment period can lead to exceptional counts having a considerable influence on the distribution of data, and ultimately the SFRG grade (see Section 3.2 for further explanation). It is possible that the high enterococci count which coincided with Cyclone Fehi has had a measurable effect on this latest SFRG grade.

5.3 State of the Environment samples

The bathing beach results from SEM surveys over the 2017-2018 summer period are summarised in Table 32, in ascending order of median count. Historical medians are also presented in this table, as well as the updated trend analysis statistics.

Table 32 Summary of SEM enterococci results, including historical results and trend analysis statistics

Beach	Current results (2017-2018)		Historic results (1995-2017)		Long term trend analysis		
	Median	Number of samples	Median	Number of samples	Kendall tau	Mann-Kendall p- value	False Discovery Rate p-value
Urenui	1	9	4	90	Insufficient data (triennial)		
Fitzroy	3	13	4	284	-0.519	0.001	0.005
Opunake	3	13	1	172	-0.037	0.802	0.850
Oakura (Camp)	4	13	3	284	-0.149	0.318	0.636
Onaero (Settlement)	7	7	8	90	Insufficient data (triennial)		
Onaero (Surf Club)	8	13	9	233	0.104	0.576	0.823
East End	10	13	10	170	-0.135	0.482	0.803

Beach	Current results (2017-2018)		Historic results (1995-2017)		Long term trend analysis		
	Median	Number of samples	Median	Number of samples	Kendall tau	Mann-Kendall p- value	False Discovery Rate p-value
Waitara East	12	12	12	324	-0.270	0.071	0.280
Ngamotu	19	13	8	286	-0.259	0.084	0.280
Waitara West	22	12	13	325	-0.028	0.850	0.850
Wai-iti	23	13	10	90	Insufficient data (triennial)		
Oakura (Surf Club)	33	13	16	287	0.176	0.241	0.601
Ohawe	39	13	20	274	-0.062	0.688	0.850

When ranking the current results (based on median enterococci count), the order of sites was generally comparable with the rankings of historical medians (Table 32). The site with the lowest median enterococci count, based on the 2017-2018 SEM surveys, was Urenui Beach (1 cfu/100 ml; Table 32, Figure 39). However, it should be noted that this site was only sampled on nine of the 13 scheduled occasions (see Section 5.1). Fitzroy, Opunake and Oakura at the camp ground were all sampled 13 times and recorded median counts of 3, 3, and 4 cfu/100 ml, respectively (Table 32, Figure 39). These low results were very similar to their respective historic medians. The enduring standard of recreational water quality at these three sites is likely attributed to their distance from riverine inputs and other point source discharges. Onaero Settlement, Onaero at the Surf Club, East End and Waitara East also recorded median counts that were comparable with their respective historical medians.

The sites with the two highest median counts were Ohawe Beach and Oakura at the Surf Club (39 and 33 cfu/100 ml, respectively; Table 32, Figure 39). These median counts were approximately double their respective historic medians (Table 32, Figure 39). Both of these sites are located in the immediate vicinity of river / stream mouths, which are known to influence enterococci counts. In the case of Oakura Beach at the Surf Club, sand accretion over the summer can cause the Waimoku Stream to meander east along the beach until it drains into the sea immediately adjacent to the sampling site (Photo 14). Median counts from Wai-iti, Waitara West and Ngamotu were also notably higher than their respective historic medians.

Photo 14 Waimoku Stream meandering along Oakura Beach towards Surf Club, 7 April 2018

Of the ten sites with sufficient data to undertake trend analyses, two sites demonstrated positive trends (i.e. increases in enterococci counts), that were not significant (at the 5% level). Seven sites demonstrated negative trends (i.e. decreases in enterococci counts), that were not significant (at the 5% level). One site, Fitzroy Beach, demonstrated a significant negative trend (Kendall tau = -0.519, Mann-Kendall p value <0.001; Table 33). Improvements in water quality at this site might have arisen in part or in whole 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.

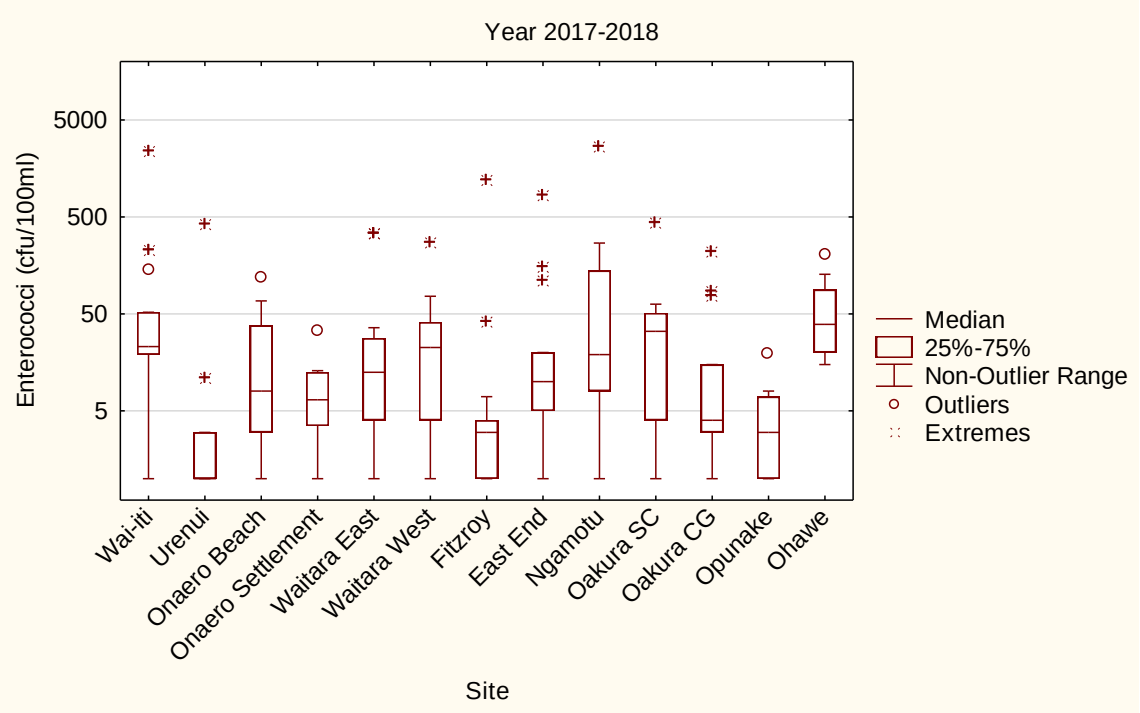


Figure 39 Box and whisker plots of enterococci at all sites during the 2017-2018 season (SEM programme data only)

5.4 Conclusion

During the 2017-2018 summer season, 245 samples were collected across 13 sites; of which 89.4% remained within Surveillance mode (≤140 cfu/100 ml). In addition to the occasional influences of freshwater and nearby birds (Photo 15), Cyclone Fehi was a probable cause for high counts across North Taranaki during one survey at the beginning of February.

Based on the 157 SEM samples, recreational water quality was generally comparable with historical results. One site, Fitzroy Beach, continued to demonstrate a significant negative trend in median enterococci counts (improving quality) based on 23 years of monitoring data. Following a season of missed sampling opportunities due to unsafe conditions, the ongoing inclusion of two rotational sites (Urenui Beach and Onaero Settlement beach), in the SEM programme is under review from a safety perspective.

Many of the popular beach sites monitored in Taranaki happen to be 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 and downstream environments (TRC 2017). In order to minimize potential health and safety risks, the Council recommends reducing coastal recreational activities in the vicinity of stream mouths for up to three days following heavy rainfall.

Photo 15 Black-backed gulls at the mouth of the Waiwhakaiho River

6 Recommendations

As a result of the 2017-2018 bathing beach recreational water quality survey it is recommended:

1. THAT the 2018-2019 summer survey be performed at 14 sites continuing with the existing sampling protocol (sites monitored annually, plus Year 1 sites).
2. THAT the 2018-2019 summer survey also includes weekly 'extended samples' at eight sites (Onaero, Waitara West, Waitara East, Fitzroy, Ngamotu, Oakura Surf Club, Opunake and Ohawe) between December and February in accordance with MfE, 2003 guidelines to provide up to date public information on beach conditions throughout the holiday periods.
3. THAT follow-up sampling be performed as deemed necessary by Council staff.
4. THAT photographs of the position of the Waimoku Stream and Waingongoro River mouths are taken over the 2018-2019 season to aid the interpretation of faecal indicator bacteria results at the Oakura Beach and Ohawe Beach sites respectively.
5. THAT public 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	The bathing season generally 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 millisiemens/metre (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 millilitre 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 millilitre 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 Category (MAC)	A measurement of water quality over time as provided by historical (five years) microbiological results – A, B, C or D
RMA	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 hypothetical condition of a site in the absence of specific monitoring data, based on both risk and past 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 a Science Services Manager.

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Appendix I

Complete marine recreational water quality results for 2017-2018 summer season

Wai-iti Beach

Date	Time	Temperature	Conductivity	Enterococci	Programme
	NZST	°C	mS/m@20°C	cfu/100ml	
07 Nov 2017	10:40	17.1	4690	1	SEM
20 Nov 2017	10:10	17.3	4770	3	SEM
04 Dec 2017	08:05	19.6	4730	19	SEM
15 Jan 2018	10:30	22.7	4390	52	SEM
30 Jan 2018	08:38	23.7	4530	7	SEM
01 Feb 2018	09:35	22.6	4600	2400	SEM
07 Feb 2018	11:00	23.5	4780	670	FOLLOW UP
09 Feb 2018	11:20	23	4620	8	FOLLOW UP
16 Feb 2018	09:30	22.1	4580	230	SEM
19 Feb 2018	12:25	24.2	4480	48	SEM
05 Mar 2018	12:45	23.6	4720	140	SEM
19 Mar 2018	10:50	20.3	4660	23	SEM
21 Mar 2018	10:10	19.9	4820	19	SEM
03 Apr 2018	11:35	20.6	4770	23	SEM
06 Apr 2018	11:30	20.2	4710	41	SEM

Urenui Beach

Date	Time	Temperature	Conductivity	Enterococci	Programme
	NZST	°C	mS/m@20°C	cfu/100ml	
07 Nov 2017	11:15	17.3	4640	<1	SEM
20 Nov 2017	10:40	17.8	4790	1	SEM
04 Dec 2017	08:45	19.8	4730	<1	SEM
15 Jan 2018	10:10	23.5	4720	<1	SEM
30 Jan 2018	08:15	23.6	4810	1	SEM
16 Feb 2018	09:05	22.3	4730	420	SEM
19 Feb 2018	11:50		4630	11	SEM
21 Mar 2018	12:50	19.9	4810	3	SEM
06 Apr 2018	12:05	20.3	4760	<1	SEM

Onaero Beach at the Surf Club

Date	Time	Temperature	Conductivity	Enterococci	Programme
	NZST	°C	mS/m@20°C	cfu/100ml	
07 Nov 2017	11:35	17.5	4680	<1	SEM
20 Nov 2017	10:50	18.3	4760	5	SEM
28 Nov 2017	09:46	19.1	4800	<1	EXTENDED
04 Dec 2017	09:00	19.8	4800	1	SEM
12 Dec 2017	09:04	21.5	3720	240	EXTENDED
18 Dec 2017	09:25	19.5	4790	13	EXTENDED
28 Dec 2017	08:30	19	4760	5	EXTENDED
03 Jan 2018	09:05	19.1	4720	13	EXTENDED
09 Jan 2018	08:30	20.1	1951	160	EXTENDED
11 Jan 2018	12:40	22.6	1255	120	FOLLOW UP
15 Jan 2018	09:33	22.6	4740	9	SEM
25 Jan 2018	09:30	22.5	3930	100	EXTENDED
30 Jan 2018	08:38	22.9	4820	13	SEM
01 Feb 2018	10:45	22.7	4760	120	SEM
07 Feb 2018	10:00	22.9	4560	44	EXTENDED
16 Feb 2018	08:35	21.8	4570	68	SEM
19 Feb 2018	11:10	24.1	4550	38	SEM
01 Mar 2018	09:50	22	4500	220	EXTENDED
05 Mar 2018	11:25	22.6	4700	<1	SEM
13 Mar 2018	09:15	19.5	3690	100	EXTENDED
19 Mar 2018	10:00	19.9	4730	8	SEM
21 Mar 2018	11:05	19.7	4780	59	SEM
27 Mar 2018	09:15	20.3	4260	39	EXTENDED
03 Apr 2018	10:30	20.4	4730	3	SEM
06 Apr 2018	12:30	20.6	4740	5	SEM

Onaero Settlement Beach

Date	Time	Temperature	Conductivity	Enterococci	Programme
	NZST	°C	mS/m@20°C	cfu/100ml	
07 Nov 2017	11:50	16.8	4720	4	SEM
20 Nov 2017	11:10	18.4	4770	3	SEM
04 Dec 2017	09:15	19.9	4690	13	SEM
15 Jan 2018	09:20	22.5	4680	33	SEM
30 Jan 2018	07:24	22.6	4800	7	SEM
16 Feb 2018	08:25	21.4	4750	12	SEM
06 Apr 2018	12:40	20.5	4780	<1	SEM

Waitara East Beach

Date	Time	Temperature	Conductivity	Enterococci	Programme
	NZST	°C	mS/m@20°C	cfu/100ml	
07 Nov 2017	12:10	16.9	4180	8	SEM
20 Nov 2017	11:45	18	4530	14	SEM
28 Nov 2017	10:17	20.7	4760	3	EXTENDED
04 Dec 2017	09:45	19.5	4680	17	SEM
12 Dec 2017	09:50	23.6	4490	3	EXTENDED
18 Dec 2017	08:55	19.6	4650	5	EXTENDED
28 Dec 2017	09:15	19.1	4690	<1	EXTENDED
03 Jan 2018	09:40	18.4	4750	17	EXTENDED
09 Jan 2018	08:56	19.9	4110	21	EXTENDED
15 Jan 2018	08:57	23	4520	11	SEM
25 Jan 2018	09:00	23	3110	16	EXTENDED
30 Jan 2018	07:00	22.5	4690	340	SEM
31 Jan 2018	13:30	24.5	4560	<10	FOLLOW UP
07 Feb 2018	09:20	21.3	3540	22	EXTENDED
16 Feb 2018	08:04	22.1	4640	20	SEM
19 Feb 2018	10:35	23.9	4660	4	SEM
01 Mar 2018	10:20	22.3	4110	13	EXTENDED
05 Mar 2018	10:45	23.5	4700	1	SEM
13 Mar 2018	10:10	20	2410	75	EXTENDED
19 Mar 2018	09:15	19.5	4640	36	SEM
21 Mar 2018	11:50	19.9	4470	340	SEM
27 Mar 2018	09:45	20.3	3670	17	EXTENDED
03 Apr 2018	10:05	19.9	4380	4	SEM
06 Apr 2018	13:10	20	4120	1	SEM

Waitara West Beach

Date	Time	Temperature	Conductivity	Enterococci	Programme
	NZST	°C	mS/m@20°C	cfu/100ml	
07 Nov 2017	12:35	16.9	4220	<1	SEM
20 Nov 2017	12:20	17.9	4770	4	SEM
28 Nov 2017	10:36	19.8	4370	<1	EXTENDED
04 Dec 2017	10:30	20.1	4700	76	SEM
12 Dec 2017	10:10	22.1	4430	3	EXTENDED
18 Dec 2017	08:25	19.5	4740	3	EXTENDED
28 Dec 2017	09:30	19.2	3900	4	EXTENDED
03 Jan 2018	10:00	19.4	4680	16	EXTENDED
09 Jan 2018	09:15	20.6	3300	85	EXTENDED
15 Jan 2018	08:20	22.4	4620	11	SEM
25 Jan 2018	09:40		3570	8	EXTENDED
30 Jan 2018	06:20	23.1	4820	<1	SEM
07 Feb 2018	09:00	21.3	4340	21	EXTENDED
16 Feb 2018	07:30	21.5	4350	34	SEM
19 Feb 2018	10:05	23.6	4640	5	SEM

Date	Time	Temperature	Conductivity	Enterococci	Programme
	NZST	°C	mS/m@20°C	cfu/100ml	
01 Mar 2018	10:30	21.9	4580	4	EXTENDED
05 Mar 2018	10:20	23	4650	4	SEM
13 Mar 2018	09:40	20.6	4680	46	EXTENDED
19 Mar 2018	09:00	19.6	4760	35	SEM
21 Mar 2018	12:15	19.8	4740	36	SEM
27 Mar 2018	10:00	19.6	2650	42	EXTENDED
03 Apr 2018	09:40	19.5	4400	46	SEM
06 Apr 2018	13:50	20.7	4760	271	SEM
09 Apr 2018	10:40	19.1	3780	31	FOLLOW UP

Fitzroy Beach

Date	Time	Temperature	Conductivity	Enterococci	Programme
	NZST	°C	mS/m@20°C	cfu/100ml	
07 Nov 2017	10:05	14.4	4770	<1	SEM
20 Nov 2017	09:47	15.4	4790	2	SEM
28 Nov 2017	12:16	19	4730	<1	EXTENDED
04 Dec 2017	10:25	20.2	4670	41	SEM
12 Dec 2017	11:15	20.1	4730	<1	EXTENDED
18 Dec 2017	08:32	18.5	4810	3	EXTENDED
28 Dec 2017	10:55	16.3	4770	1	EXTENDED
03 Jan 2018	11:09	19.1	4740	5	EXTENDED
09 Jan 2018	10:40	21.3	4690	<1	EXTENDED
15 Jan 2018	10:35	23.7	4780	1	SEM
25 Jan 2018	11:00	22.4	4750	4	EXTENDED
30 Jan 2018	09:52	22.9	4820	4	SEM
01 Feb 2018	10:50	21.8	4700	1200	SEM
07 Feb 2018	12:30	21.5	4770	<1	EXTENDED
16 Feb 2018	11:25	22.9	4770	<1	SEM
19 Feb 2018	12:50	23.2	4810	7	SEM
01 Mar 2018	12:10	22.9	4620	4	EXTENDED
05 Mar 2018	10:35	22.9	4710	3	SEM
13 Mar 2018	11:20	19.8	4640	200	EXTENDED
15 Mar 2018	13:25	19.7	4770	<10	FOLLOW UP
19 Mar 2018	09:40	19.8	4770	<1	SEM
27 Mar 2018	11:15	20.6	4200	95	EXTENDED
03 Apr 2018	10:14	19.9	4780	3	SEM
06 Apr 2018	11:50	20.1	4820	4	SEM
07 Apr 2018	12:35	20.2	4540	<1	SEM

East End Beach

Date	Time	Temperature	Conductivity	Enterococci	Programme
	NZST	°C	mS/m@20°C	cfu/100ml	
07 Nov 2017	10:30	15.5	4720	2	SEM
20 Nov 2017	10:00	15.8	4780	20	SEM
04 Dec 2017	10:05	19.8	4540	110	SEM
15 Jan 2018	10:15	23.8	4770	3	SEM
30 Jan 2018	09:42	23.2	4590	150	SEM
31 Jan 2018	13:00	23.3	4750	10	FOLLOW UP
01 Feb 2018	10:25	21.5	4690	820	SEM
07 Feb 2018	12:15	21.3	4780	2	FOLLOW UP
16 Feb 2018	11:00	22.6	4780	11	SEM
19 Feb 2018	12:45	23.4	4830	10	SEM
05 Mar 2018	10:55	23	4770	5	SEM
19 Mar 2018	09:50	18	4770	5	SEM
03 Apr 2018	10:25	20.1	4590	19	SEM
06 Apr 2018	11:40	20.4	4800	<1	SEM
07 Apr 2018	12:45	20.1	4490	7	SEM

Ngamotu Beach

Date	Time	Temperature	Conductivity	Enterococci	Programme
	NZST	°C	mS/m@20°C	cfu/100ml	
07 Nov 2017	11:15	17.4	4690	8	SEM
20 Nov 2017	10:45	17.3	4790	9	SEM
28 Nov 2017	12:40	21.3	4470	<1	EXTENDED
04 Dec 2017	09:00	18.9	4810	1	SEM
12 Dec 2017	11:40	22	4710	15	EXTENDED
18 Dec 2017	10:00	18.2	4800	19	EXTENDED
28 Dec 2017	11:20	18.5	4740	<1	EXTENDED
03 Jan 2018	11:58	21.4	4600	11	EXTENDED
09 Jan 2018	11:00	20.4	4740	8	EXTENDED
15 Jan 2018	09:10	23.6	4690	210	SEM
17 Jan 2018	07:35	21.8		60	FOLLOW UP
25 Jan 2018	11:20	23.4	4850	99	EXTENDED
30 Jan 2018	09:09	23.5	4820	91	SEM
01 Feb 2018	09:30	21.9	4760	2600	SEM
07 Feb 2018	11:30	22.1	4620	250	EXTENDED
09 Feb 2018	13:25	22.7	4840	120	FOLLOW UP
16 Feb 2018	09:55	21.9	4760	110	SEM
19 Feb 2018	11:35	24	4780	7	SEM
01 Mar 2018	12:30	22.1	4640	31	EXTENDED
05 Mar 2018	12:30	25.1	4660	19	SEM
13 Mar 2018	12:00	19.7	4680	64	EXTENDED
19 Mar 2018	10:45	20.3	4740	140	SEM
27 Mar 2018	11:45	21.1	4480	72	EXTENDED
03 Apr 2018	11:25	20.9	4790	8	SEM

Date	Time	Temperature	Conductivity	Enterococci	Programme
	NZST	°C	mS/m@20°C	cfu/100ml	
06 Apr 2018	12:20	20.1	4810	269	SEM
07 Apr 2018	13:35	20.5	4730	9	SEM

Oakura Beach at the Surf Club

Date	Time	Temperature	Conductivity	Enterococci	Programme
	NZST	°C	mS/m@20°C	cfu/100ml	
07 Nov 2017	12:10	16	4760	4	SEM
20 Nov 2017	11:55	17.7	4720	1	SEM
28 Nov 2017	13:00	20.2	4380	210	EXTENDED
04 Dec 2017	08:20	18	4720	19	SEM
12 Dec 2017	12:30	20.1	4750	<1	EXTENDED
18 Dec 2017	11:01	18.3	4780	160	EXTENDED
28 Dec 2017	11:45	19.7	4640	56	EXTENDED
03 Jan 2018	12:30	19.7	4560	8	EXTENDED
09 Jan 2018	12:15	20.3	4630	55	EXTENDED
15 Jan 2018	08:25	21.6	4790	12	SEM
25 Jan 2018	11:48	22.7	4760	52	EXTENDED
30 Jan 2018	08:40	22.5	4690	48	SEM
01 Feb 2018	09:00	21.7	4740	440	SEM
07 Feb 2018	09:55	20.9	4760	27	EXTENDED
16 Feb 2018	08:50	21.7	4710	55	SEM
19 Feb 2018	11:00	23	4730	63	SEM
01 Mar 2018	13:00	22.4	4270	22	EXTENDED
05 Mar 2018	13:25	24.1	4600	51	SEM
13 Mar 2018	12:30	20.2	4680	280	EXTENDED
15 Mar 2018	14:10	20.4	4730	10	FOLLOW UP
19 Mar 2018	11:30	19.7	4760	41	SEM
27 Mar 2018	12:15	20.8	3960	86	EXTENDED
03 Apr 2018	12:10	20.4	4590	33	SEM
06 Apr 2018	13:30	19.7	4830	1	SEM
07 Apr 2018	14:05	19.5	4630	<1	SEM

Oakura Beach opposite the camp ground

Date	Time	Temperature	Conductivity	Enterococci	Programme
	NZST	°C	mS/m@20°C	cfu/100ml	
07 Nov 2017	12:30	15.8	4760	<1	SEM
20 Nov 2017	11:39	18	4690	84	SEM
04 Dec 2017	08:00	18.1	4800	5	SEM
15 Jan 2018	08:15	21.9	4700	76	SEM
30 Jan 2018	08:20	22.3	4780	7	SEM
01 Feb 2018	08:45	21.5	4770	220	SEM
07 Feb 2018	09:40	20.6	4840	4	FOLLOW UP

Date	Time	Temperature	Conductivity	Enterococci	Programme
	NZST	°C	mS/m@20°C	cfu/100ml	
16 Feb 2018	08:40	21.6	4780	15	SEM
19 Feb 2018	10:50	22.8	4760	<1	SEM
05 Mar 2018	13:40	23.9	4750	4	SEM
19 Mar 2018	11:45	20	4760	3	SEM
03 Apr 2018	12:20	20.7	4680	3	SEM
06 Apr 2018	13:15	19.7	4820	3	SEM
07 Apr 2018	14:30	19.4	4630	<1	SEM

Opunake Beach

Date	Time	Temperature	Conductivity	Enterococci	Programme
	NZST	°C	mS/m@20°C	cfu/100ml	
07 Nov 2017	13:00	17.8	4750	<1	SEM
20 Nov 2017	12:20	16.5	4570	<1	SEM
28 Nov 2017	11:40	19.4	4420	<1	EXTENDED
04 Dec 2017	10:50	20.8	4560	7	SEM
12 Dec 2017	10:00	22	4700	3	EXTENDED
18 Dec 2017	11:30	20.9	4770	<1	EXTENDED
28 Dec 2017	12:45	16.3	4730	<1	EXTENDED
03 Jan 2018	10:13	19.9	4720	8	EXTENDED
09 Jan 2018	09:45	20.8	3440	140	EXTENDED
15 Jan 2018	10:40	22.2	4670	8	SEM
25 Jan 2018	11:30	24.1	4780	3	EXTENDED
30 Jan 2018	10:20	22.7	4830	<1	SEM
01 Feb 2018	09:15	22.1	4760	19	SEM
07 Feb 2018	11:42	20.8	4700	5	EXTENDED E
16 Feb 2018	11:05	23.3	4790	6	SEM
19 Feb 2018	13:00	23	4860	3	SEM
01 Mar 2018	11:40	22.3	4170	5	EXTENDED
05 Mar 2018	13:30	23	4800	<1	SEM
13 Mar 2018	09:00	18.3	4010	150	EXTENDED
15 Mar 2018	08:15	19	4750	250	FOLLOW UP
19 Mar 2018	11:40	19.7	4760	5	SEM
21 Mar 2018	13:20	21.1	4830	8	SEM
27 Mar 2018	08:30	20.8	4670	<1	EXTENDED
03 Apr 2018	12:35	20.2	4760	1	SEM
06 Apr 2018	13:20	20.1	4800	<1	SEM

Ohawe Beach

Date	Time	Temperature	Conductivity	Enterococci	Programme
	NZST	°C	mS/m@20°C	cfu/100ml	
07 Nov 2017	11:10	16.7	3800	20	SEM
20 Nov 2017	10:15	16.4	4690	20	SEM
28 Nov 2017	10:00	19.7	4000	<1	EXTENDED
04 Dec 2017	09:30	19.9	4180	15	SEM
12 Dec 2017	08:20	20.8	3590	40	EXTENDED
18 Dec 2017	09:45	21.2	4260	23	EXTENDED
28 Dec 2017	13:50	19.6	4460	6	EXTENDED
03 Jan 2018	08:30	20.6	3540	3100	EXTENDED
09 Jan 2018	10:45	20.7	3430	43	EXTENDED
15 Jan 2018	09:10	21.8	4750	17	SEM
25 Jan 2018	10:00	23.6	2780	80	EXTENDED
30 Jan 2018	09:10	23.6	4730	39	SEM
01 Feb 2018	10:30	22.9	4810	43	SEM
07 Feb 2018	10:05	20.9	3460	44	EXTENDED
16 Feb 2018	09:35	21.8	4400	58	SEM
19 Feb 2018	11:25	23.3	3990	110	SEM
01 Mar 2018	10:20	21.3	4650	87	EXTENDED
05 Mar 2018	11:50	22.1	4360	200	SEM
07 Mar 2018	09:00	19.6	4570	<10	FOLLOW UP
13 Mar 2018	10:05	18	3330	330	EXTENDED
14 Mar 2018	12:05	18.4	2520	146	FOLLOW UP
19 Mar 2018	09:50	18.8	4650	17	SEM
21 Mar 2018	11:15	19	3980	89	SEM
27 Mar 2018	09:45	20.5	4740	<2	EXTENDED
03 Apr 2018	10:55	19.1	3800	128	SEM
06 Apr 2018	13:20	19.3	3900	37	SEM

Appendix II

High tide times

Date	Programme	Time (NZST)	Height (m)
07 Nov 2017	SEM	1141	3.7
20 Nov 2017	SEM	1039	3.4
28 Nov 2017	EXTENDED	1656	2.9
04 Dec 2017	SEM	0953	3.8
12 Dec 2017	EXTENDED	1725	3.0
18 Dec 2017	EXTENDED	0946	3.3
28 Dec 2017	EXTENDED	1709	3.0
03 Jan 2018	EXTENDED	1030	3.8
09 Jan 2018	EXTENDED	1538	3.0
15 Jan 2018	SEM	0850	3.1
25 Jan 2018	EXTENDED	1427	3.0
30 Jan 2018	SEM	0836	3.5
01 Feb 2018	SEM	1017	3.8
07 Feb 2018	EXTENDED	1453	3.0
16 Feb 2018	SEM	1015	3.4
19 Feb 2018	SEM	1155	3.5
01 Mar 2018	EXTENDED	0914	3.6
05 Mar 2018	SEM	1206	3.6
13 Mar 2018	EXTENDED	0705	2.8
19 Mar 2018	SEM	1154	3.5
21 Mar 2018	SEM	1210	3.5
27 Mar 2018	EXTENDED	0602	3.0
03 Apr 2018	SEM	1137	3.5
06 Apr 2018	SEM	1334	2.9

Appendix III

Monthly rainfall across Taranaki (provisional)

Area representing	SITE:	Nov RF	Nov % of normal	Dec RF	Dec % of normal	Jan RF	Jan % of normal	Feb RF	Feb % of normal	March RF	Mar % of normal	April RF	April % of normal	TOTAL	% of norm for period
Mountain and ranges	Nth Egmont	262.5	54%	104.5	17%	561	135%	482.5	118%	346	81%	525	106%	2281.5	80%
	Dawson Falls	207	50%	73.5	17%	746.5	232%	649	199%	483.5	132%	559	117%	2718.5	116%
	Kahui Hut	150	37%	96.5	23%	500	176%	453	218%	435.5	148%	491.5	119%	2126.5	105%
	Mangorei Upper	127	n/a	65.5	n/a	313	n/a	253	n/a	278	n/a	222.5	n/a	1259	n/a
New Plymouth	Hillsborough	54.5	43%	58.5	50%	143	130%	132	139%	206	155%	104.5	61%	698.5	93%
	Brooklands Zoo	42	39%	33	22%	118.5	109%	109.5	104%	275	278%	93	75%	671	97%
Bell Block & Waitara	Mangati	51.6	48%	55.4	55%	120.2	132%	128	168%	166.2	182%	75.4	38%	596.8	89%
	Motunui	64	69%	40.5	34%	151.5	213%	106.5	124%	207	258%	75	67%	644.5	115%
Eastern side of Mtn	Egmont Village	75	37%	51	25%	178.5	123%	183.5	118%	237	158%	128	67%	853	81%
	Everett Park	82.5	51%	38	21%	175	137%	198	166%	202.5	145%	123	81%	819	93%
	Inglewood	90	45%	69.5	36%	203	121%	212	143%	235.5	154%	138	76%	948	91%
	Midhurst (NIWA)	110	50%	39.5	22%	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	Stratford (311m)	68.5	58%	75.5	49%	173.5	163%	197.5	180%	275.5	234%	187.5	143%	978	140%
North Eastern Hill Country	Waitanguru (EW site)	128	59%	68	32%	203.5	140%	272	211%	n/a	n/a	n/a	n/a	n/a	n/a
	Kotare	96.5	52%	39	18%	164.5	121%	158.5	138%	229.5	215%	170.5	117%	858.5	94%
Eastern Hill Country	Mangaehu	43	39%	34.5	27%	155.5	183%	159	160%	214	224%	170	136%	776	104%
	Kaka Rd – Uruti (280m)	97.5	50%	58	27%	206.5	145%	139.5	99%	262.5	196%	143	91%	907	101%
	Pohokura Saddle (300m)	103	64%	45.5	26%	206.5	179%	129.5	107%	254	220%	191	128%	929.5	133%
Western Coastal	Stony	50.5	36%	23.5	13%	125.5	115%	117	103%	198	180%	200.5	123%	715	97%
	Kapoaiaia – Cape Egmont	27.4	29%	26	25%	85.4	88%	75.6	83%	193	227%	119.8	102%	527.2	92%
	Taungatara	36.5	31%	18.5	15%	79.5	89%	72	109%	182	202%	176	142%	564.5	103%
Southern Coastal	Kaupokonui	14	16%	16.5	17%	88	130%	63	108%	168.5	265%	127	137%	477	105%
	Duffys - Hawera	18.5	22%	41.5	44%	89	142%	71.5	120%	159	238%	125.5	125%	505	95%
	Patea	15	19%	12.4	13%	109.6	170%	99	164%	131.4	212%	109.6	110%	477	90%
Eastern and Southern Hill Country	Charlies	103	97%	58	42%	269	292%	113.5	164%	259.5	244%	233.5	162%	1036.5	162%
	Moana Trig	61.5	51%	44	35%	151	152%	117.5	146%	175.5	161%	198.5	137%	748	115%
	Rimunui Stn Waitotara	56	49%	47	41%	177	215%	79	98%	128.5	161%	176.5	181%	664	90%
	Ngutuwera	18	17%	36	32%	127.5	144%	94.5	138%	145	195%	167.5	165%	588.5	77%
Southern Coastal	Waitotara at Hawken Rd	17.8	n/a	43.6	n/a	120.8	n/a	172.8	n/a	164.8	n/a	135.4	n/a	655.2	n/a

Appendix IV

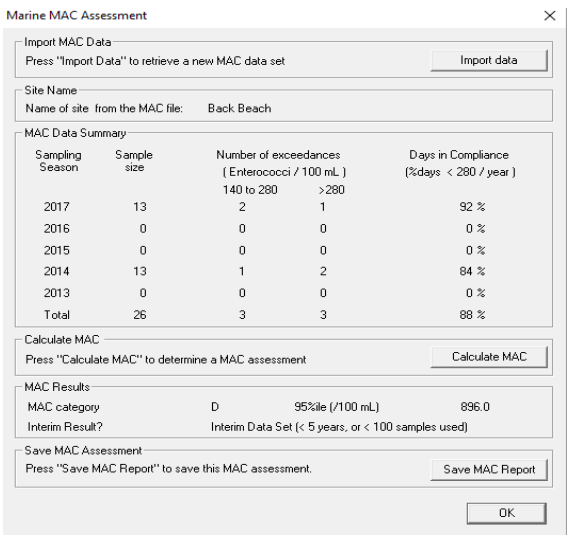
SFRG Assessments 2013-2018

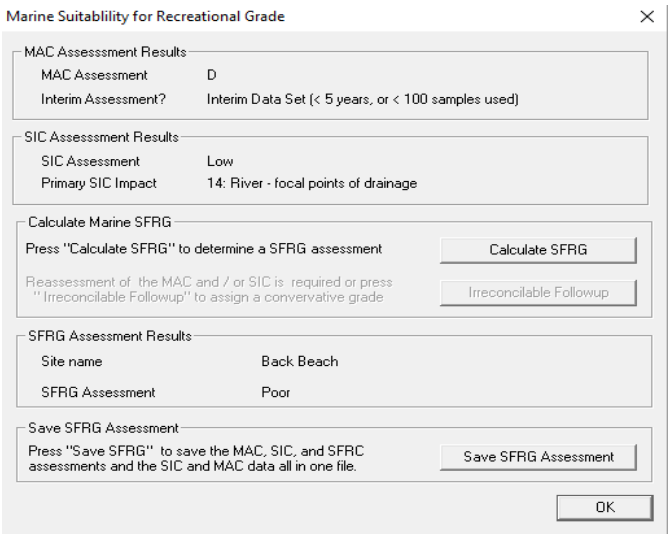
Site	Sanitary Inspection Category	MAC			SFRG Grade	%of all inspection in compliance
		95%ile	No of samples	Category		
Wai-iti	Moderate	664.0	26	D	Poor	96%
Urenui	Moderate	186.6	22	B	Good	95%
Onaero	Moderate	222.0	108	C	Fair	96%
Onaero Settlement	Low 14	114.0	20	B	Good	100%
Waitara (East)	Moderate	268.0	86	C	Fair	95%
Waitara (West)	Moderate	175.0	75	B	Good	97%
Bell Block	Moderate	162.4	26	B	Good	96
Fitzroy	Moderate	92.1	109	B	Good	98%
East End	Moderate	115.0	65	B	Good	98%
Ngamotu	Moderate	172.0	109	B	Good	98%
Back*	Low 14	896.0	26	D	Poor	88
Oakura (SC)	Moderate	210.0	110	C	Fair	96%
Oakura (CG)	Moderate	78.0	65	B	Good	100%
Opunake*	Moderate	30.1	108	A	Good	100%
Ohawe	Moderate	340.5	87	C	Fair	94%
Patea (Mana Bay)	Moderate	ID	ID	ID	ID	ID
Patea	Moderate	ID	ID	ID	ID	ID
Waverley	Moderate	ID	ID	ID	ID	ID
Wai-inu	Moderate	ID	ID	ID	ID	ID

* Irreconcilable Followup

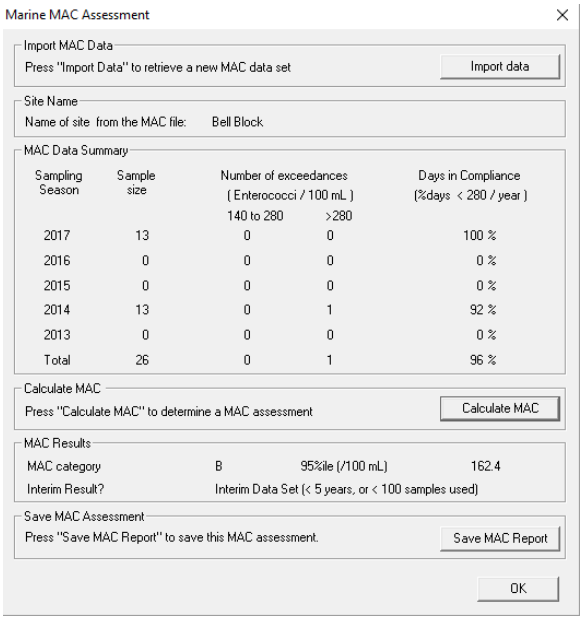
ID Insufficient data

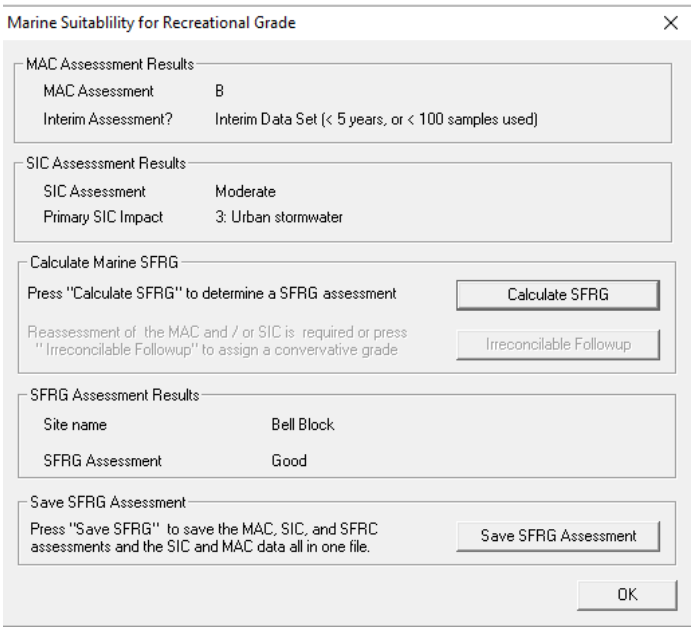
Back Beach *



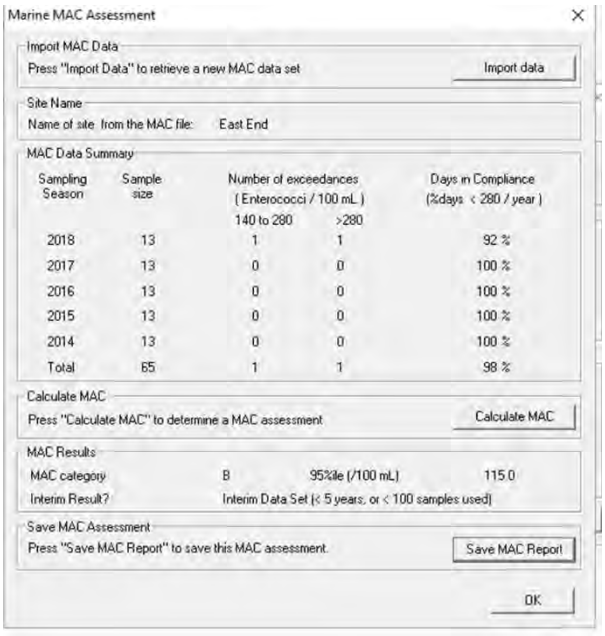


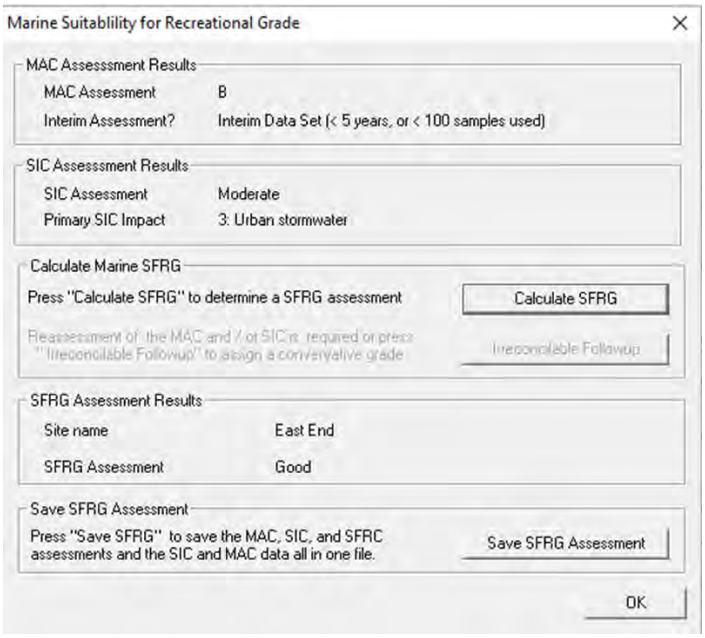
Bell Block



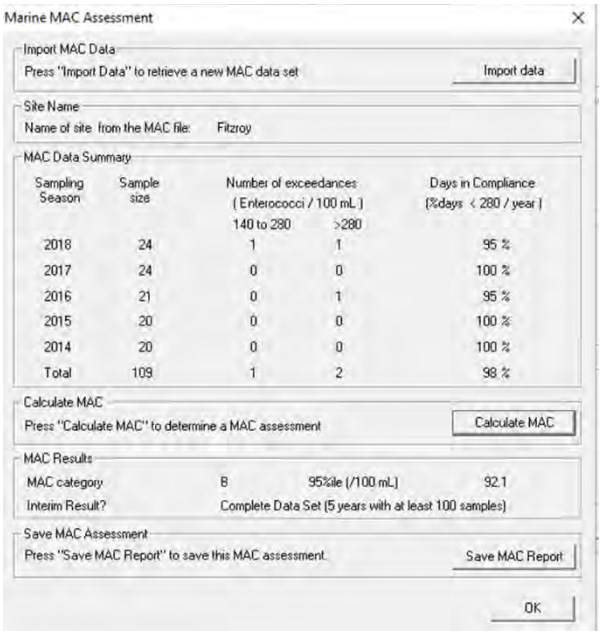


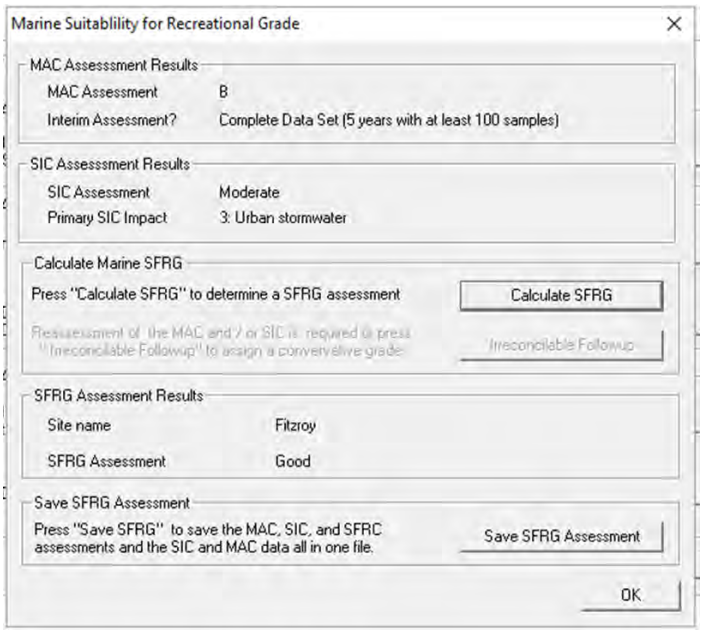
East End



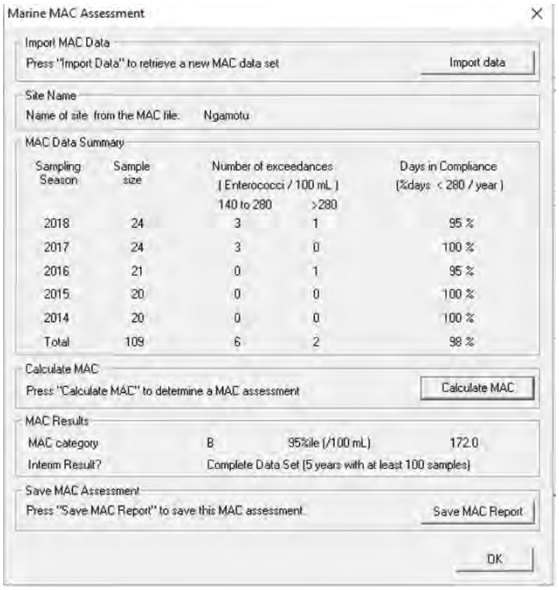


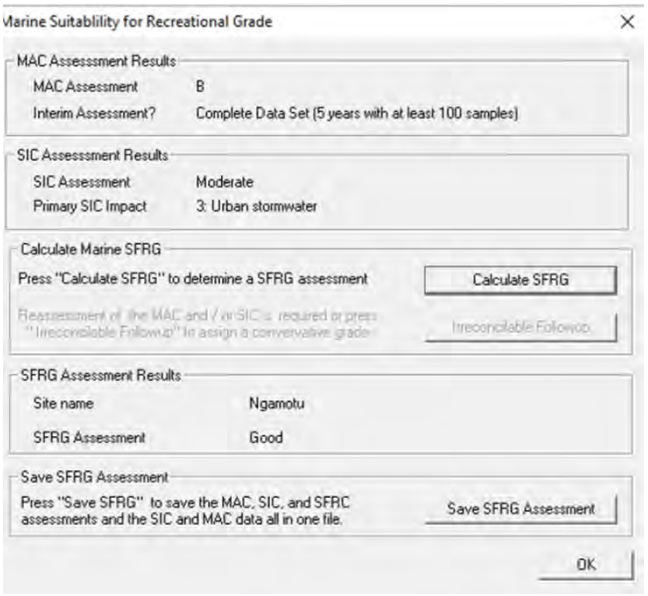
Fitzroy



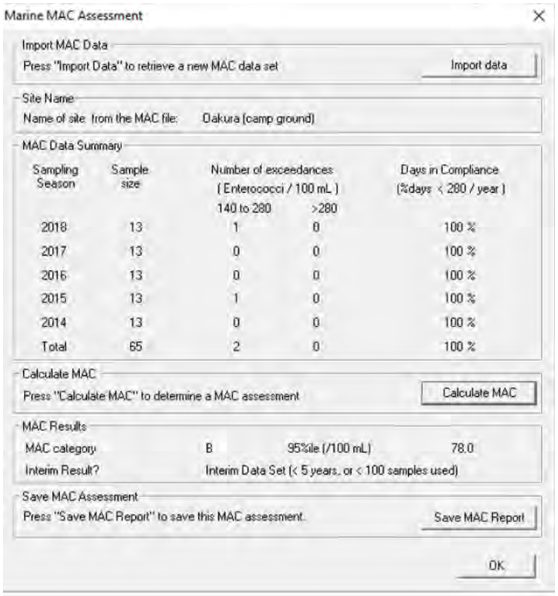


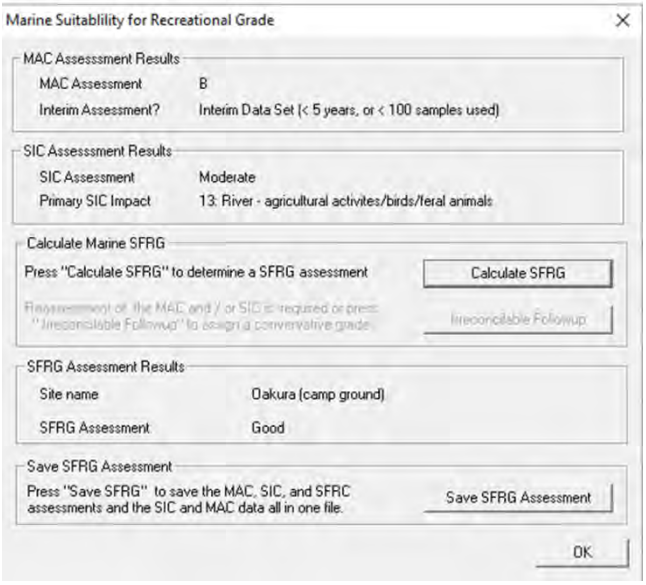
Ngamotu



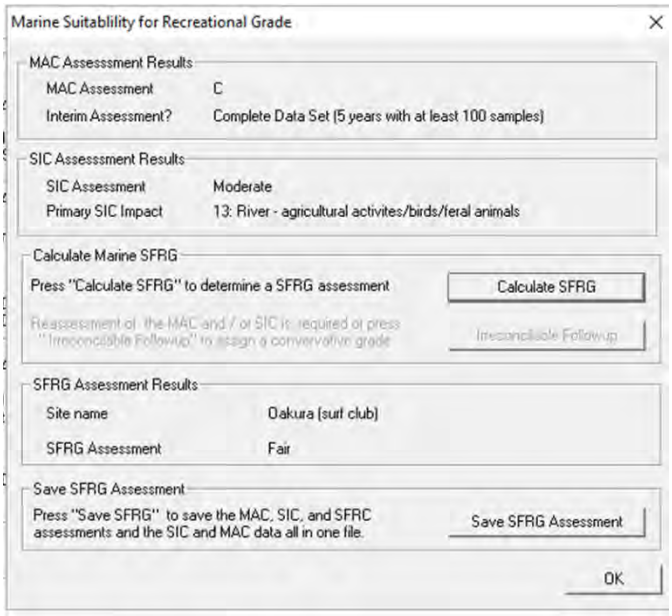


Oakura (Camp Ground)

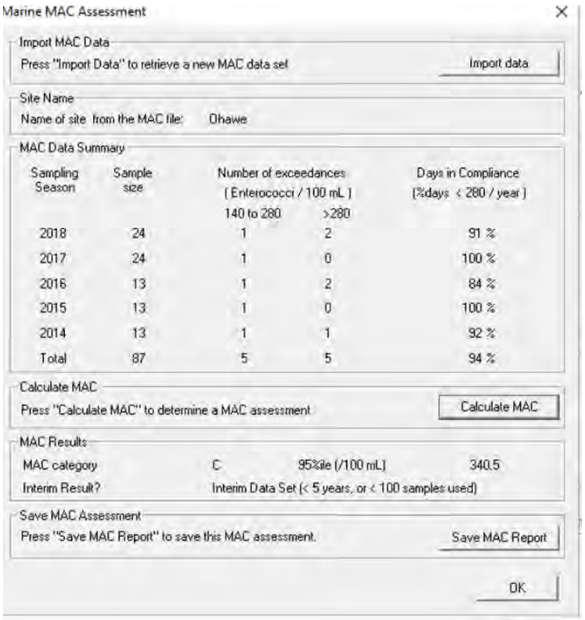


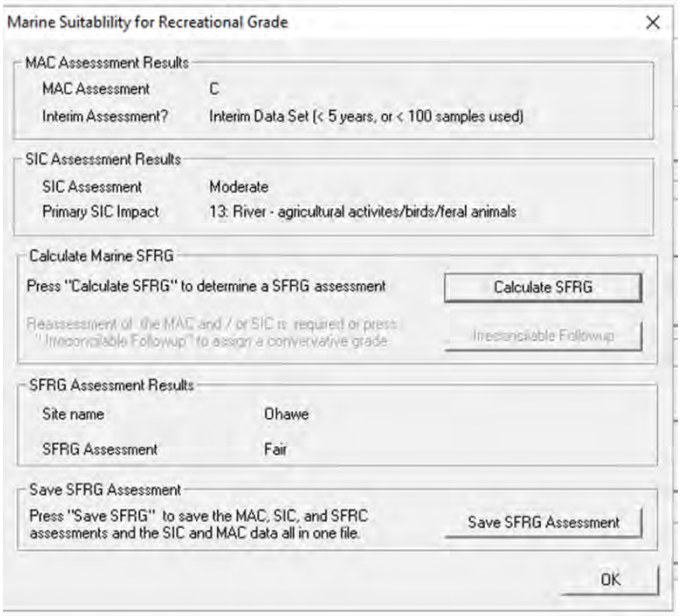


Oakura (Surf Club)

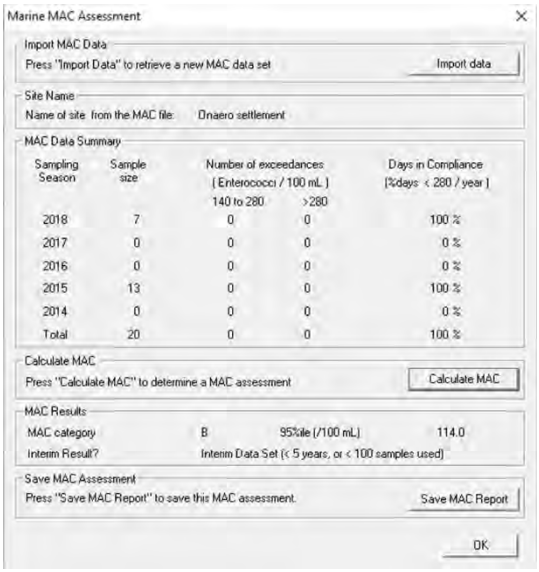


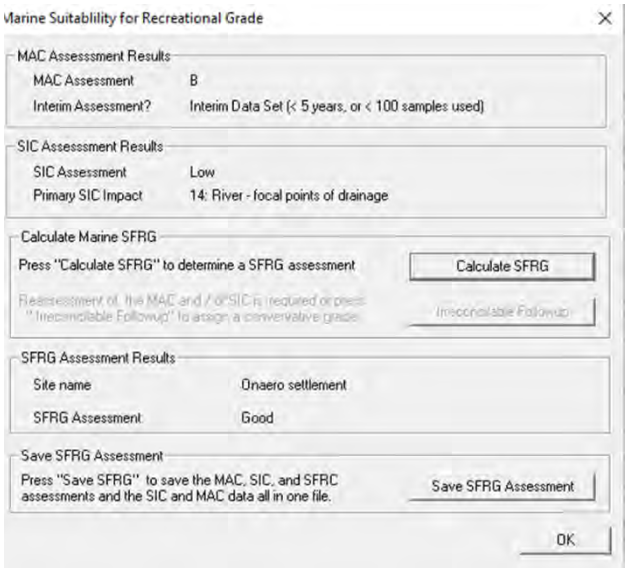
Ohawe



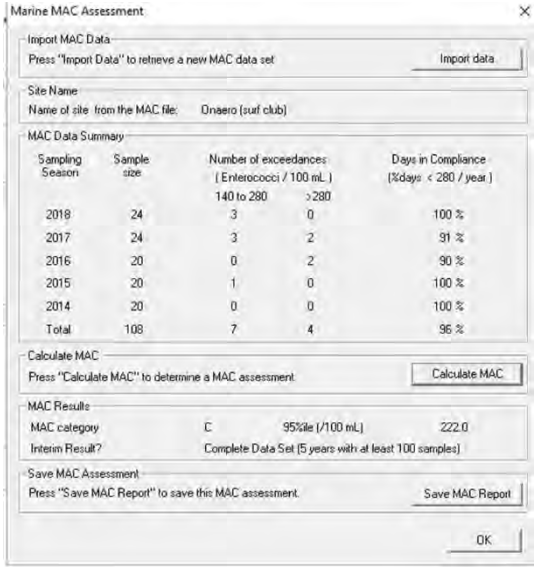


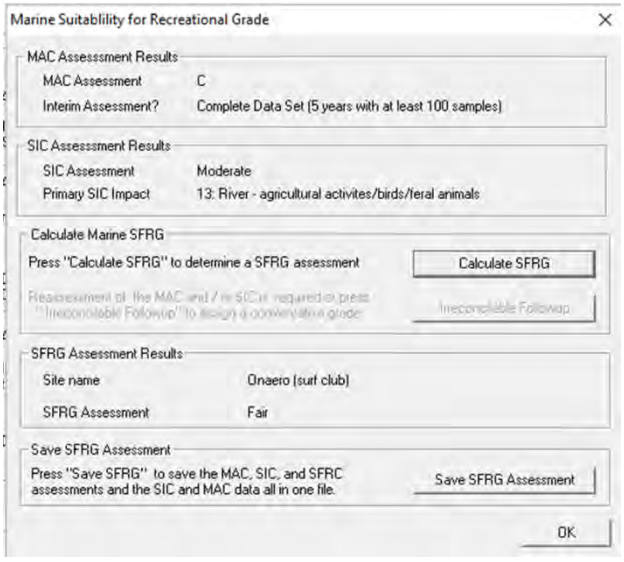
Onaero Settlement



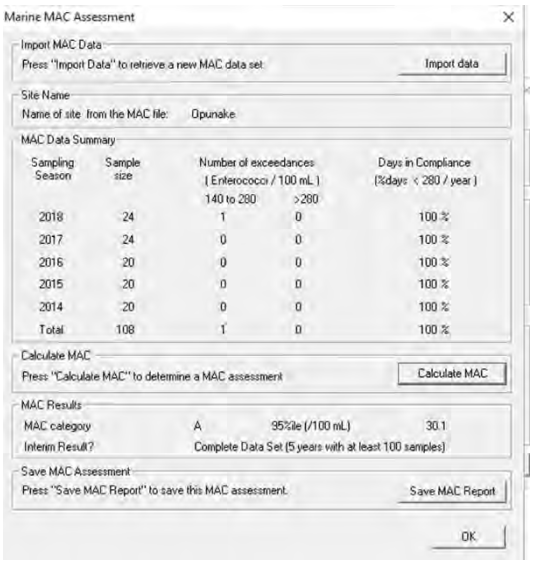


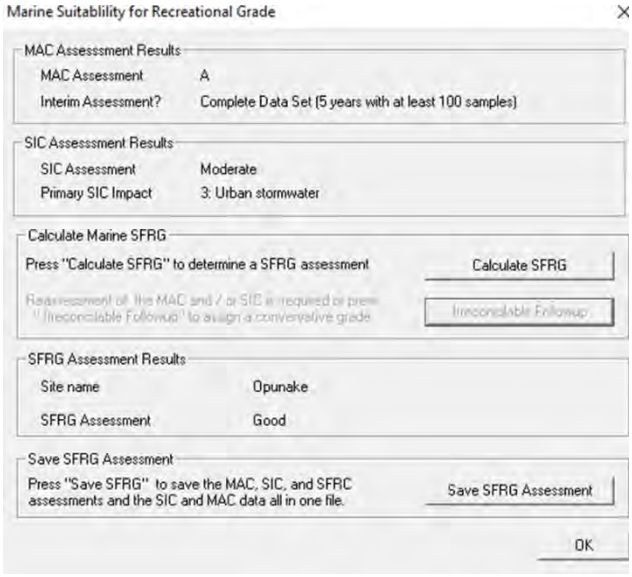
Onaero Surf Club



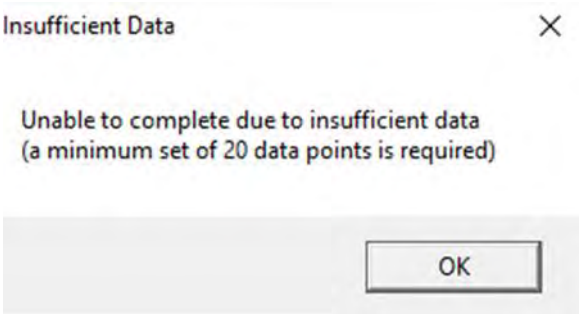


Opunake*

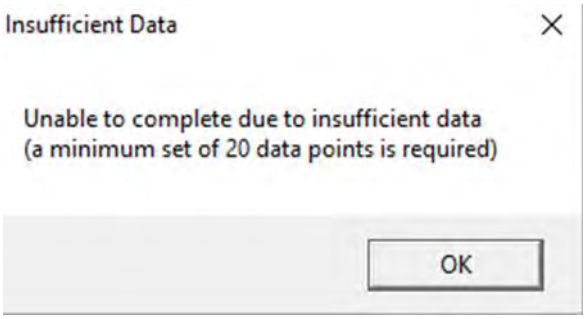




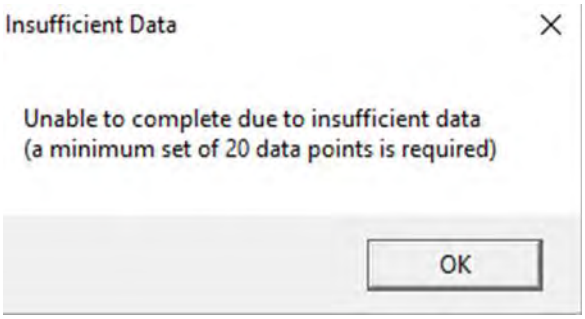
Patea



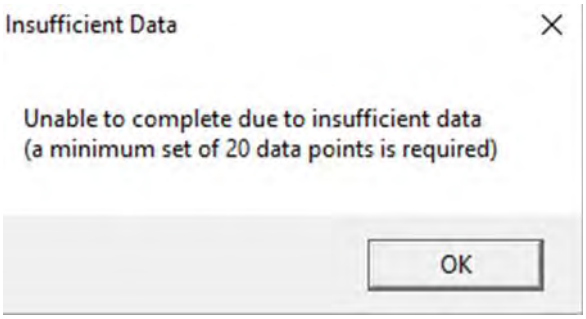
Wai-inu



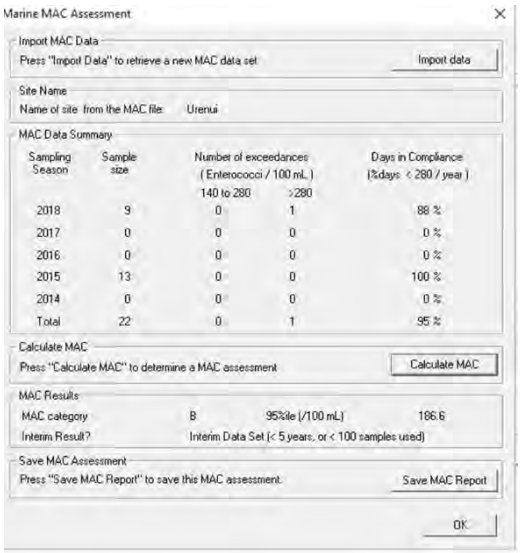
Mana Bay

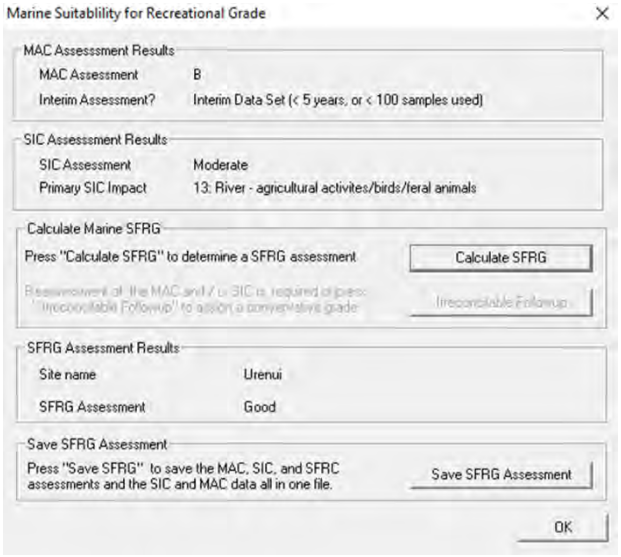


Waverley

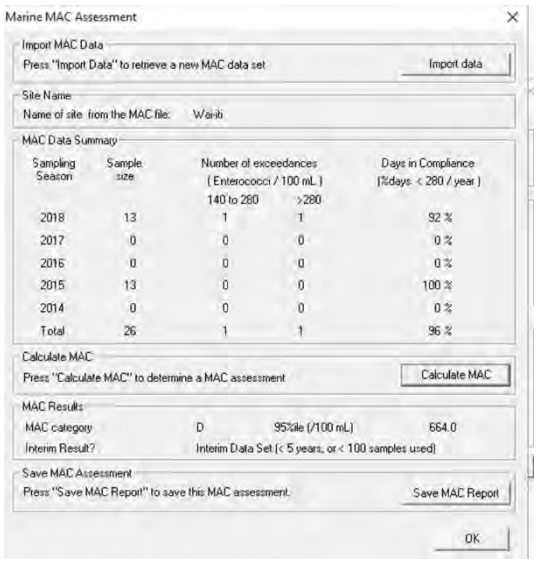


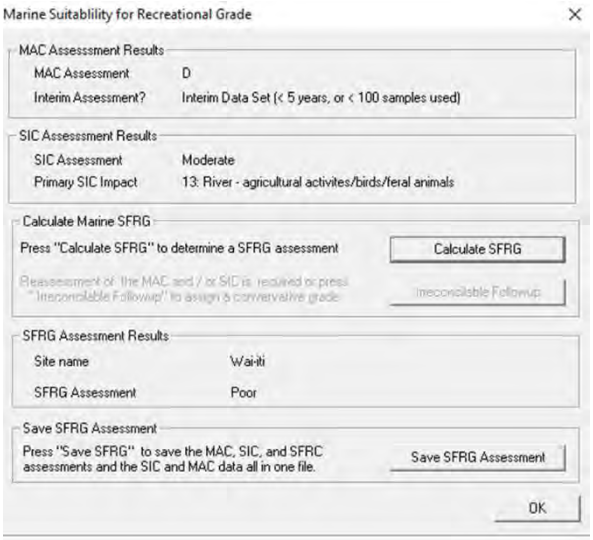
Urenui



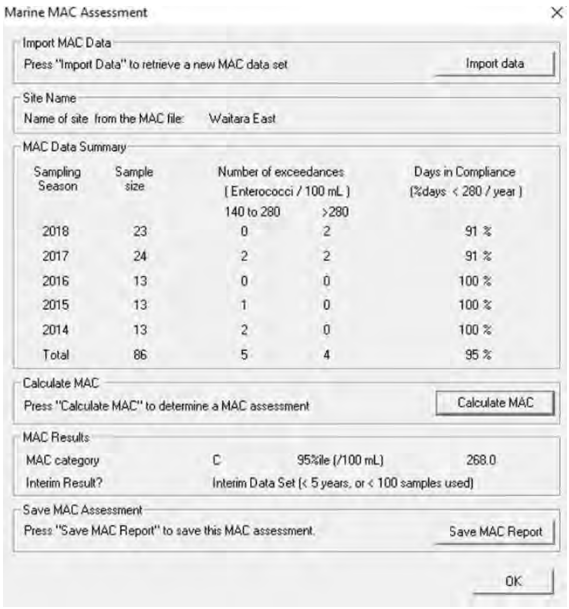


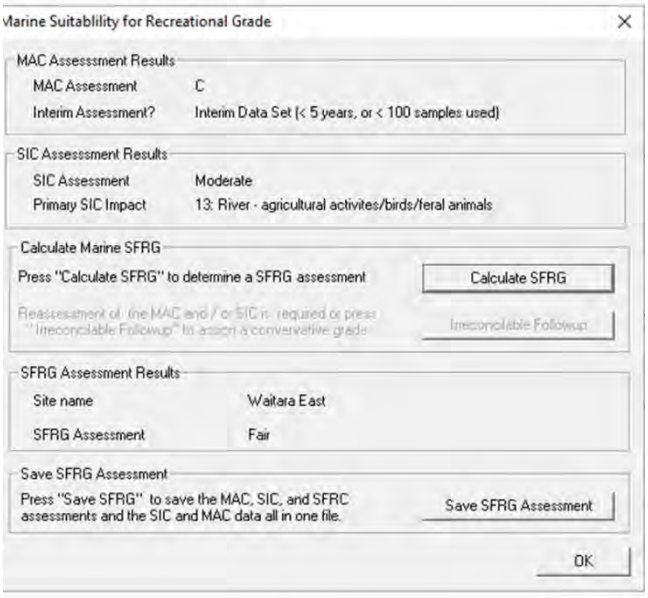
Wai-iti



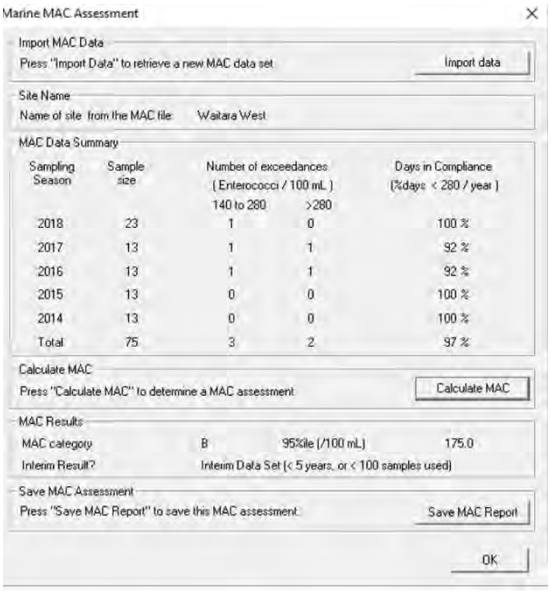


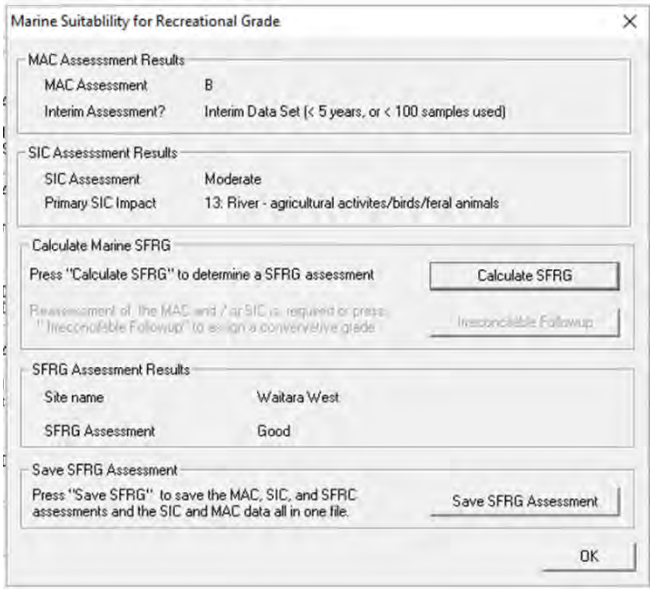
Waitara (East)





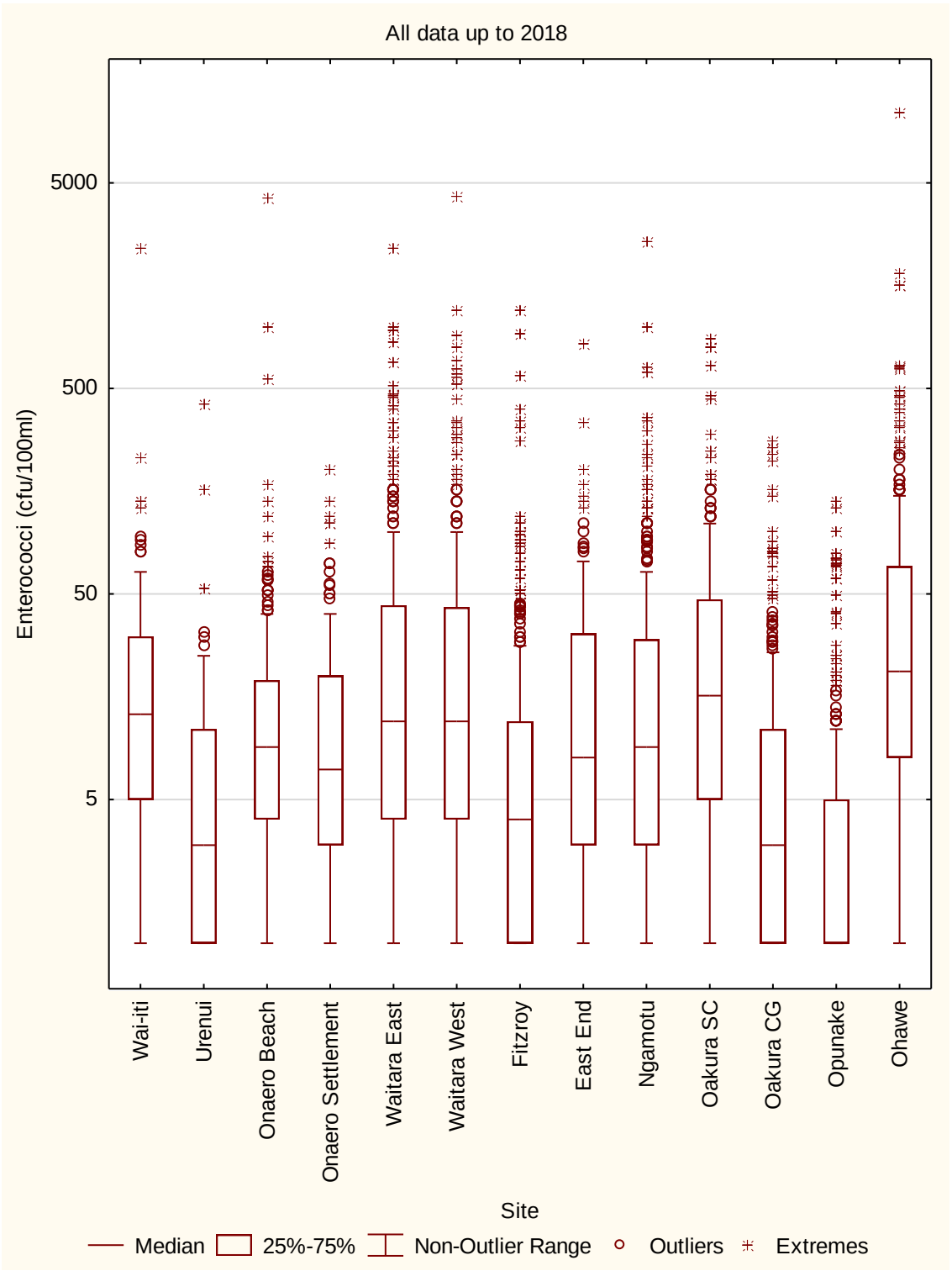
Waitara (West)





Appendix V

Box and whisker plots for all SEM enterococci data until 2018


All data up to 2018
Enterococci (cfu/100ml)
5000
500
50
5
Wai-iti
Urenui
Onaero Beach
Onaero Settlement
Waitara East
Waitara West
Fitzroy
East End
Ngamotu
Oakura SC
Oakura CG
Opunake
Ohawe
Site
Median
25%-75%
Non-Outlier Range
Outliers
Extremes