MARLBOROUGH DISTRICT COUNCIL

Recreational Water Quality Report 2016-2017

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Executive Summary

Twelve coastal beaches and nine river sites were sampled weekly from the beginning of November 2016 until the end of March 2017. Samples were analysed for the concentration of faecal indicator bacteria (Enterococci/E.coli). The results were assessed according to national guidelines in order to determine if water quality was safe for recreational activities such as swimming and surfing.

The majority of the coastal sites had recreational water quality consistently safe for swimming. Only two of the twelve coastal beaches had Enterococci concentrations considered unsafe for recreational activities. These sites were Moeatpu Bay – Double Bay Reserve and Waikutakuta/Robin Hood Bay – East. At both sites, the high bacteria concentrations were caused by prolonged survival and possible procreation of the bacteria in organic material and sediment that was deposited onto the beach following intensive rainfall events. The effect was particularly noticeable at Waikutakuta/Robin Hood Bay – East where large deposits of gorse were causing extremely high Enterococci concentrations during high tide when a substantial amount of the gorse became submerged in the surf. Once most of the gorse was removed, bacteria concentrations declined.

The majority of river sites had consistently low E. coli concentrations with only occasional samples indicating a slightly increased health risk. However, following the Kaikoura Earthquake significant amounts of rainfall caused flooding in some parts of the region, which would have resulted in unsafe E. coli concentrations at a number of river sites. Due to road damage caused by the earthquake samples were not taken during this event, but it is unlikely that persons were swimming at the time.

An earlier rainfall event caused unsafe E. coli concentrations in the Rai River at Rai Falls and the Te Hoiere/Pelorus River at Totara Flat, but concentrations quickly returned to safe levels.

The Taylor River had again, the worst recreational water quality with a number of samples with unsafe E. coli concentrations during lower flows. Although, the long-term trend shows some improvements, further damage to parts of the Blenheim sewerage system during the recent Kaikoura earthquake is likely to result in increased E. coli concentrations. Due to the extensive damage to particularly the older earthenware pipes, all pipes of this type will be replaced in the coming years. This should result in less cross contamination between the sewerage and stormwater systems and subsequently result in better water quality in the Taylor River in the future.

The monitoring results from this summer season were combined with the results from the four previous summers to calculated SFR Grades, which represent the overall suitability of water quality for swimming at the sites.

The majority of sites have a SFR Grade of “Fair”. Only one site, the Taylor River at Riverside is graded “Very Poor”. Three sites are graded “Poor”, but a larger number of sites (seven) have a SFR Grade of either “Very Good” or “Good”.

Using the monitoring data to assign E. coli state band according to the National Policy Statement for Freshwater (NPS-FM) revealed that the SFR Grading is generally more stringent than both the current NPS-FM and the proposed changes to the NPS-FM.

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1. Introduction

Marlborough has a number of beautiful beaches and rivers that are popular with visitors and local residents during the warmer months of the year. Swimming, boating, surfing and fishing are only a few of the many water based recreational activities that take place in the region. However, accidental ingestion of water can result in illness when faecal bacteria concentrations in the water are high. The risk of infection is highest for activities such as swimming and surfing.

Campylobacteriosis and Cryptosporidiosis are two of the most common gastrointestinal illnesses associated with water use. These illnesses often cause vomiting, stomach cramps and diarrhoea from two to ten days after infection. The potentially long delay between infection and the first symptoms means that the source of infection can be difficult to determine. Nevertheless, in 2014, over 50% of Campylobacteriosis cases and over 30% of Cryotosporidiosis cases in New Zealand had recreational water contact as a risk factor for the infection [1].

In order to allow us to evaluate the risk to water users, council takes weekly water samples from the most popular beaches during the summer months. The samples are analysed for faecal indicator bacteria and results are assessed according to national guidelines published by the Ministry for the Environment [10].

This report presents the results for the samples taken during the summer season of 2016/2017 and investigates long term trends for faecal indicator bacteria concentrations where possible. It also presents a review of SFR Grades, which are a valuable way of gauging the overall recreational water quality of a site.

It is important to note that the Recreational Water Quality program is exclusively focused on health based risks associated with faecal contamination and results are not reflective of the general water quality of a site, the presence of toxic algae or other risks associated with a site (eg; high water flows or strong currents).

2. Recreational Water Quality Monitoring

The recreational water quality of twelve coastal beaches and nine river sites was monitored from the beginning of November 2016 until the end of March 2017. Samples were taken weekly, usually at the beginning of each week, independent of weather conditions and tide levels. Hill Laboratories in Blenheim was contracted to measure the indicator bacteria concentrations in the samples. Bacteria levels were determined as MPN counts using Enterolert for Enterococci and Colilert for E. coli after up to 24 hour incubation at 41^{o}C and 35^{o}C respectively.

As soon as analysis results were received from the laboratory, the indicator bacteria concentrations were assessed according to the Microbiological Water Quality Guidelines. The guidelines are described in more detail in the following sections.

In order to provide the public with up-to-date information, the results are also displayed on the Marlborough District Council website (www.marlborough.govt.nz). This is done in the form of a map based application with direct links to our data base. This ensures that information is accessible to the public as soon as the laboratory results are electronically transferred into the data base. The same information can also be viewed in a slightly different format on the LAWA website (www.lawa.org.nz).

3. The Microbiological Water Quality Guidelines

In 2003 the Ministry for the Environment (MfE) and the Ministry of Health (MoH) published a Guideline document, a framework for the monitoring of the microbiological water quality of recreational areas [10]. The document provides general recommendations in regard to the management of recreational water quality and guideline values allowing the assessment of results from individual samples. The document also presents a method to evaluate the overall bacterial risk at a site, not just at the time a sample is taken, the Suitability for Contact Recreation Grade (SFR Grade). This grade takes into account the risks of faecal contamination from the surrounding areas and the sampling results over a five year period.

3.1. Guideline values for individual samples

Measuring the concentrations of all microorganisms that can be hazardous for the health of water users is both difficult and expensive. A more cost effective approach is the use of indicator bacteria. These are comparatively easier to measure and are generally present when water is contaminated with harmful organisms such as Salmonella, Campylobacter, Giardia or Cryptosporidium. High concentrations of indicator bacteria are a sign that the water is potentially contaminated with human sewage or animal faeces, which results in an increased health risk associated with the use of the water body for recreational activities, such as swimming.

Two different indicator bacteria are used depending on the type of water that is being monitored. Freshwater samples are analysed for the concentration of E. coli, while Enterococci are the preferred indicator bacterium for coastal samples. The 2003 Guideline document provides two guideline values for each of the two indicator bacteria. Based on these guidelines, sample results are categorised into three “Modes”, which allow a decision to be made on whether the water can be considered safe for contact recreation. Table 1 outlines these “Modes” and their meaning as well as the actions that need to be taken as a result. In this report, the lower limit for the Alert Mode is referred to as the Alert Guideline, which corresponds to concentrations of 260 E. coli/100mL and 140 Enterococci/100mL. The upper limit for the Alert Mode (lower limit of the Action Mode) is referred to as the Action Guideline and corresponds to concentrations of 550 E. coli/100mL and 280 Enterococci/100mL.

Mode	Freshwater E. coli/100mL	Coastal Enterococci/100mL	Meaning	Required Action
Green Mode	<260	<140	**Safe** for contact recreation	Conitue routine monitoring
	260	140	**Alert Guideline**	
Alert Mode	260 - 550	140 - 280	**Increased risk** for health	Investigate possible causes and increase sampling frequency if no cause can be found, otherwise continue routine sampling
	550	280	**Action Guideline**	
Action Mode	>550	>280	**Unsafe** for conctact recreation	Increase sampling frequency and warn the public that the beach is considered unsafe (Warning signs)

Table 1: Modes and the corresponding Guidelines as outlined by the Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas [10].[1]

If indicator bacteria concentrations are above the Alert or Action Guideline possible causes are considered and the District Health Board is informed. A joint decision is made on how to proceed. Usually, warning signs are erected at sites with unsafe levels of indicator bacteria. The sites are then sampled more frequently until indicator bacteria concentrations have returned to safe levels and warning signs can be removed. A flowchart outlining the process is shown in Appendix 3.

[1] For coastal samples the Action Mode is usually only applied after concentrations in two consecutive samples exceed 280 Enterococci/100mL; however if a high number of people is expected to visit the beach (i.e. during holiday periods), a precautionary approach is taken and warning signs are erected after only one exceedance.

3.2. Suitability for Contact Recreation Grades (SFR Grades)

Although, individual results provide information about the recreational water quality of a site for the date and time a sample was taken, water quality is inherently variable and can quickly change within very short time frames, especially as a result of rainfall (see Section 4). This is particularly a problem for the measurement of E. coli or Enterococci concentrations, because there are currently no methods to monitor these bacteria in real-time. Due to the incubation methods currently used, there is a minimum 18-hour delay before the result of a sample can be known. Additionally, the sampling frequency is limited by practicality and budget constraints, which means we cannot sample often enough to ensure that every occasion when water quality is unsafe can be notified. For that reason, the main purpose of the sampling program is the analysis of the results of several years of sampling to obtain a general picture of the recreational water quality of a site. The results of this analysis are expressed in a grading system, the Suitability for Contact Recreation Grades or SFR Grades.

The Grades are based on a 'reasonable risk' approach in regard to the possibility of contracting water borne diseases associated with faecal contamination when pursuing recreational activities in and around the water.

The SFR Grade is the combination of a catchment assessment (Sanitary Inspection Category, SIC) and an assessment of the Microbiological Water Quality (Microbiological Assessment Category, MAC).

The catchment assessment is primarily focused on potential sources of faecal contamination. SICs based on this assessment range from Very Low, Low, Moderate, High to Very High (Risk). Sites surrounded by bush and forest are given a SIC of Very Low. Low intensity agriculture in the catchment results in a SIC of Low. Categories of High and Very High are given to sites likely to directly receive treated or untreated sewage or run-off from high-intensity agriculture.

The MAC is derived from the Enterococci or E. coli concentrations in routine samples taken from a site over five consecutive summers. MACs range from A to D (Table 2) and are based on the upper 95th percentile (95%ile) calculated with the Hazen method.

MAC (Microbiological Assessment Category)	**Coastal**	**Freshwater**
	Enterococci/100mL*	E. coli/100mL*
A	<41	<131
B	41 - 200	131 - 260
C	201 - 500	261 - 550
D	>500	>550

* upper 95th Percentile (95%ile) of routine sampling over 5 consecutive summers

Table 2: Microbiological Assessment Categories (MAC).

The SIC and the MAC for a site are then combined into the SFR Grade (Table 3). The Grades range from Very Good, Good, Fair, Poor to Very Poor. Table 4 outlines the definitions for the individual Grades.

SFR Grade (Suitability for Contact Recreation Grade)		**MAC** (Microbiological Assessment Category)			
		A	B	C	D
SIC (Sanitary Inspection Category)	Very Low	Very Good	Very Good	*	*
	Low	Very Good	Good	Fair	*
	Moderate	*	Good	Fair	Poor
	High	*	*	Poor	Very Poor
	Very High	*	*	*	Very Poor

* unexpected result (further investigation is necessary)

Table 3: Deriving SFR Grades from the MAC and SIC categories.

SFR Grade	Meaning
Very Good	Considered satisfactory for swimming at all times.
Good	Satisfactory for swimming most of the time with exceptions following rainfall.
Fair	Generally satisfactory for swimming. Caution should be taken during periods of high rainfall and swimming avoided if water is discoloured.
Poor	Swimming should be avoided, particularly by the very young, the very old and those with compromised immunity.
Very Poor	Generally swimming is not recommended.

Table 4: Suitability for Contact Recreation Grades (SFR Grades) and their meaning.

The SFR Grades for the sites currently sampled were last reviewed in the Recreational Water Quality Report for the 2015/2016 summer season. The recreational water quality of some sites has changed since and SFR Grades were again reviewed as part of this report. Most of the new sites that were added as a result of a site usage survey in 2012 have now been sampled for five summer seasons. This means, for the first time, we have a complete data set for theses site to calculate SFR Grades. We now have SFR Grades for nearly all sites that are currently monitored as part of the Recreational Water Quality program.

4. Influence of Rainfall

Rainfall greatly influences recreational water quality at the majority of sites monitored. Even small rainfall events can wash animal droppings from pastures, roofs, roads and other surfaces into rivers and coastal waters. In urban areas run-off from hard surfaces picks up bird droppings, dog faeces, and other contaminants and is collected in the stormwater system, which is discharging directly into the local waterways. Larger rainfall events can also cause septic tanks to overflow if these are not properly sealed or maintained.

It is generally recommended to not go swimming for 48 hours after rainfall, particularly in waterways that are known to be affected by rural or urban run-off.

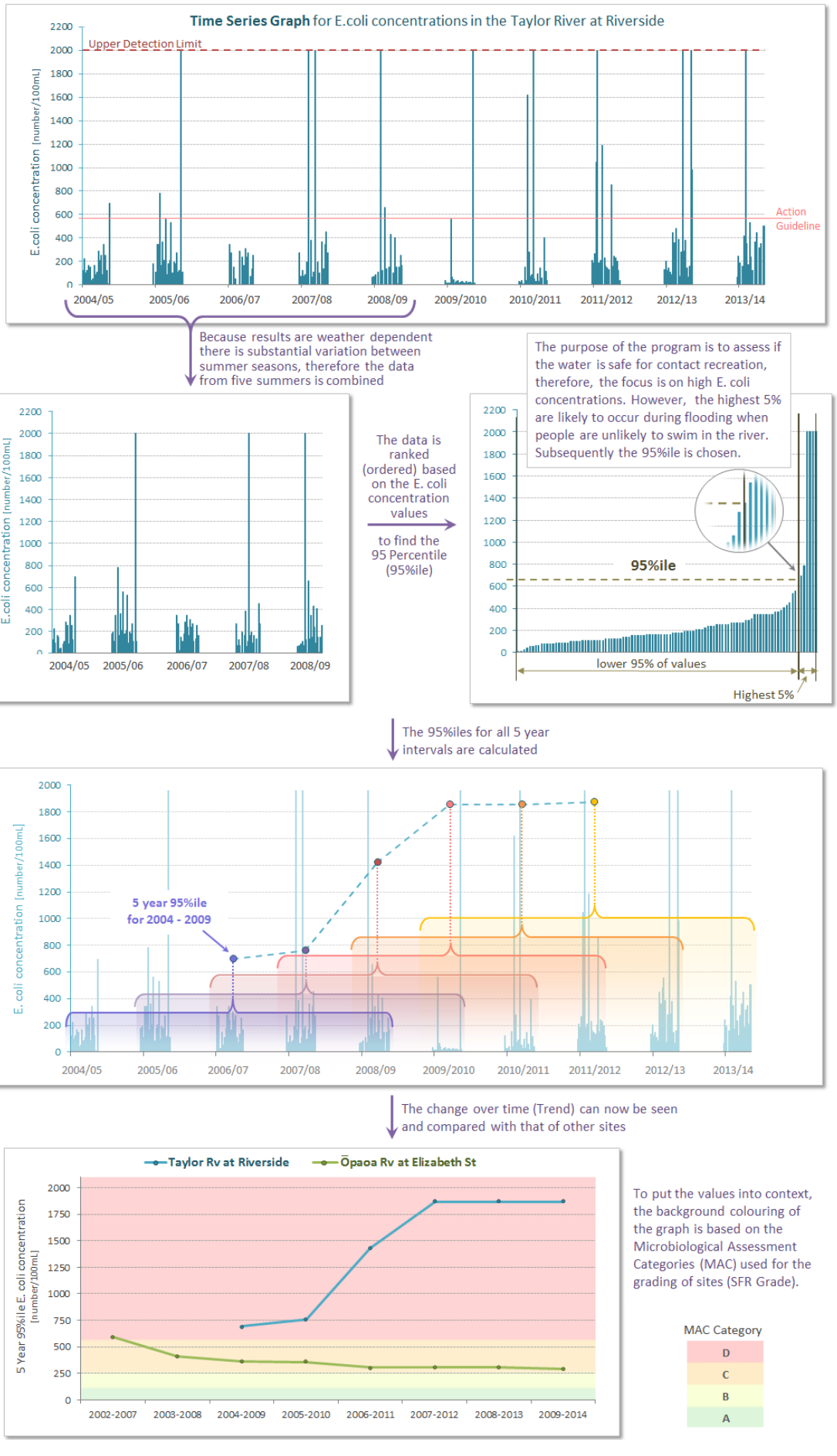
5. Results

The following chapters present the results for this summer as well as changes of faecal bacteria concentrations over time (long-term trends). Where appropriate, sites are grouped into sets of two or three sites. For each group the concentration of faecal indicator bacteria in the samples taken from each site during the 2016/17 summer is shown, together with rainfall and flow data recorded at nearby sites. This allows the results to be viewed with regard to rainfall and flood events. A map shows the location of the sampling sites as well as the rainfall and/or flow recorder. For sites with longer monitoring records, the changes over time are shown using the 5-year-95%ile (MAC) values (Figure 2), which are also used for the calculation of the SFR Grades (see Section 3.2).[2]

Summary tables showing the numerical results for all samples taken this season can be found in the Appendices. Additionally, Appendix 2 contains graphs showing the compliance history and box and whiskers plots for sites that have been monitored for more than three years.

▶ Figure 1: Creation of 5-Year-95%ile Graphs, used to display long-term trends.

[2] Note that in previous reports, the calculation of the upper 95%ile for the analysis of trends used the Excel method instead of the Hazen method. The Hazen method gives generally slightly higher results. For consistency in regard to SFR Grades, this report uses the Hazen method to show trends. Consequently, there are slight differences to trend graphs in previous report.


Time Series Graph for E.coli concentrations in the Taylor River at Riverside
Upper Detection Limit
Action Guideline
E.coli concentration [number/100mL]
2004/05
2005/06
2006/07
2007/08
2008/09
2009/2010
2010/2011
2011/2012
2012/13
2013/14
Because results are weather dependent there is substantial variation between summer seasons, therefore the data from five summers is combined
The data is ranked (ordered) based on the E. coli concentration values
to find the 95 Percentile (95%ile)
The purpose of the program is to assess if the water is safe for contact recreation, therefore, the focus is on high E. coli concentrations. However, the highest 5% are likely to occur during flooding when people are unlikely to swim in the river. Subsequently the 95%ile is chosen.
95%ile
lower 95% of values
Highest 5%
The 95%iles for all 5 year intervals are calculated
5 year 95%ile for 2004 - 2009
E. coli concentration [number/100mL]
The change over time (Trend) can now be seen and compared with that of other sites
Taylor Rv at Riverside
Ōpaoa Rv at Elizabeth St
5 Year 95%ile E. coli concentration [number/100mL]
2002-2007
2003-2008
2004-2009
2005-2010
2006-2011
2007-2012
2008-2013
2009-2014
To put the values into context, the background colouring of the graph is based on the Microbiological Assessment Categories (MAC) used for the grading of sites (SFR Grade).
MAC Category
D
C
B
A

5.1. Moetapu Bay

Sites

Moetapu Bay is the only site in the Pelorus Sound/Te Hoiere currently monitored as part of the program. It was added only recently after an aerial survey in 2012 identified it as a possible high-use area. There are several beaches along the wider bay and monitoring was initially carried out at the small DoC campground (Figure 2). However, field observations showed that the Double Bay Reserve had generally more visitors. The higher use combined with greater residential development around Double Bay Reserve mean that the risk of a person becoming ill from waterborne diseases is greater at this site. Subsequently, monitoring at the DoC campground was discontinued and is now carried out at the Double Bay Reserve only.

Moetapu Bay is located in close proximity to the mouth of the Te Hoiere/Pelorus River and water quality is impacted by river floods.

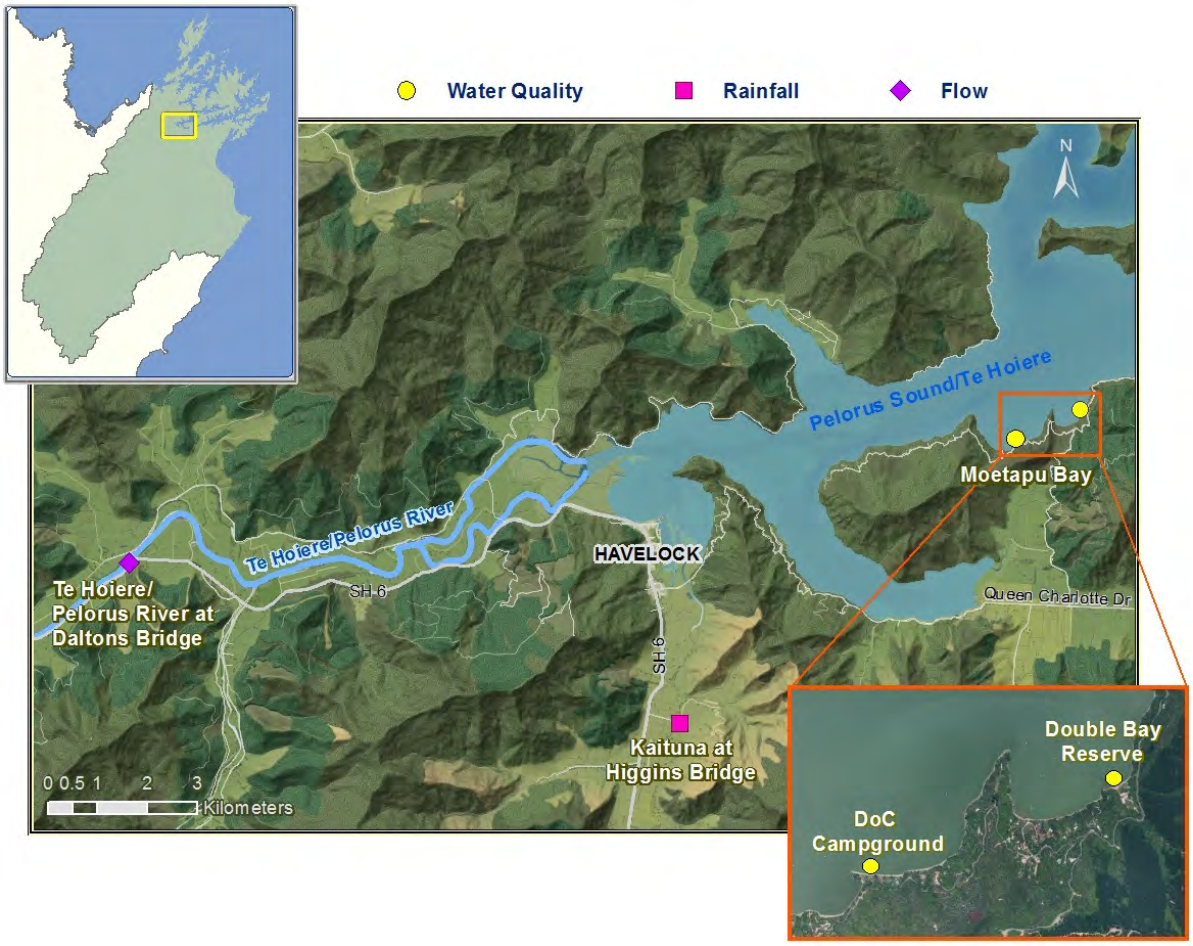


Figure 2: Location of the Moetapu Bay sampling sites, the (simulated[3]) Te Hoiere/Pelorus River flow recorder and the Kaituna at Higgens Bridge rain gauge.

Results

Two samples taken from Moetapu Bay this summer were above the Action Guideline. The sample with the highest Enterococci concentrations was taken at the end of March following some rainfall. An earlier sample with high bacteria concentrations, however, was taken during a period of fine weather. A follow-up sample taken two days later had comparatively low levels of Enterococci (Figure 3).

[3] The flow is simulated based on data from flow recorders further upstream.

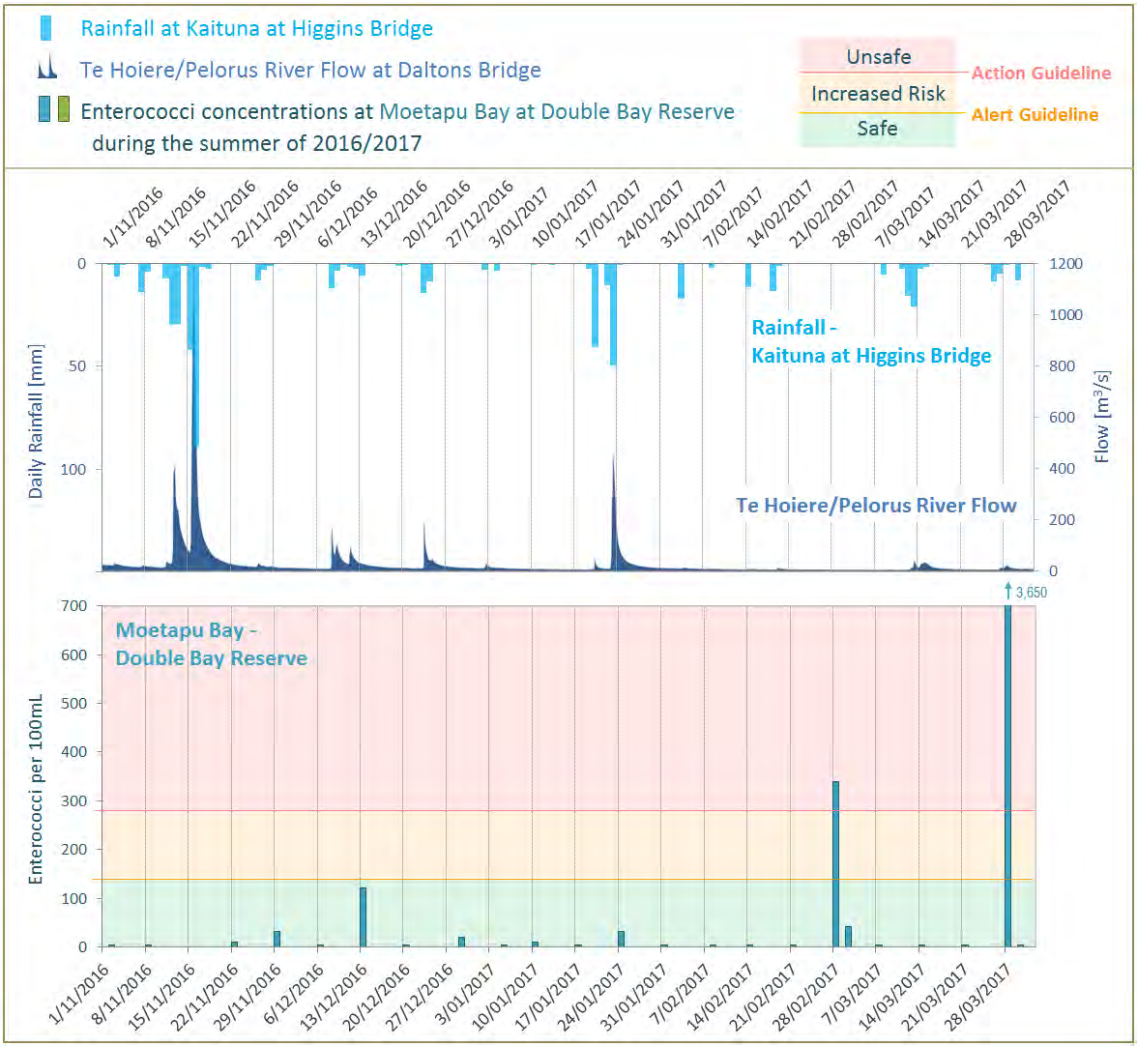


Figure 3: Enterococci concentrations at Moetapu Bay – Double Bay Reserve for the 2016/17 summer season.

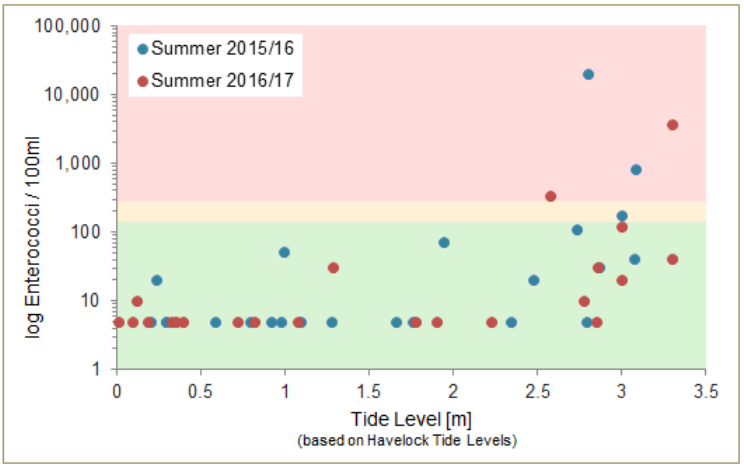


Figure 4: Changes of Enterococci concentrations with Tide heights during the last two summer seasons at Moetapu Bay – Double Bay Reserve.

Results from the previous summer season had shown that Enterococci concentrations in Moetapu Bay remained high for some time following flooding in the Te Hoiere/Pelorus River catchment, but

bacteria levels were very variable. Closer investigation revealed that Enterococci concentrations were highest during high tides [8]. Te Hoiere/Pelorus River floods bring high loads of faecal bacteria into the Sound, some of which bind to sediment and organic material which is deposited onto beaches in the Pelorus Sound/Te Hoiere. Faecal indicator bacteria can survive in the environment for extended time periods when protected from light and harsh environmental conditions [1, 11]. Overseas research has shown that the number of faecal indicator bacteria in beach sand is highest in the zone of the highest wave up-rush [11]. This explains the high Enterococci concentrations during high tide in Moetapu Bay. A small stream flowing into the bay provides additional favourable conditions saturating the deposited sediment and small organic debris on the beach (needles, twigs etc.) with freshwater rather than the more detrimental saltwater (Figure 5). Although there was no large flood event in the Te Hoiere/Pelorus River in the week preceding the first sample with high Enterococci counts this summer, there was a high tide when this sample was taken. This indicates that during high tide Enterococci concentrations can exceed safe levels for several weeks or even months following Te Hoiere/Pelorus River floods. Plotting the results from the last two summer seasons confirms this (Figure 4).

Figure 5: The small stream flowing into Moetapu Bay at the Double Bay Reserve sampling site. Note the significant amount of small organic debris in the stream and on the beach.

5.2. Anakiwa and Mistletoe Bay

Sites

Anakiwa is located in the innermost part of the Queen Charlotte Sound/Totaranui. The microbiological water quality is influenced by the surrounding residential development and large numbers of seabirds (ie; oystercatcher, swans and ducks). Water quality is expected to also be influence by Linkwater Stream and Ada Creek. These two streams drain pastoral land and flow into the Sound 2 km from the Anakiwa sampling site. Monthly monitoring of Linkwater Stream has shown that its water quality is marginal and E. coli concentrations are frequently high [7]. The council has conducted a catchment-wide investigation of the water quality in Linkwater Stream and Ada Creek to identify sources of faecal contamination. Results of this investigation are expected to be published by the end of the year.

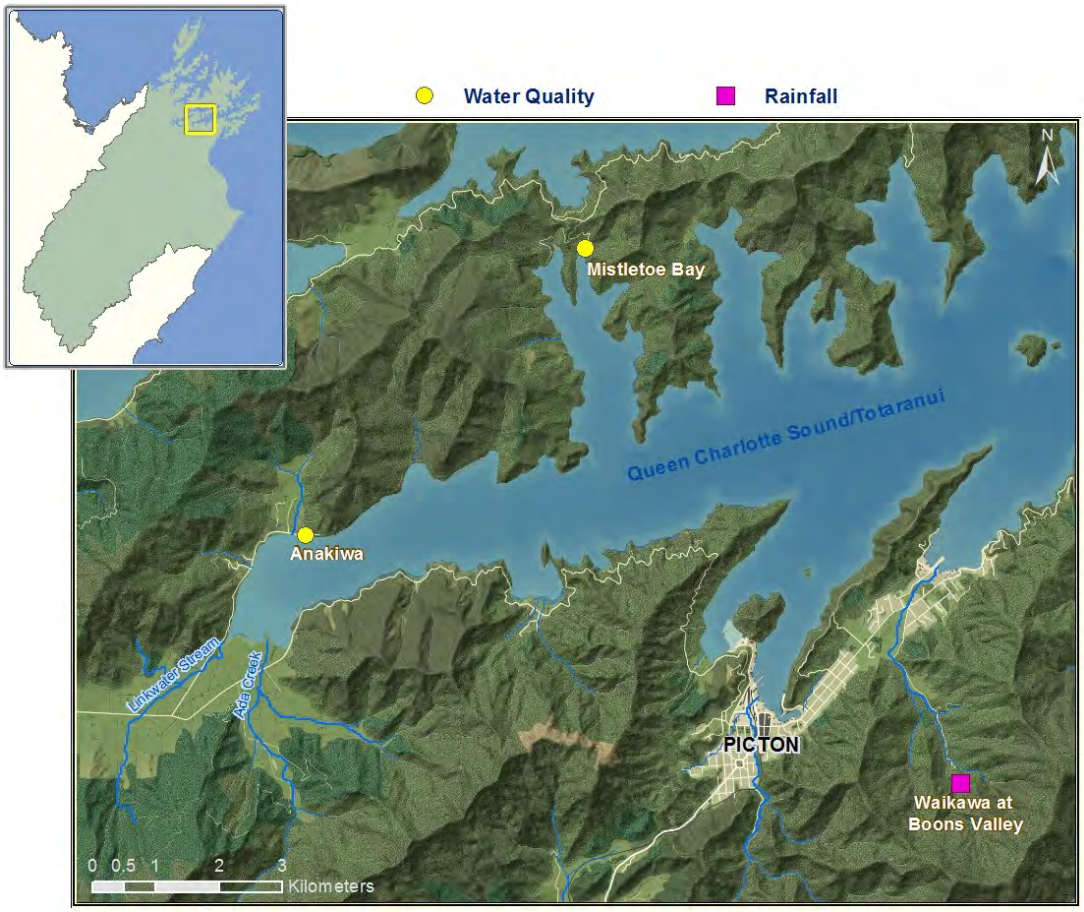


Figure 6: Location of the Anakiwa and Mistletoe Bay sampling sites and the Waikawa rain gauge.

Compared to Anakiwa, Mistletoe Bay has few possible sources of faecal contamination. The enclosed Bay is surrounded by bush-clad hills. The buildings of the Mistletoe Bay Trust are the only residential developments in the immediate catchment.

Results

Enterococci concentrations at Anakiwa Bay and Mistletoe Bay were below guideline levels during the whole monitoring period (Figure 7).

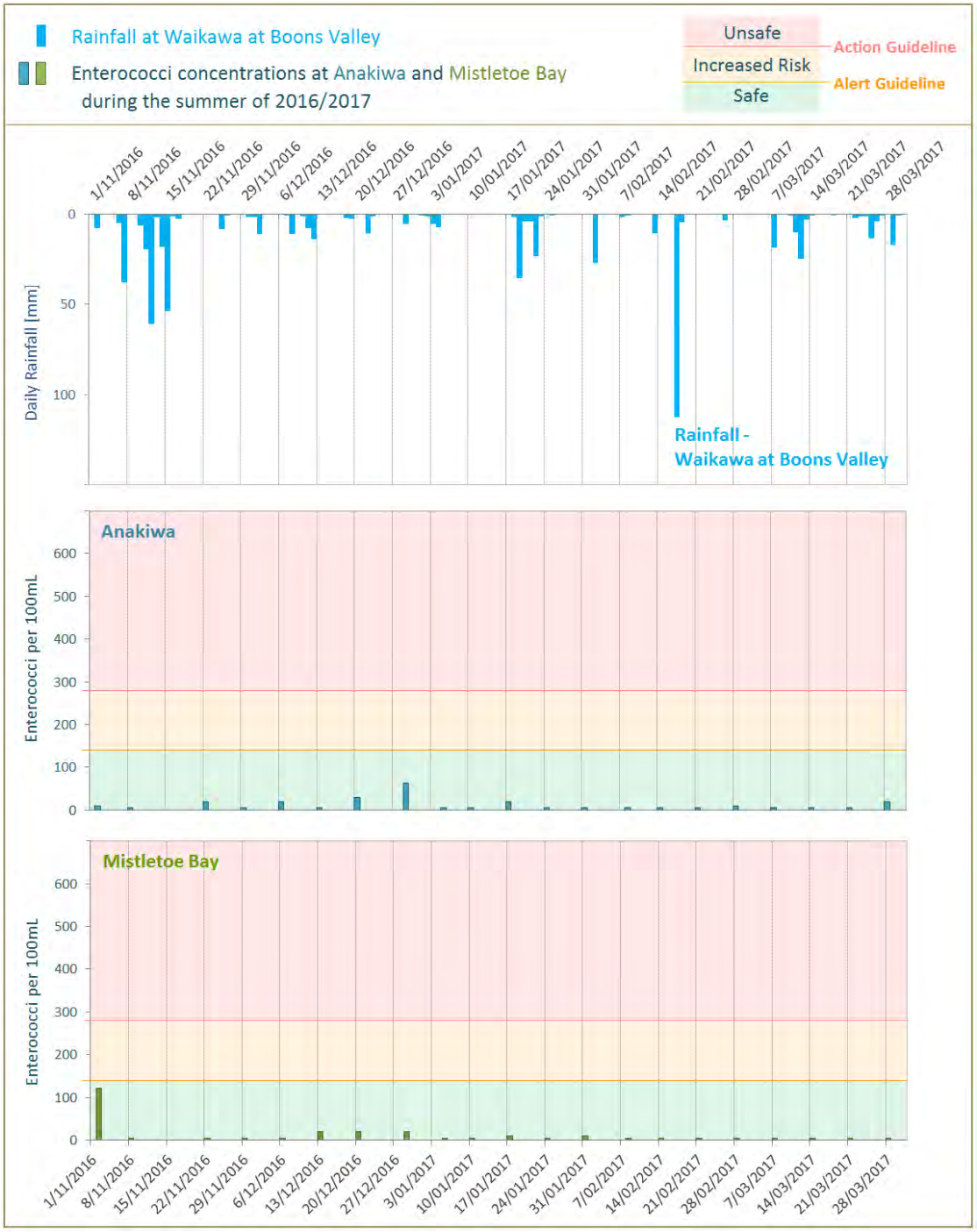


Figure 7: Enterococci concentrations at Anakiwa and Mistletoe Bay for the 2016/17 summer.

Enterococci concentrations in Mistletoe Bay had increased in recent years, particularly during rainfall events [8]. The Mistletoe Bay Camp Trust are the sole occupants of the immediate catchment. The Trust has upgraded the camp sewerage systems to high standards in recent years. However, investigations carried out in January last year revealed particularly high faecal bacteria concentrations in and downstream of a pond located in close proximity to an older building in the upper part of the catchment. Upon receiving the information the Trust carried out its own investigations and it was revealed that an old septic tank was the likely source of contamination. This tank has since been removed. Although targeted investigative sampling during rainfall is yet to be carried out, the consistently low Enterococci concentrations observed this summer indicate that bacterial water quality has improved significantly. Unfortunately, the higher Enterococci concentrations observed in previous

summers will result in a lower SFR Grade for several years, as the calculation of the grade combines data from five consecutive summer season. Mistletoe Bay has currently a SFR Grade of 'Fair'.

The long term trend for Anakiwa shows little change in recent years after significant improvement during early monitoring (Figure 8). Anakiwa has a SFR Grade of 'Good'.

The long term trend for Mistletoe Bay shows that Enterococci concentrations are still higher than in Anakiwa, despite similar results for both bays this summer. The reason is the calculation, which is the same as is used to determine the SFR Grade.

In the recent beach usage survey Anakiwa was the second most popular beach [9]. There were significantly fewer persons going for a swim at Mistletoe Bay, but numbers were sufficient to allow continued monitoring. Therefore, regular monitoring will continue in both bays in the future.

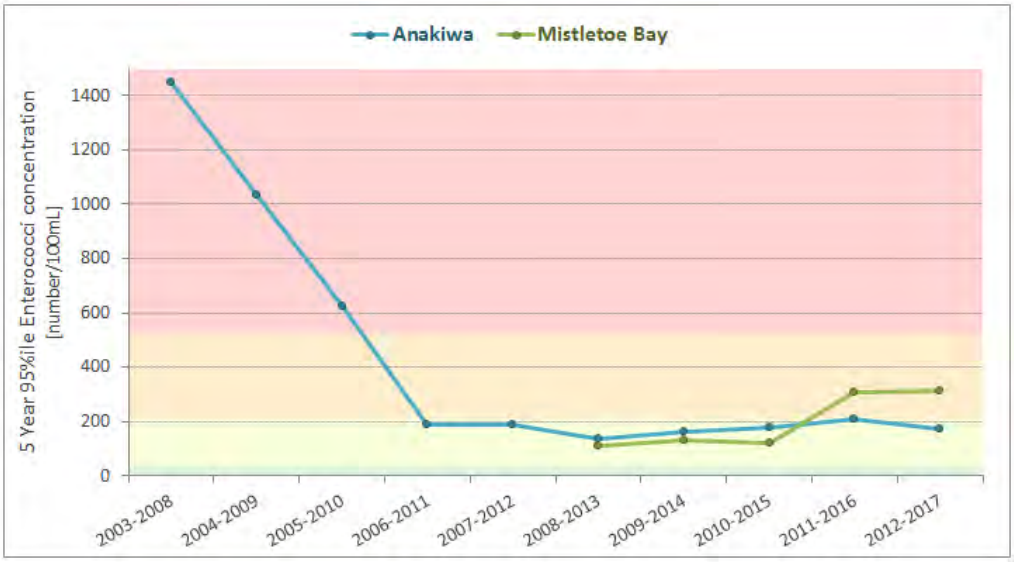


Figure 8: The 5-year 95%ile Enterococci concentrations for Anakiwa and Mistletoe Bay.

5.3. Momorangi, Ngakuta and Governors Bay

Sites

Momorangi Bay, Ngakuta Bay and Governors Bay are neighbouring bays in the Queen Charlotte Sound/Totaranui. Ngakuta Bay is the largest and most enclosed bay in this group and also has the greatest amount of residential development in the catchment. There are nearly 100 houses and holiday homes compared to less than 20 in Momorangi Bay and none in Governors Bay. Momorangi Bay, however, has a very popular campground, which attracts more visitors during the summer months than the other two bays combined.

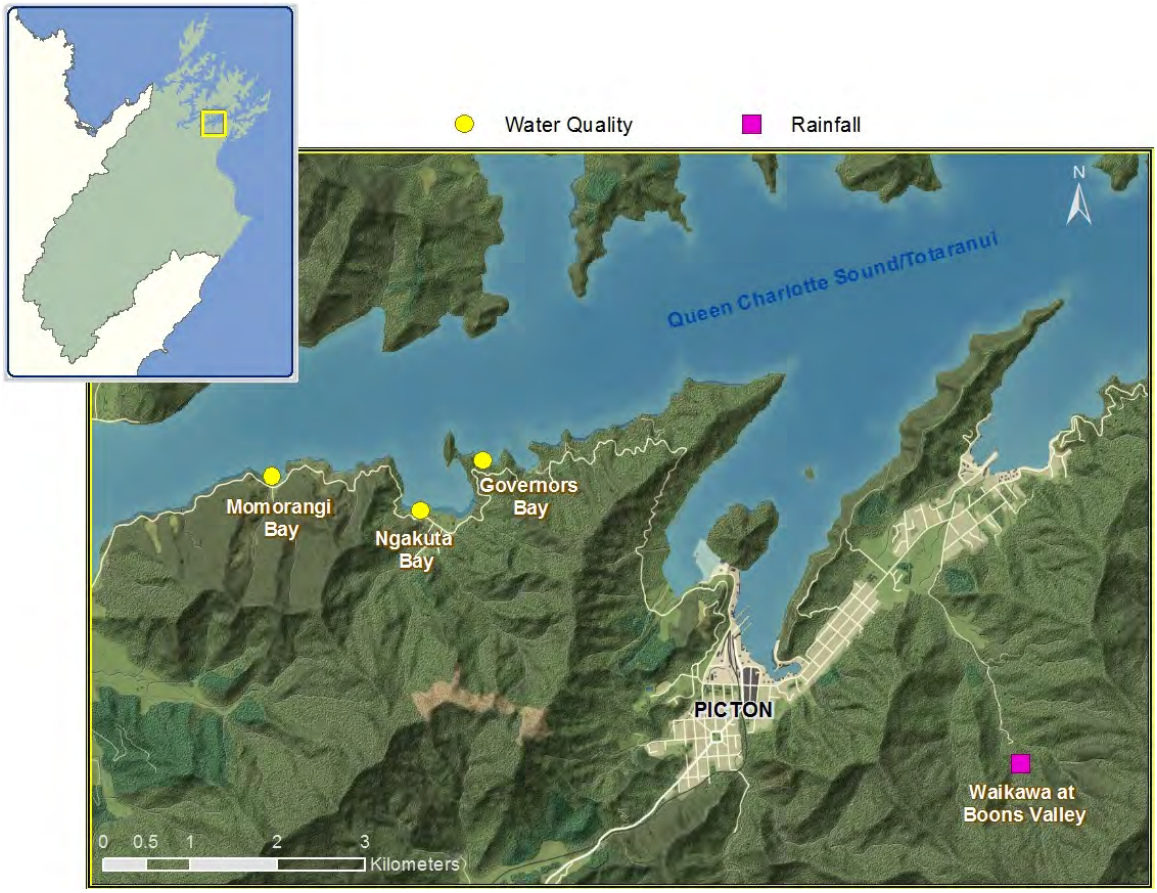


Figure 9: Map showing the sampling sites at Momorangi Bay, Ngakuta Bay and Governors Bay, as well as the rainfall recorder at Boons Valley.

Results

Except for one slight exceedance of the Alert Guideline at each of the bays, bacteria concentrations were at safe levels throughout the summer months. All three exceedances occurred at different dates, but were all related to rainfall (Figure 10). Anecdotal evidence from residence in the area, suggests that, despite their close proximity, rainfall intensities can vary greatly between the individual bays during the same rainfall event. This also means, that the rainfall recorded at Waikawa, which is seven kilometres away and at higher altitude, should only be used as indicator for the occurrence of rainfall events, but is likely misleading in regard to rainfall intensities in the individual bays.

Figure 10: Enterococci concentrations at Momorangi Bay, Ngakuta Bay and Governors Bay during the 2016/17 summer season.

During the last two summer seasons, faecal bacteria concentrations in Momorangi Bay were at unsafe levels on several occasions during dry weather conditions. All dry weather exceedances could be traced to problems with the Momorangi camp sewerage system. Several repairs and improvements to the systems have since been completed and the low Enterococci concentrations observed this summer prove the success of this work. As with Mistletoe Bay, the previous results will affect the grading of Momorangi Bay for quite some time. For this reason, Momorangi Bay will remain graded as 'Poor', despite the currently good bacterial water quality. The long term trend for Momorangi Bay is also still affected by the sample results from the previous two summer seasons (Figure 11).

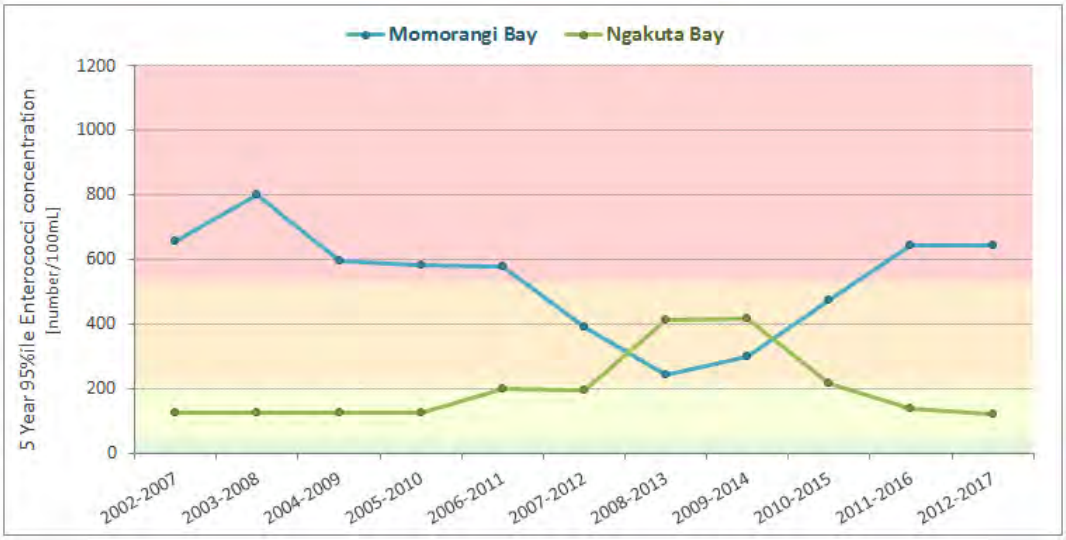


Figure 11: The 5-year 95%ile Enterococci concentrations for Momorangi Bay and Ngakuta Bay.

The long term trend for Ngakuta Bay shows that Enterococci concentrations have returned to levels observed in the early years of monitoring. It is still uncertain what had caused the temporary increase in bacteria levels in the five years between 2011 and 2015.

Ngakuta Bay and Governors Bay, both, have a SFR Grade of 'Good'.

5.4. Picton Foreshore and Waikawa Bay

Sites

The Picton Foreshore is a relatively small beach area. Nevertheless, the close proximity to the Picton town center, the information center, the aquarium and a large playground make it a popular destination for local residents and visitors. The Picton Maritime Festival and other events result in large numbers of visitors to the beach. Waikawa Bay, on the other hand, is predominantly used by local residents.

The water quality of the Picton Foreshore and Waikawa Bay are both influenced by the urban environment that surrounds these sites. The substantially greater amount of residential development of the Picton Township is reflected in the generally poorer water quality at the Picton Foreshore.

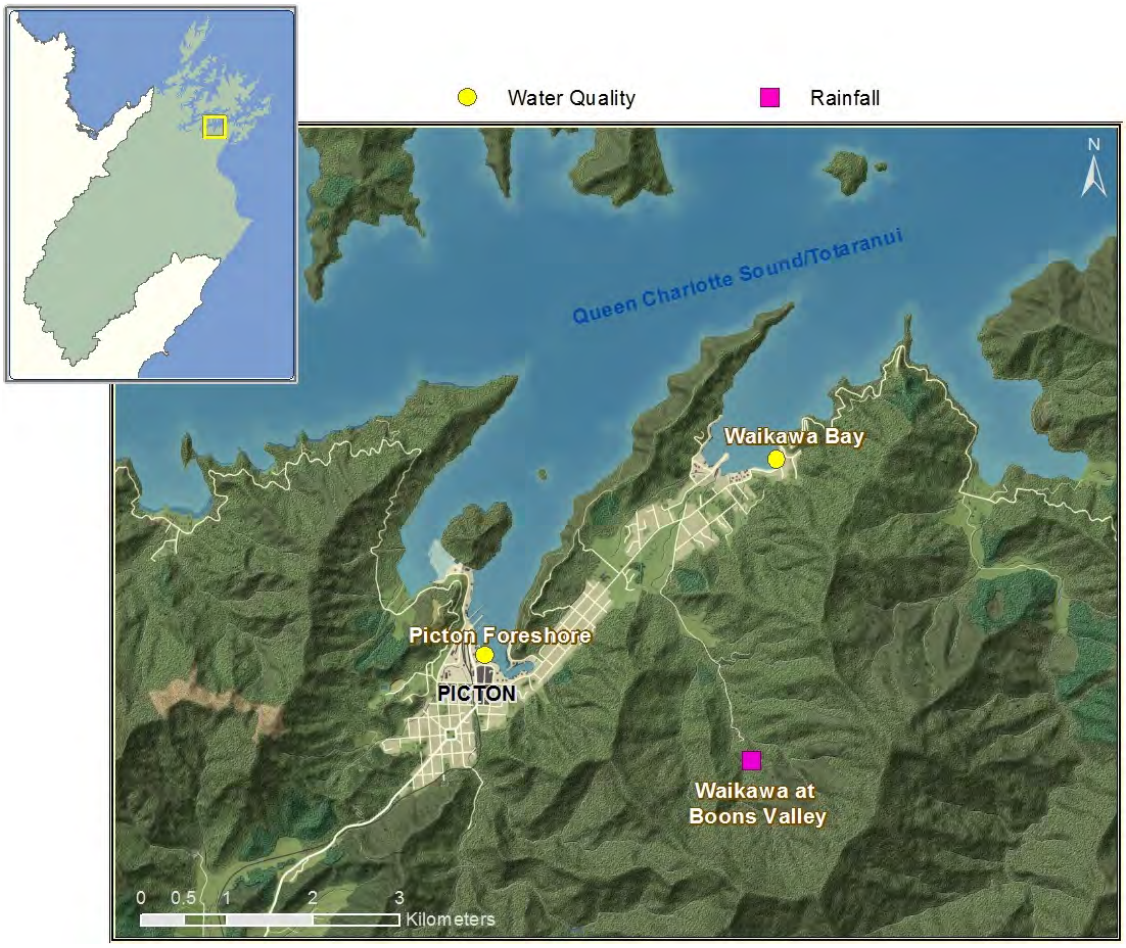


Figure 12: Locations of the Picton Foreshore and Waikawa Bay sampling sites as well as the rainfall recorder at Boons Valley.

Results

Enterococci concentrations at the Picton Foreshore and Waikawa Bay have been at safe levels during the whole summer. The only exception is a slight exceedance of the Alert Guideline in January at Waikawa Bay. Surprisingly, the sample was taken during a long dry weather period. Field notes indicate that the water was slightly turbid. This was most likely a result of the disturbance of the seabed in the shallower parts due to strong blustery winds on that day. Faecal bacteria can survive for weeks or month within fine sediment. Therefore, re-suspended sediment is the most likely source for the higher Enterococci concentrations observed on that day.

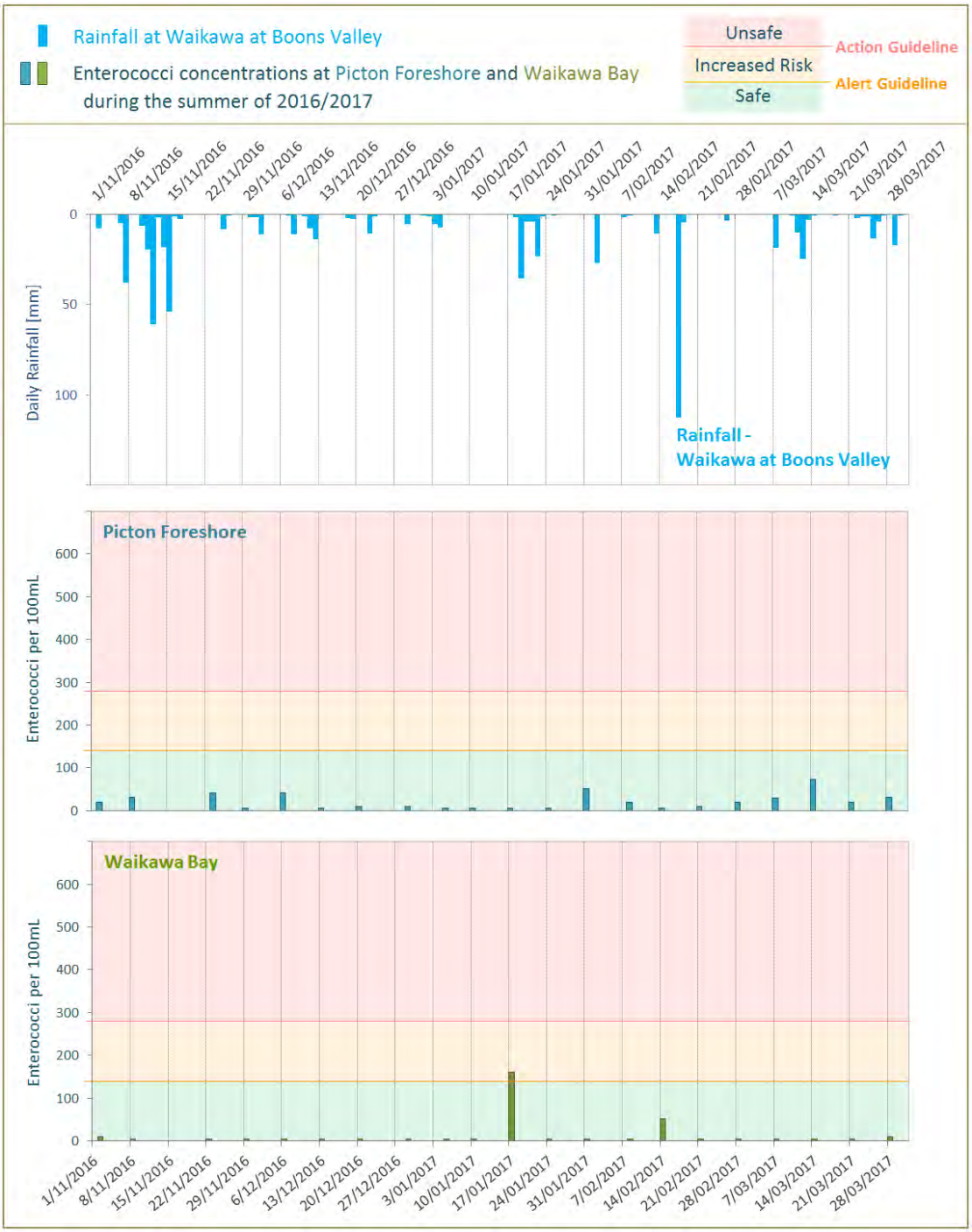


Figure 13: Enterococci concentrations at Picton Foreshore and Waikawa Bay during the 2016/17 summer season.

The long term trends for Picton Foreshore and Waikawa Bay, both, show very little change in the last four years. Enterococci concentrations at the Picton Foreshore were significantly higher during the early years of monitoring and appear to have stabilised at significantly lower levels. Nevertheless, faecal bacteria concentrations are still higher at Picton Foreshore compared to Waikawa Bay. High Enterococci concentrations are usually a result of rainfall, but last season, at Picton Foreshore occasional unsafe bacteria levels were also observed during dry weather. This summer no such guideline exceedances during dry weather were detected. The infrequency of these events makes investigation of the cause(s) very difficult.

Picton Foreshore has a SFR Grade of 'Fair', a significant improvement from the grading of 'Very Poor' several years ago. Bacterial water quality in Waikawa Bay has changed very little since monitoring began with a consistent SFR Grade of 'Good'.

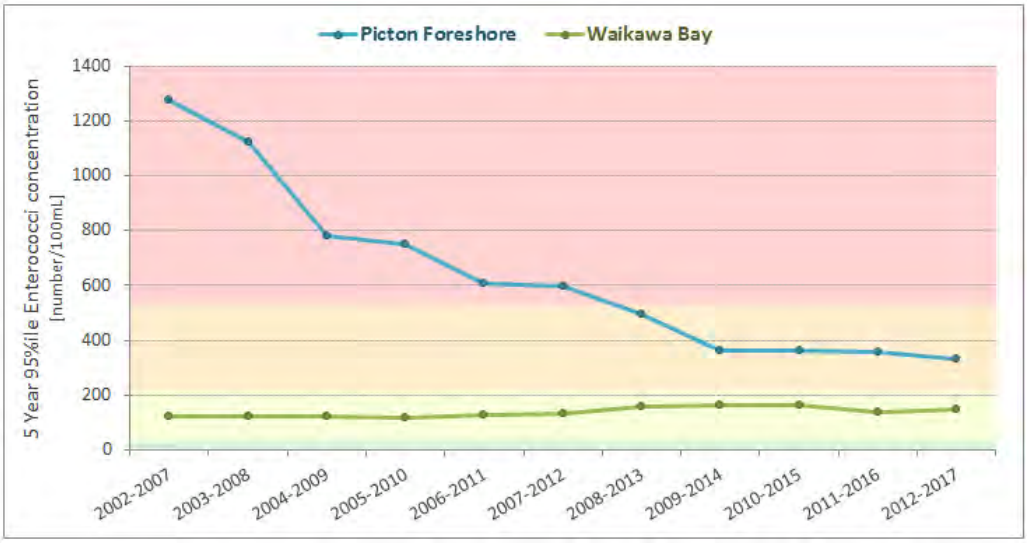


Figure 14: The 5-year 95%ile Enterococci concentrations for Picton Foreshore and Waikawa Bay.

5.5. Pukatea/Whites Bay and Waikutakuta/Robin Hood Bay

Sites

Pukatea/Whites Bay and Waikutakuta/Robin Hood Bay are located along the upper East Coast of the region. Pukatea/Whites Bay is one of the most popular beaches in Marlborough. A DoC campground is the only human impact in the bay and consequently water quality is generally very good. Waikutakuta/Robin Hood Bay, located only a few kilometres north of Pukatea/Whites Bay also offers a campground, but has a much larger catchment. Several streams flow into the bay. The largest, Stacy Creek, drains 90ha of pasture, which has a potential to affect the water quality in the bay. Waikutakuta/Robin Hood Bay is sampled at two sites, a surf beach on the Southwest side of the Bay and a swimming beach on the Northeast side, which is also used to launch boats.

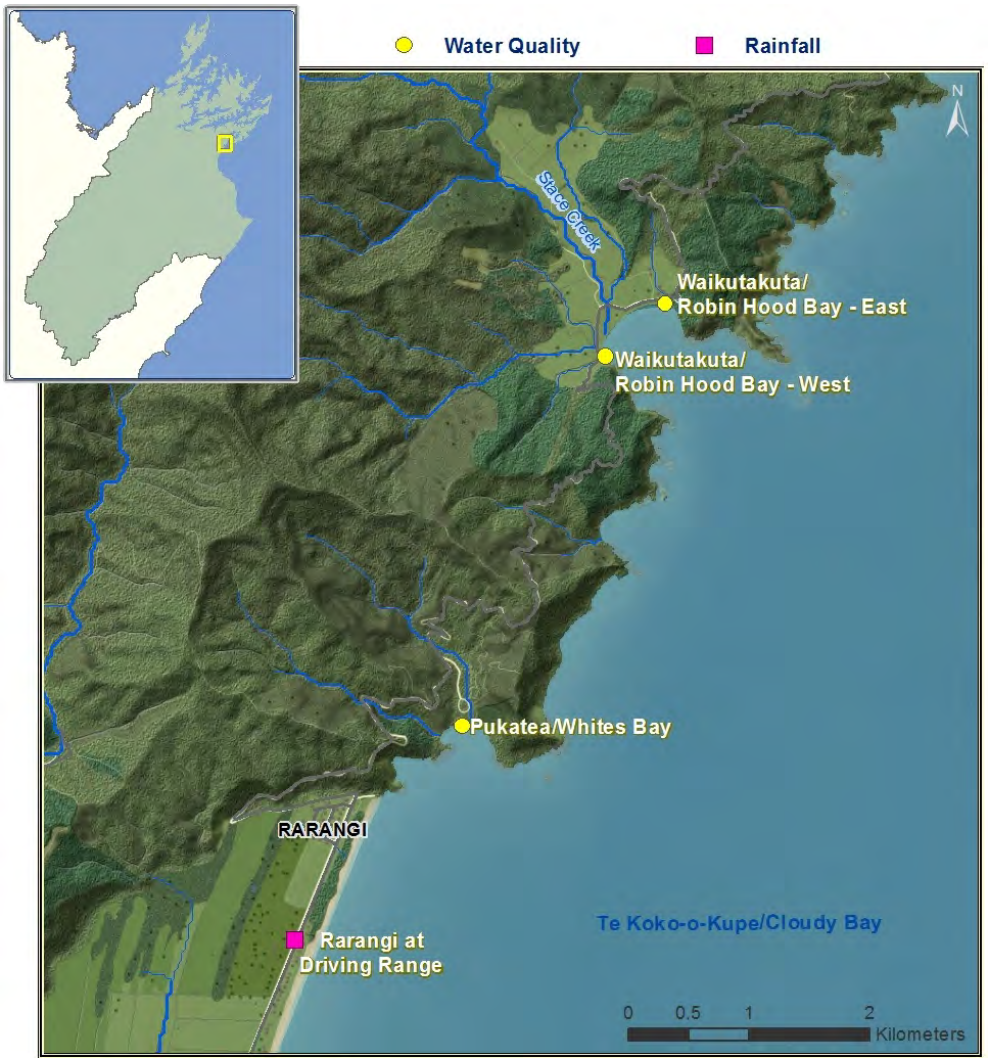


Figure 15: Locations of the Puketea/Whites Bay sampling site and the two Waikutakuta/Robin Hood Bay sampling sites, as well as the Rarangi rainfall recorder.

Results

At Robin Hood Bay, a high intensity rainfall event in February 2017 resulted in large amounts of gorse being washed out from the catchment and deposited onto the beach. The greater wave action on the western end of the bay resulted in relatively quick removal of gorse from the beach. On the eastern side of the bay, however, the gorse material remained, covering most of the upper part of the beach and slowly being buried in sand (Figure 17). Following the deposition of the gorse, Enterococci concentrations began to increase significantly (Figure 16).

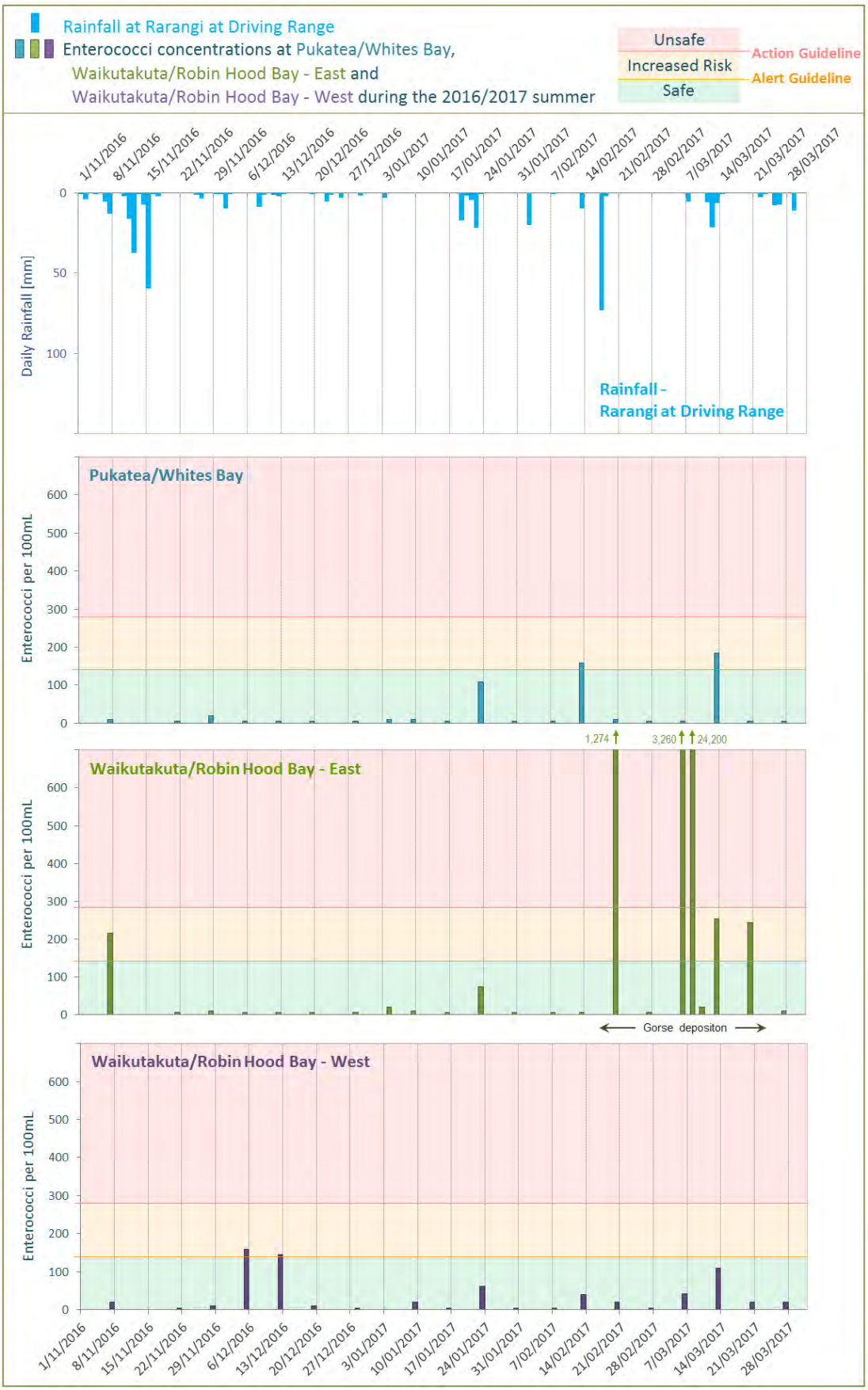


Figure 16: Enterococci concentrations at Pukatea/Whites Bay and Waikutakuta/Robin Hood Bay during the 2016/17 summer season.

Closer investigation revealed that concentrations were highest during high tide, particularly once the gorse material became submerged in the surf. Research has shown that faecal indicator bacteria can persist for several months within plant material and given the right conditions, possibly proliferate [1]. Sampling during high tide at Waikutakuta/Robin Hood Bay – East indicated that Enterococci concentrations were increasing over time. A small stream flowing across the sand, combined with the large amounts of organic material was creating a warm, moist and dark environment; perfect condition for bacterial growth. Although Enterococci bacteria appeared to be multiplying, it was unclear if the same was true for other, potentially harmful, bacteria. Testing for all possible pathogens would have incurred unreasonable costs. Therefore, warning signs remained in place for some time. On 16 March most of the gorse was moved out of the surf zone onto higher ground. The stream was also cleared of dead gorse material. The samples taken after that date indicate that Enterococci concentrations were decreasing following the clean-up.

Figure 17: Gorse deposited on the Robin Hood Bay – East beach following heavy rainfall in the catchment.

Exceedances of the Alert Guideline at Waikutakuta/Robin Hood Bay – West did not coincide with exceedances on the Eastern side. This indicates localised sources, in particular Stace Creek, which flows into the bay near the western sampling site. A large part of the pasture in the catchment of Stace Creek has been converted into vineyard, which should result in lower Enterococci concentrations in the bay. Faecal contamination is generally greater in streams flowing through pastoral land use compared to vineyards.

This season's beach usage survey [9] showed that most persons were swimming in Waikutakuta/Robin Hood Bay at the eastern beach rather than the western side. Combined with the results of this summer, which indicates a potentially greater health risk at the eastern side, Waikutakuta/Robin Hood Bay – East will be monitored as the representative site for the bay.

As of the end of this summer season, both Waikutakuta/Robin Hood Bay sites have now a complete data set for the SFR Grade assessment. Due to the problems caused by the gorse deposited on the eastern part of the bay, The East site is graded as 'Fair', while the western site has a SFR Grade of 'Good'.

Enterococci concentrations at Pukatea/Whites Bay this summer did not reach unsafe levels, but two samples with concentrations above the Alert Guideline mark the first exceedances of guideline levels since 2013 for this site. Surprisingly, the samples were associated with comparatively small rainfall. However, it is possible that the second occurrence in March was linked to what was happening at Robin Hood Bay East. Observations by the public indicate some gorse had also accumulated at Whites Bay. Nevertheless, should future sampling show similarly elevated bacteria concentrations, an investigation should be carried out in order to identify the source(s) of contamination. So far, Whites Bay has had some of the best bacterial water quality of all sites monitored as part of the program. The recreational water quality of the site is graded as 'Very Good'. The beach usage survey carried out in January this year also revealed that it is the most popular recreational swimming site in the region [9]. Therefore, significant changes to the recreational water quality would results in a higher health risk for a large number of people, particularly if the change results in unsafe levels of faecal contamination.

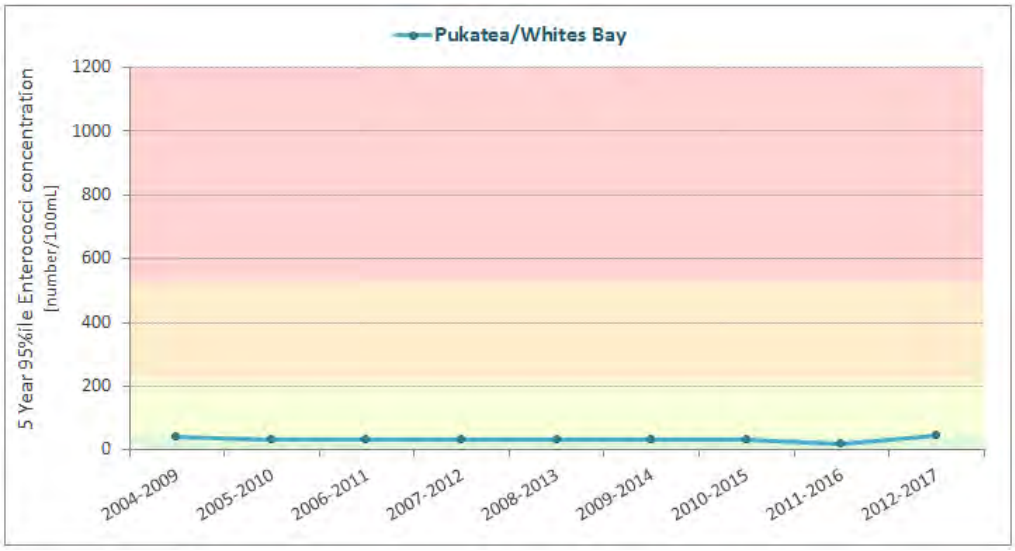


Figure 18: The 5-year 95%ile Enterococci concentrations for Pukatea/Whites Bay.

5.6. Marfells Beach

Site

Marfells Beach is the most southern sampling site, located on the lower East Coast of the region. There are no large rivers or streams flowing into the sea close to the site. Consequently, the surrounding low intensity pastoral farming has little effect on water quality. A popular DoC campground is located next to the beach and there are usually more than 100 seagulls on the beach.

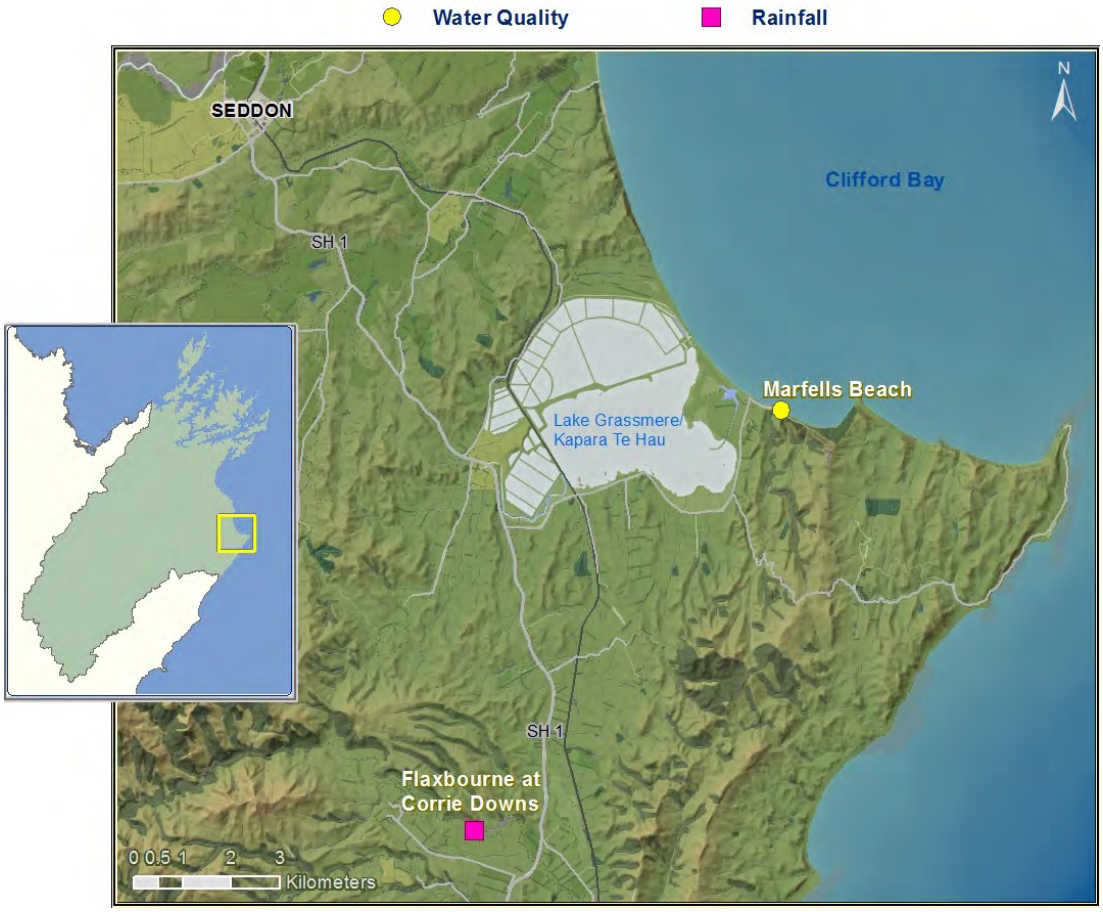


Figure 19: Map showing the location of the Marfells Beach sampling site and Flaxbourne rainfall recorder.

Results

As for the last 8 summer seasons, Enterococci concentrations at Marfells Beach have consistently been well below guideline levels (Figure 20). Marfells Beach has the best bacterial water quality of all sites monitored as part of the program. The site has a SFR Grade of 'Very Good' and the long term trend shows that there has been very little change since monitoring began in 2007 (Figure 21).

The beach usage survey carried out in January this year showed that only a very small number of swimmers were entering the water at Marfells Beach [9]. The low usage and the low risk to public health due to the good water quality mean that monitoring will be discontinued. However, the site should still be included in future site usage surveys. If these surveys show a significant increase in swimmers, regular monitoring will be justified again. Considering the very good bacterial water quality, the monitoring might only need to occur on a sporadic basis to confirm that the water quality at the site has not change. Should there be significant changes to the surrounding land use, however, more frequent monitoring might be required.

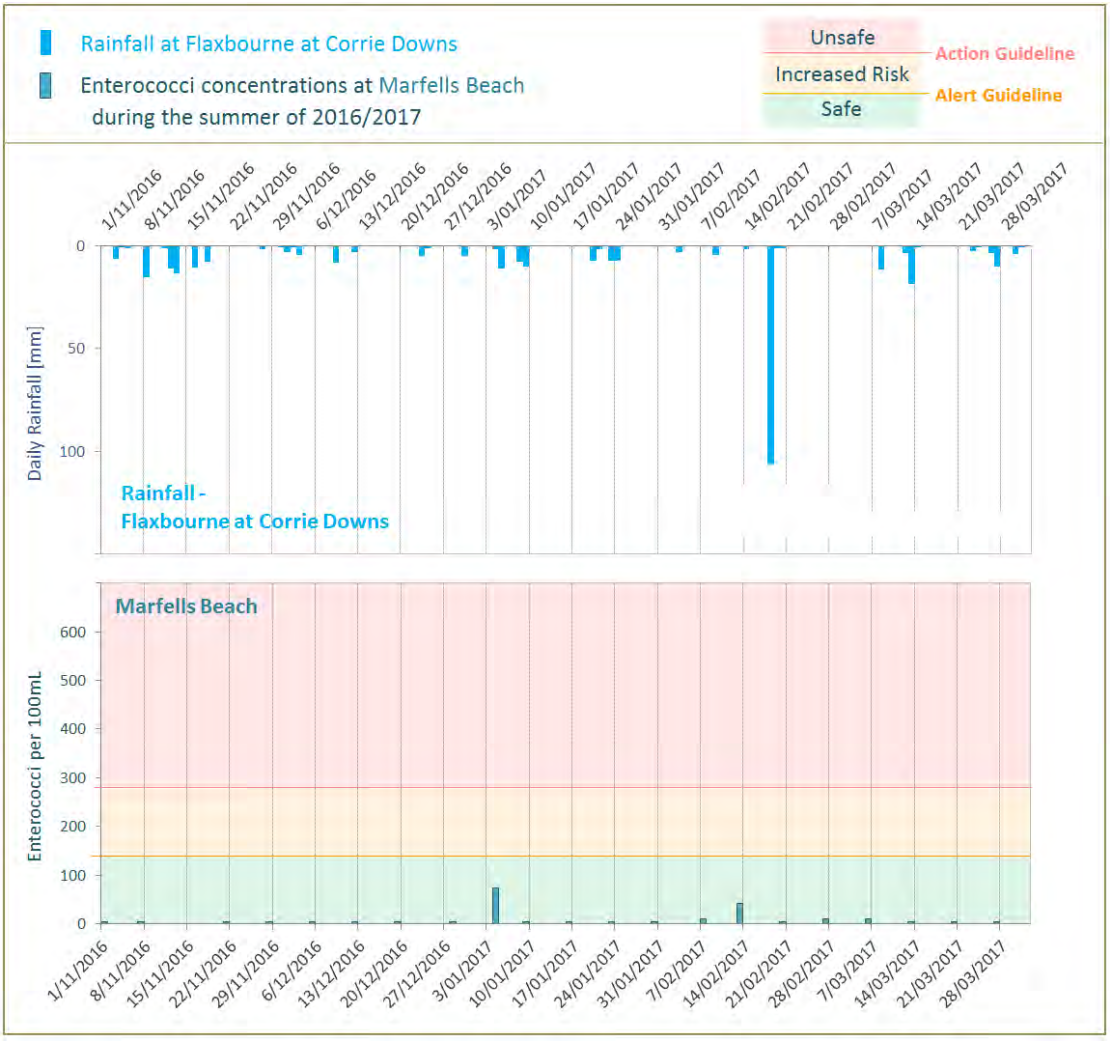


Figure 20: Enterococci concentrations at Marfells Beach during the 2016/17 summer season.

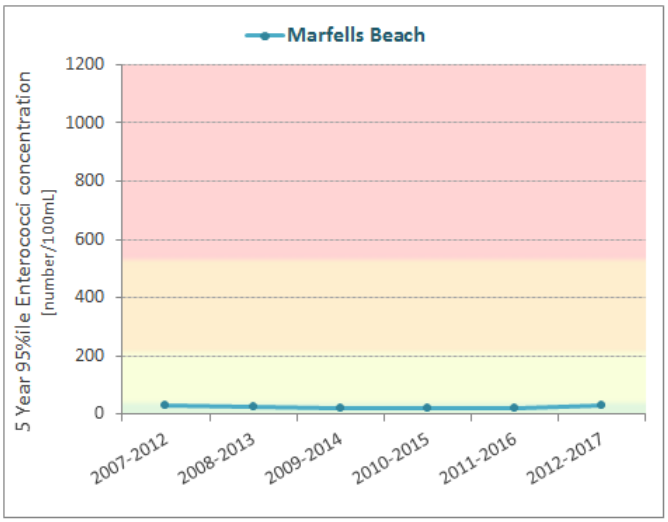


Figure 21: The 5-year 95%ile Enterococci concentrations for Marfells Beach.

5.7. Rai River and Te Hoiere/Pelorus River

Sites

The Te Hoiere/Pelorus River has two popular swimming sites that are sampled as part of the Recreational Water Quality program, Pelorus Bridge and Totara Flat. The Rai River, which is sampled at the Rai Falls, flows into the Te Hoiere/Pelorus River between the two sites, approximately 300m upstream of Totara Flat. Subsequently, water quality at Totara Flat is strongly influenced by the water quality of the Rai River.

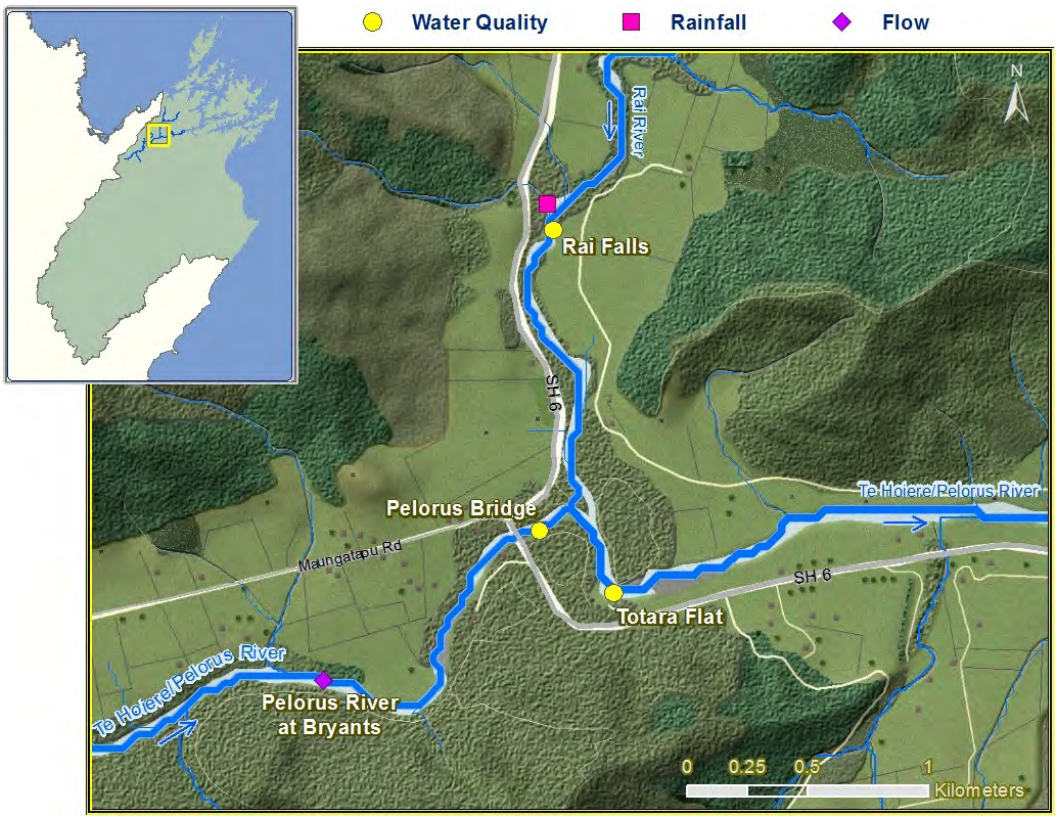


Figure 22: Locations of the Te Hoiere/Pelorus and Rai River sampling sites as well as nearby rainfall and flow recorders.

Results

A rain event that was most intense in the Rai River catchment caused the only exceedances of the Action Guideline for the Rai River at Rai Falls and Te Hoiere/Pelorus River at Totara Flat this sampling season (Figure 23).

No samples were taken during heavy rainfall in mid-November shortly after the “Kaikoura Earthquake”. Damage to roads and other infrastructure meant that no recreational water quality samples were taken in the weeks following the earthquake. The rainfall event caused significant flooding and it could be expected that E. coli concentrations were very high, but it is unlikely that persons were swimming in the river at the time.

As in other years, E. coli concentrations were generally highest in the Rai River and lowest in the Te Hoiere/Pelorus River at the Pelorus Bridge. This is reflected in the SFR Grades for the sites. The bacterial water quality of the Rai River at Rai Falls is graded ‘poor’, while the Te Hoiere/Pelorus River is graded ‘fair’ at Totara Flat and ‘good’ at the Pelorus Bridge.

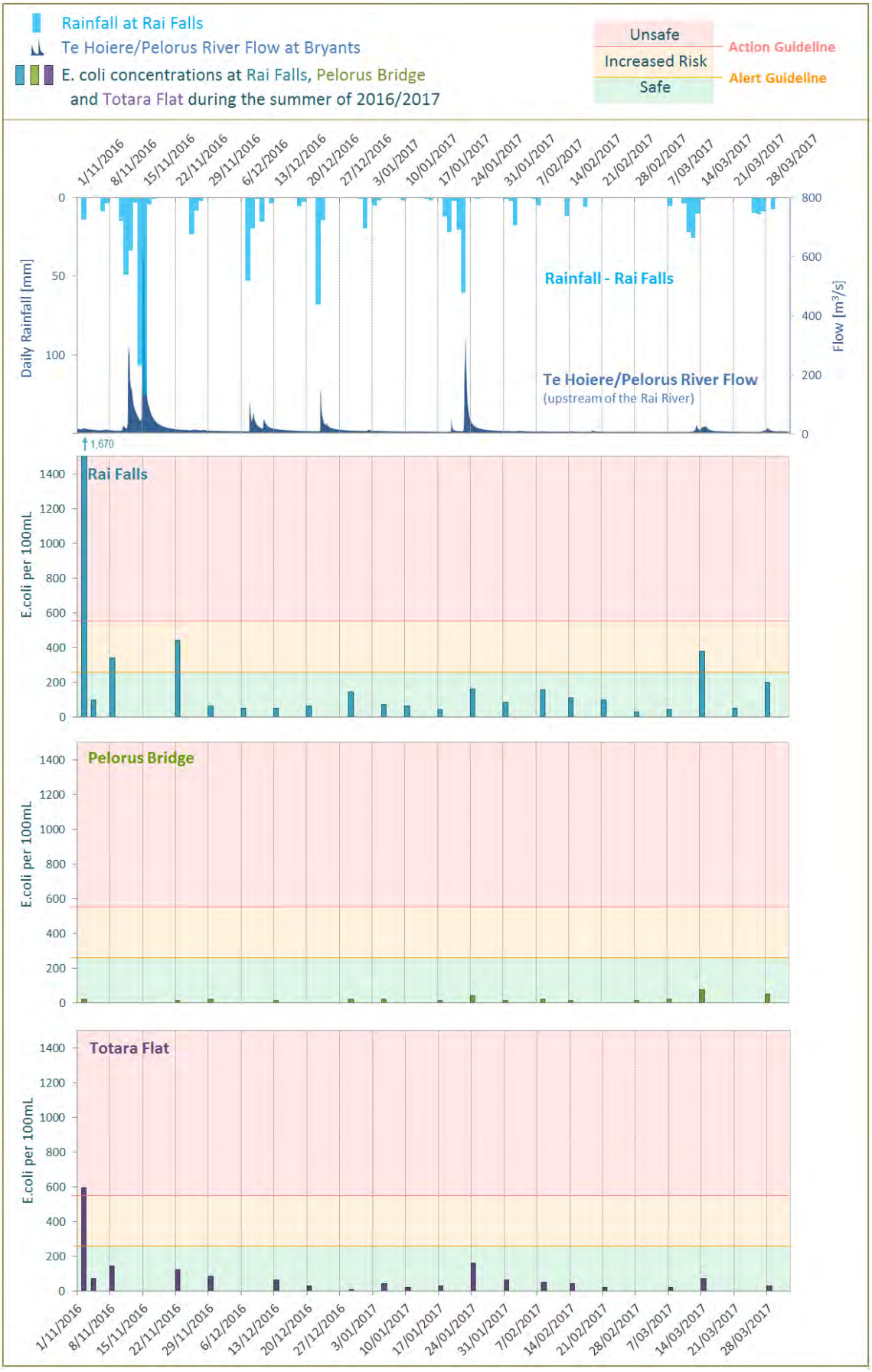


Figure 23: E. coli concentrations in the Rai and Te Hoiere/Pelorus River in the 2016/17 summer.

The long term trends shows significant improvements for all three sites in recent years (Figure 24). While Enterococci concentrations at the two Te Hoiere/Pelorus sites appear to have stabilised, water quality in the Rai River appears to be improving further. Unfortunately, this year's beach usage survey indicates that very few people were swimming at the Rai Falls [9]. Only 3 persons were recorded entering the water at the site during the four hour survey. In contrast, the two Te Hoiere/Pelorus River sites were both on the top of the popularity list, with 152 swimmers at the Pelorus Bridge and 94 swimmers at Totara Flat.

Due to the low usage of the Rai River at Rai Falls by swimmers, weekly monitoring will be discontinued at this site. However, predictive E. coli models have recently been developed for Rai Falls as well as for Totara Flat. These models have the potential to provide more relevant up-to-data indication of E. coli concentrations. They can provide continues predictions, rather than one result per week. In order to test the models some further sampling will need to be carried out at the Rai Falls, potentially warranting continuing the weekly monitoring for a limited time period. Sampling of the Rai Falls will also continue on a monthly basis as part of the State of the Environment program.

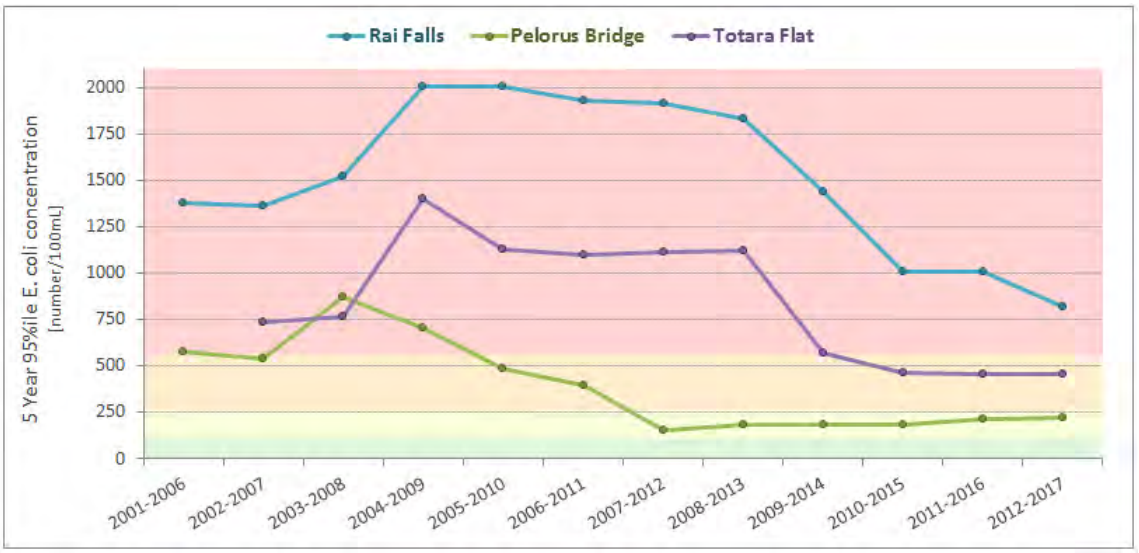


Figure 24: The 5-year 95%ile E.coli concentrations for the Rai River at Rai Falls and the two Te Hoiere/Pelorus River sites.

5.8. Waihopai River

Site

The Waihopai River swimming hole at the Craiglochart #2 Bridge is particularly popular with local residents. Often there will be nobody at the site when samples are taken, but it is known that school groups and families use the site frequently, especially in the weekends. Over a quarter of the catchment area has been converted to pasture, but grazing is mostly of low intensity.

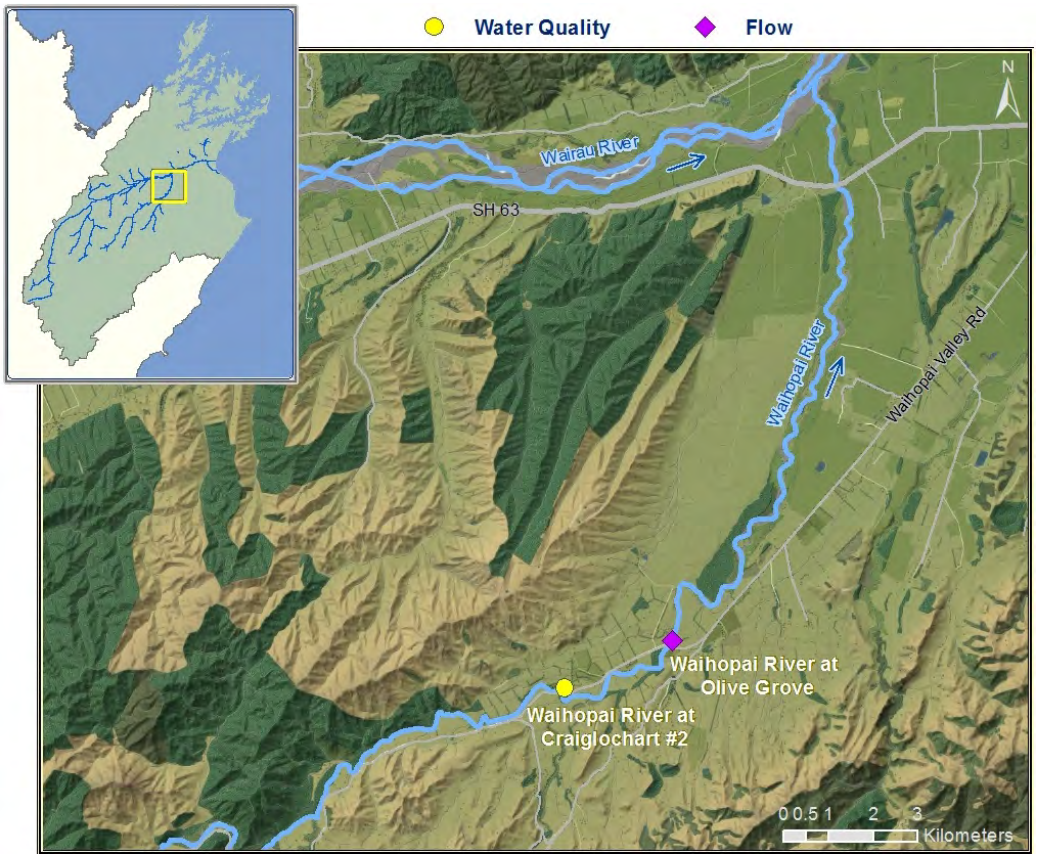


Figure 25: Location of the Waihopai River sampling site and the flow recorder.

Results

Elevated E. coli concentrations in the Waihopai River this summer were generally associated with increases in flow (Figure 26). The only sample with a faecal bacteria concentration above one of the guidelines was taken when the water was very turbid according to field observations. Therefore, it is unlikely that persons were swimming in the river at the time. Since heavy rainfall caused several slips in the upper catchment in recent years, water has been turbid during relatively small increases in flow. Previous analysis has shown that there is no clear relationship between E. coli concentrations and turbidity [8]. Council's general advice to the public is to avoid swimming in water that looks discoloured.

The Waihopai River at Craiglochart #2 is one of three sites for which a predictive E. coli concentration model has been developed [see Section 5.7]. This will provide better information to the public regarding the health risk from faecal contamination at this site.

The long term trend shows that E. coli concentrations have nearly returned to levels similar to those observed in the early years of monitoring (Figure 26). This reverses a temporary improvement in E. coli levels between 2011 and 2014. It is unclear what had caused the improvement or the recent deterioration. It is possible that different sources caused high E. coli concentrations in the early years and in recent years. The trend data and SFR Grading for the recent years has been strongly influenced by unusually high E. coli concentrations in the 2012/2013 summer season. However, these results will not be incorporated into the calculations next year. Therefore, should E. coli

concentrations next summer be as low as this season, the SFR Grade and long term trend will improve.

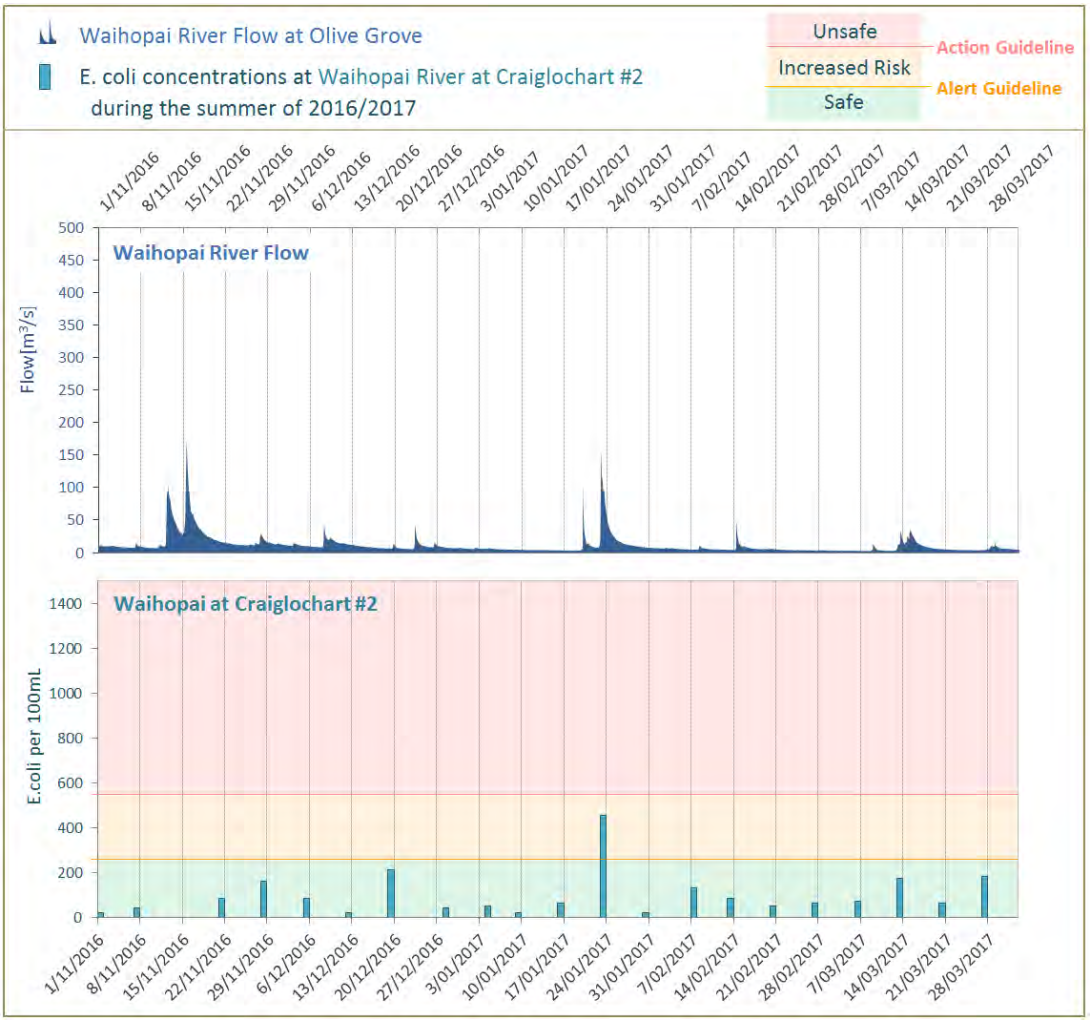


Figure 26: E. coli concentrations in the Waihopai River at Craiglochart #2 during the 2016/17 summer season.

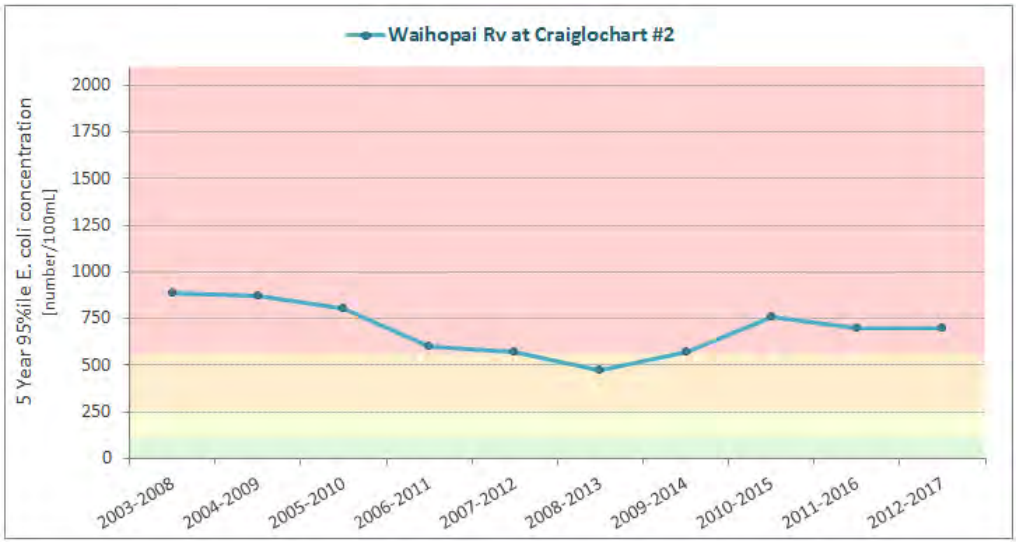


Figure 27: The 5-year 95%ile E.coli concentrations for the Waihopai River at Craiglochart #2.

5.9. Wairau River

Sites

There are three sites located along the Wairau River that are sampled as part of the Recreational Water Quality program. The two sites located furthest downstream, Ferry Bridge and Blenheim Rowing Club, have been part of the program for some time, while the site at the State Highway Six Bridge was added relatively recently as a result of a beach usage survey carried out in 2012 [4].

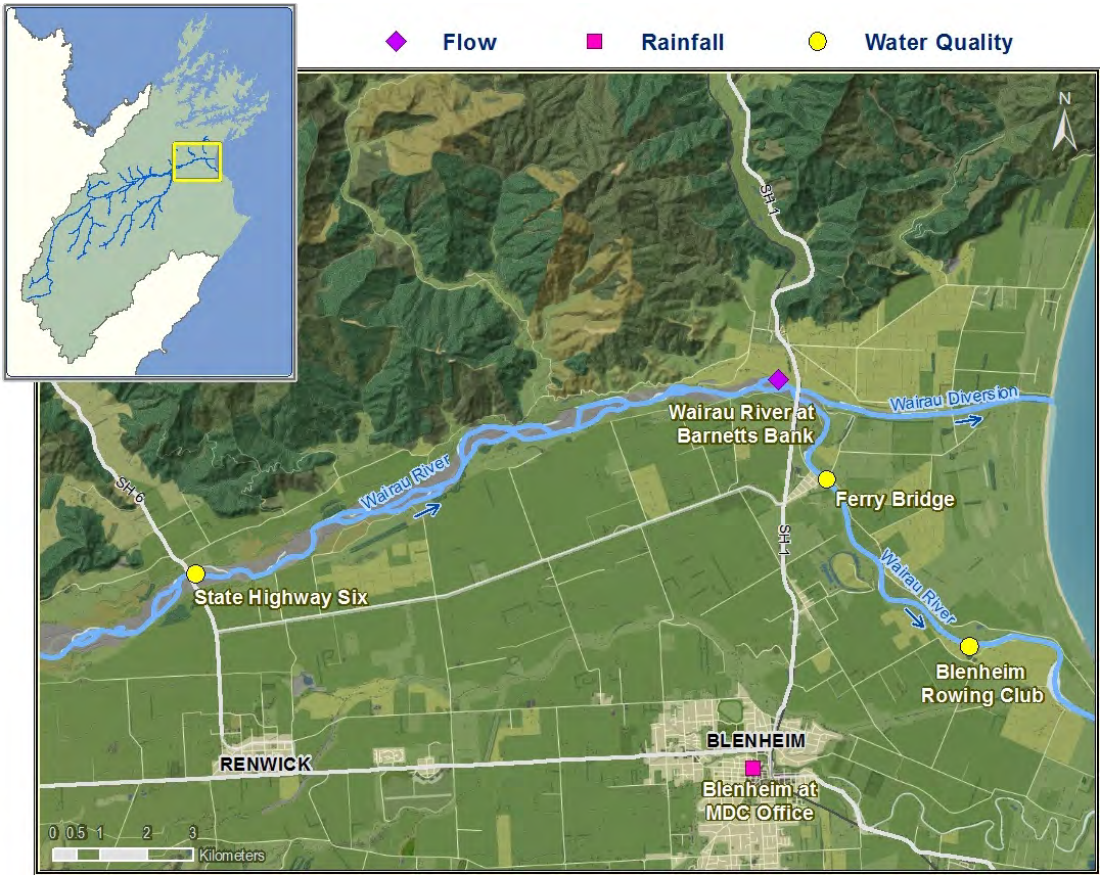


Figure 28: Location of the three Wairau River sampling sites and the Wairau River flow recorder.

Results

None of the samples taken from the Wairau River this summer season had unsafe E. coli concentrations, however, as was noted in Section 5.7, no samples were taken during a large flood event following the “Kaikoura Earthquake” in November 2016. A number of samples had elevated E. coli concentrations above the Alert Guideline, but these were all associated with increased river flows or localised rainfall events. The highest number of guideline exceedances was recorded at the Blenheim Rowing Club. Field notes indicated that the water was either slightly turbid or turbid when the samples were taken, which means that there were visual clues for the degraded water quality at the time.

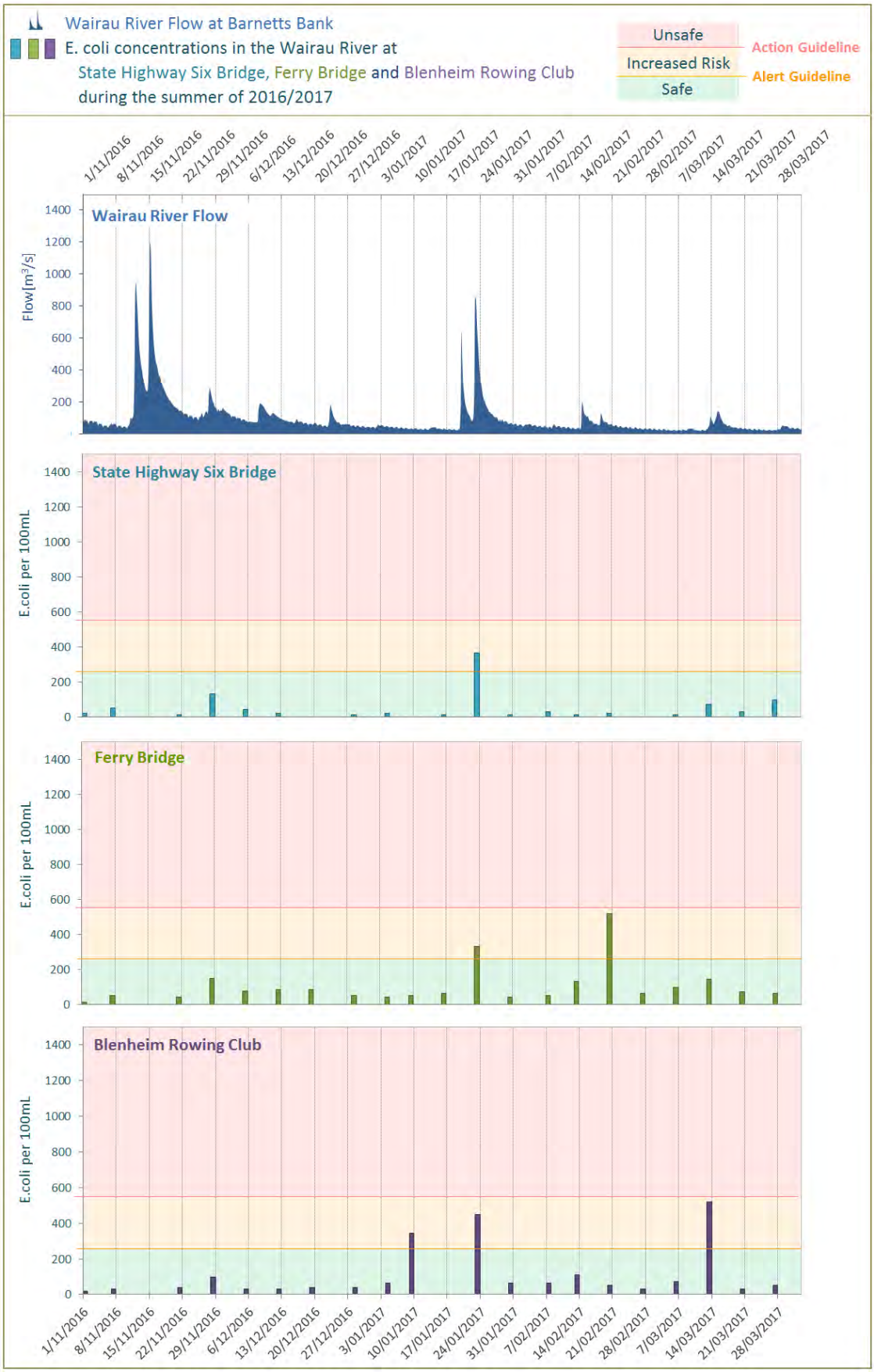


Figure 29: E. coli concentrations at the three Wairau River monitoring sites during the 2016/17 summer season.

In recent years bacterial water quality has been generally better at the Blenheim Rowing Club, compared to the other two Wairau River sites further upstream. This was reflected in a better SFR Grade for the Blenheim Rowing Club. The long term trend, however, shows a slow increase in E. coli concentrations at this site and levels are now similar to those observed at the Ferry Bridge. Should the upward trend persist, an investigation into the possible sources should be carried out. All three Wairau River sites now have the same SFR Grade of 'Fair'.

During the recent recreational site usage survey, no swimmers were recorded at two large swimming holes downstream of the State Highway Six Bridge[4]. Of the two other Wairau River sites, Ferry Bridge was the most popular, with 33 swimmers. At the Blenheim Rowing Club 22 persons were swimming during the four hour survey. As a consequence of the survey results, regular monitoring of recreational water quality at State Highway Six will not be continued.

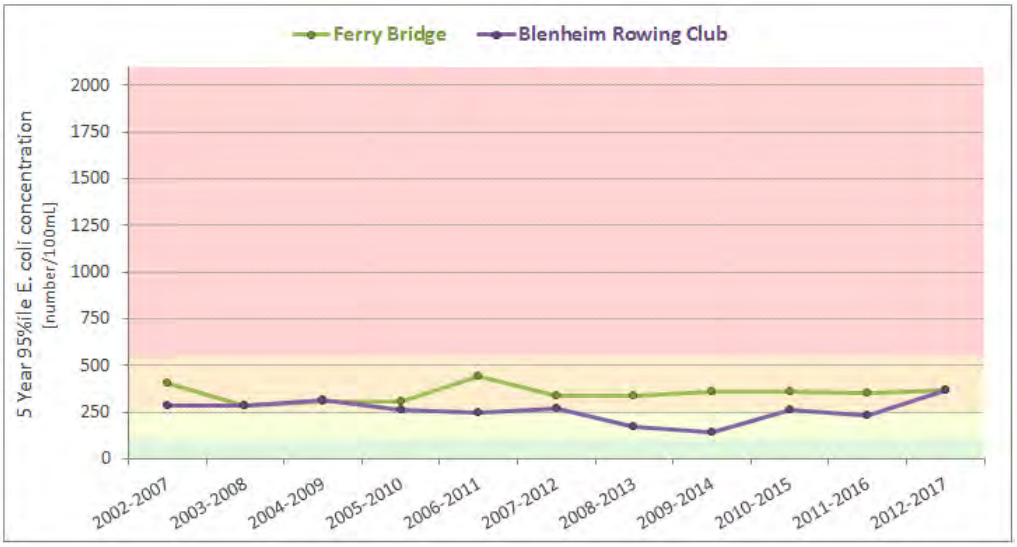


Figure 30: The 5-year 95%ile E.coli concentrations in the Wairau River at Ferry Bridge and the Blenheim Rowing Club.

[4] The Wairau Rowing Club was also monitored during this survey and no swimmers were entering the water at this site also.

5.10. Taylor River and Ōpaoa River

Sites

The Taylor River at Riverside is one of the popular features of the Blenheim town centre with a small amphitheatre-type area providing a shaded resting place with a view of the Taylor River. It is also a popular spot to feed ducks and an access point to the Riverside Park with walkways along and across the Taylor River.

The Ōpaoa River at Elizabeth St Bridge is sampled as a representative site for primarily private access of the river from the many properties located along its banks, but public access is possible in a number of areas and both the Ōpaoa and Taylor River are popular for relaxing kayaking trips.

Both sampling sites are located in Blenheim and are therefore heavily influenced by their urban environment. Although both rivers also flow through rural areas, the agricultural land use in the catchment appears to have limited impact on the recreational water quality at the sites.

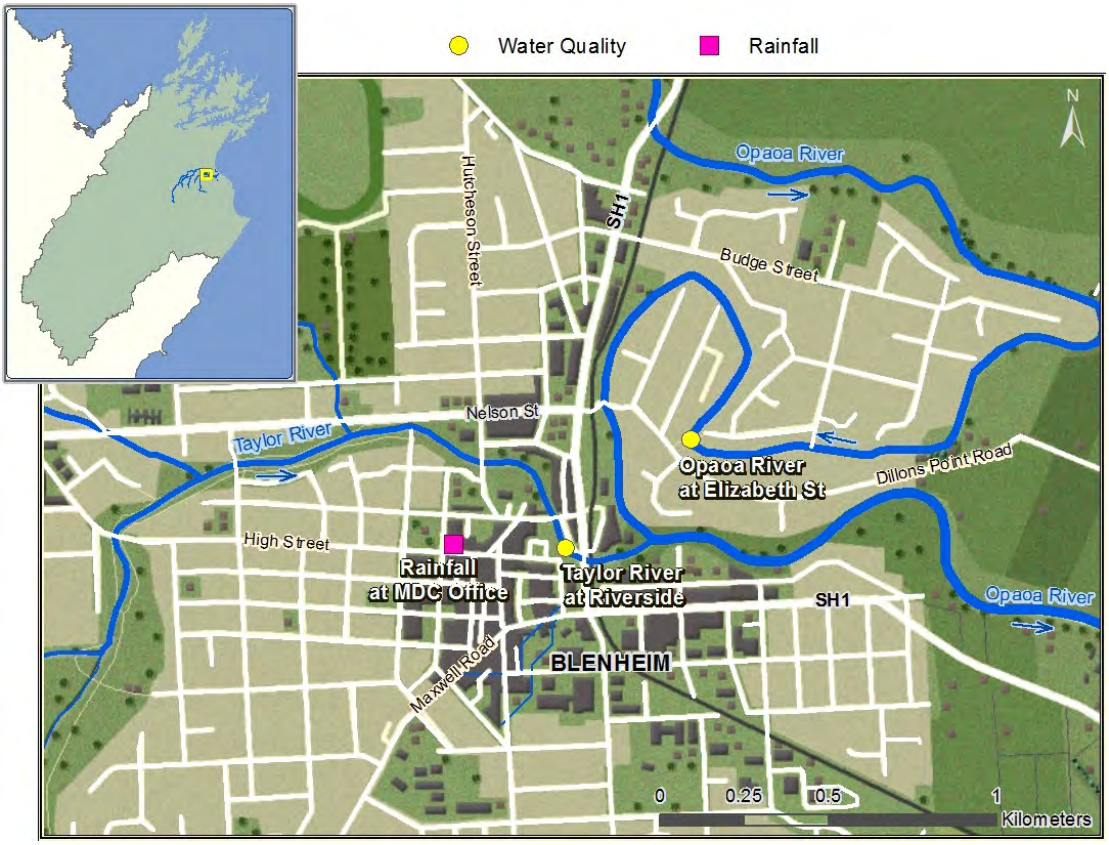


Figure 31: Location of the Taylor River and Ōpaoa River sampling sites as well as the Blenheim MDC rainfall recorder.

Results

As in previous summers, E. coli concentrations in the Taylor River reached unsafe levels during rainfall events as well as low flow conditions. The sample with the highest E. coli level was taken during rainfall on 13 February, but three samples with unsafe E. coli levels taken earlier in the season were not associated with rainfall. Bacteria concentrations in these samples were similar to those observed during low flow conditions in the previous season.

A MDC stormwater quality report [12] released in May last year revealed that occasionally high numbers of E. coli were discharged into the Taylor River from some of the stormwater pipes during dry weather conditions, indicating potential sewage contamination in some of the pipes. As a result, testing and extensive repair work was carried out on parts of the effected stormwater and sewerage network.

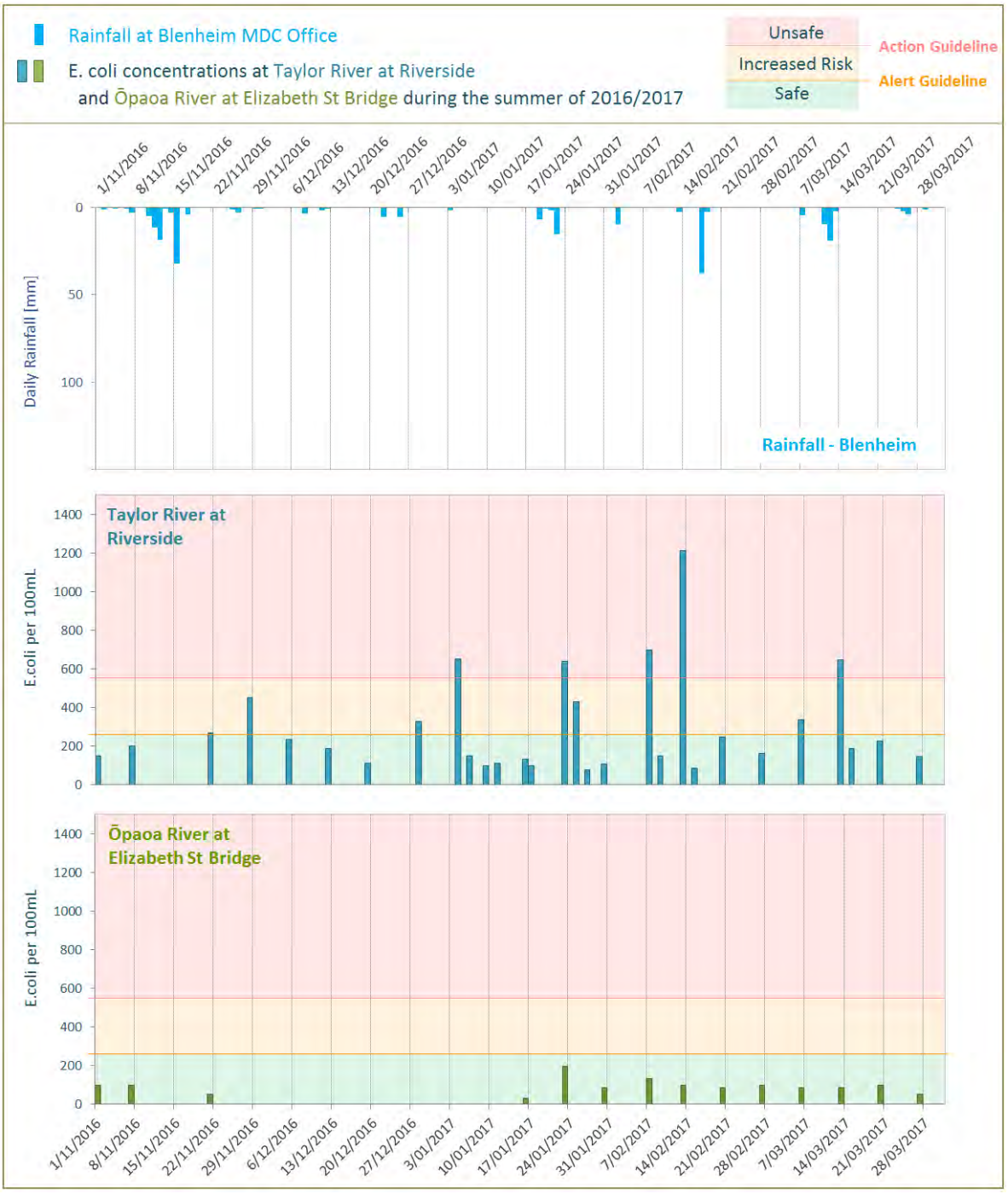


Figure 32: E. coli concentrations in the Taylor River at Riverside and the Opaoa River at Elizabeth St Bridge during the 2016/17 summer season.

Following the Kaikoura earthquake new damage was suspected and a survey of the network revealed extensive damage to the older earthenware pipes. Moreover, the earthenware pipes are reaching the end of their lifespan. Therefore, rather than replacing damaged pipes only, it was decided to replace all earthenware pipes with PVC pipes. PVC pipes are less likely to be damaged in earthquakes. Due to the large extent of the network needing replacement, the work will take a number of years. Until the replacement is complete, stormwater outlets will be sampled on a regular basis to identify areas where cross-contamination into the stormwater system is having a significant impact on the water quality of the Taylor River.

This summer already a number of stormwater discharges into the lower Taylor River were sampled several times. The sampling showed high E. coli concentrations in at least one of the samples from all stormwater outlets. However, it is important to note that the stormwater network services a very large area and rare spikes in E. coli concentrations are likely the result of individual actions rather than a sign of contamination of stormwater with sewage. For example, bird and other animal faeces are washed into the stormwater system when driveways, roofs and other hard surfaces are cleaned.

However, the discharge of one of the stormwater outlets located near the Riverside sampling site was contaminated with high concentrations of E. coli on a regular basis. This part of the stormwater and sewerage network is currently being inspected and repaired.

The long-term trend for the Taylor River shows the first improvements since E. coli concentrations reached very high levels in 2012. This is likely the results of recent repairs to the stormwater and sewerage network by the Assets and Services department. However, further improvements are necessary to change the current SFR Grade of 'Very Poor'. The Taylor River at Riverside is the only site with this grade, which is the lowest in the grading system.

E. coli concentrations in the Opaoa River this summer were at similar levels as observed in previous seasons. During the Kaikoura earthquake the Elizabeth St Bridge was damaged and the area around the site was cordoned off as a precautionary measure until mid-January. Therefore, no samples were taken during this time period, but it is unlikely that results were significantly different to those observed later in the season.

The Opaoa River at Elizabeth St Bridge has a SFR Grade of 'Fair' and there has been very little change of bacterial water quality in recent years. Due to the access difficulties following the earthquake this site could not be included in the site usage survey this summer. However, there were very few swimmers at the Malthouse Reserve downstream. Anecdotal evidence suggests that the usage of the Elizabeth St site is similarly low. It was decided that the low usage does not justify regular monitoring at this site. Considering the very consistent bacterial water quality over the last decade, the risk to swimmers in the Opaoa River can be considered minimal as long as the general advice of waiting for at least two days after rainfall is adhered to. . However, monitoring of the Opaoa River will not cease altogether. The river will continue be monitored at two sites on a monthly bases as part of the State of the Environment program.

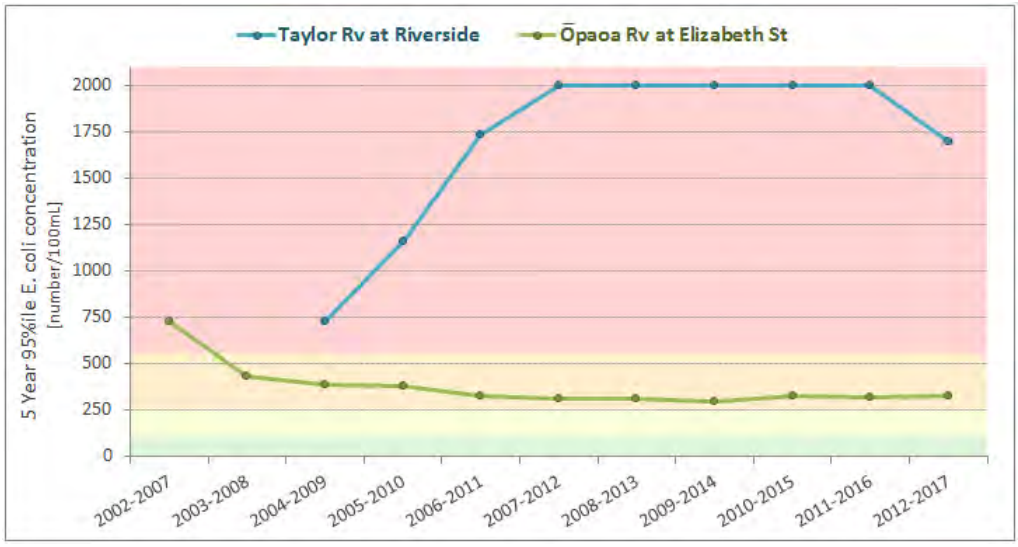


Figure 33: The 5-year 95%ile E.coli concentrations in the Taylor River at Riverside and the Opaoa River at Elizabeth St.

5.11. The National Policy Statement for Freshwater Management (NPS-FM)

In 2014 a new NPS-FM was released. This document introduced value bands for a number of parameters that are used to represent the state of water quality in rivers and lakes. The Bands usually range from A, which represent best water quality to D, which is referred to as the 'National Bottom Lines'. Water quality within the D band is considered unacceptable and measures need to be taken to improve water quality. One of the parameters for which the NPS-FM provides value bands is the concentration of E. coli. The statistic used to calculate the E. coli state for waterways managed for swimming is the 95th percentile (Table 5).

Current NPS-FM (2014)

Attribube State (Band)	95th Percentile [E.coli/100mL]	Narrative Attribute State
A	≤ 260	People are exposed to a low risk of infection (up to 1% risk)
B	> 260 and ≤ 540	People are exposed to a moderate risk of infection (less 5% risk)
D	> 540	Unacceptable state

Note: There is no C state for swimmability

Table 5: The E. coli states as defined by the NPS-FM 2014.

Objectives from the NPS-FM were integrated into the proposed Marlborough Environment Plan (pMEP) and the E. coli swimming limits of the NPS-FM are represented in Objective 15.1e of the pMEP. This objective requires that in waterbodies valued for swimming, the 95th percentile should not exceed 540 E.coli/100mL. This is equivalent to the A or B state of the NPS-FM.

A companion guide document for the NPS-FM recommends a minimum of 30 samples over three years for the calculation of the E. coli state.

In February 2017 the Government published a consultation document titled "Clean Water" outlining proposed changes to the NPS-FM. The "Clean Water" document introduced a change in the calculation of the E. coli state for water ways. Instead of the one 95th percentile statistic only, the calculation of three additional statistics is required to assign a band (Table 6). Additionally, it is proposed that all larger rivers are managed for "swimmability", not only the waterbodies known to be valued for swimming. The new document also introduces an additional band and does not specify a national bottom line for the E. coli state. However, it is stated that bands A to C represent acceptable water quality, while waterways with E. coli concentrations in the D or E band are required to be improved where possible.

Proposed Changes to the NPS-FM (2017)

Attribube State (Band)	I Percentage of samples above 540 E.coli/100mL	II Median [E. coli/100mL]	III 95th Percentile [E. coli/100mL]	IV Percentage of samples above 260 E.coli/100mL	Narrative Attribute State
A (Excellent)	< 5%	≤ 130	≤ 540	< 20%	Safe to swim except following flood events
B (Good)	5% - 10%	≤ 130	≤ 1000	20% - 30%	Safe to swim except following heavy rain
C (Fair)	10% - 20%	≤ 130	≤ 1200	20% - 34%	Safe to swim in normal conditions
D (Intermittent)	20% - 30%	> 130	> 1200	> 34%	Not safe to swim
E (Poor)	> 30%	> 260	> 1200	> 50%	Not safe to swim

Table 6: The E. coli states as defined by the proposed changes to the NPS-FM.

Table 7 shows a comparison of the SFR Grades and the E. coli states bases on the current NPS-FM as well as the proposed changes to the NPS-FM for all river sites currently monitored as part of the Recreational Water Quality Program. There are significant differences in the gradings based on these three different approaches. Apart from the results for the Opaoa River, the SFR Grades are more stringent than the NPS-FM bands calculations. Under the proposed changes to the NPS-FM the Opaoa River would not be considered "swimmable" due to the consistently elevated E. coli concentrations observed at the site, making the median the deciding statistic. Although, background E. coli levels are generally elevated, they very rarely reach unsafe levels. Of the 99 samples taken during the five summer seasons, only one sample had E. coli concentrations considered to be unsafe for swimmers.

Site	SFR Grade	2014 NPS-FM	2017 Proposed NPS-FM				
			I	II	III	IV	Overall
Pelorus Rv at Pelorus Bridge	Good	A	A	A-C	A	A	A
Wairau Rv at State Highway Six	Fair	A	insufficiant data				
Wairau Rv at Blenheim Rowing Club	Fair	A	A	A-C	A	A	A
Wairau Rv at Ferry Bridge	Fair	B	A	A-C	A	A	A
Pelorus Rv at Totara Flat	Fair	B	A	A-C	A	A	A
Opaoa Rv at Elizabeth St	Fair	B	A	D	A	A	D
Waihopai Rv at Craighlochart #2	Poor	B	B	A-C	B	A	B
Rai Rv at Rai Falls	Poor	D	C	A-C	B	A	C
Taylor Rv at Riverside	Very Poor	D	C	D	C-D	D	D

Table 7: The state of the currently monitored river sites according the SFR Grading, the 2014 NPS-FM and the proposed changes to the NPS-FM.

The Waihopai River at Craiglochart #2, which has a current SFR Grade of "Poor" has a E. coli state in the B band for both the current NPS-FM and under the proposed changes. However, it needs to be noted that the site had a SFR Grade of "Fair" in recent years.

The Rai River at Rai Fall is another site with a SFR Grade of "Poor". While the current NPS-FM puts it into the D band and therefore below the national bottom line, the proposed changes will grade it as "swimmable" with an E. coli state in the C band.

Overall, the proposed changes to the NPS-FM will result in a greater discrepancy between E. coli states and SFR Grades than the current NPS-FM.

6. Summary and Discussion

Of the coastal sites monitored as part of the program, only Robin Hood Bay – East and Moetapu Bay had Enterococci concentrations above safe levels during the summer season 2016/2017. The high bacteria numbers at Robin Hood Bay were a result of gorse that was washed into the bay and deposited on the beach during a storm event that caused significant flooding in the catchment. Enterococci number increased over time indicating that the bacteria were multiplying within the gorse material. Although, research has shown that Enterococci bacteria can multiply in the environment, the very high bacteria numbers observed at Robin Hood Bay mark a rare case. This was likely a result of the relatively dense organic material which was kept moist by a small stream flowing across the beach. Once most of the gorse was removed from the beach, Enterococci concentrations decreased. However, due to the high Enterococci concentrations observed this summer, the SFR Grade for the site has deteriorated from an interim grade of “Very Good” to a grade of “Fair”. This grade will likely stay the same for the next years even if Enterococci counts are low in the following summer seasons, because the calculation includes the data from the previous four summers.

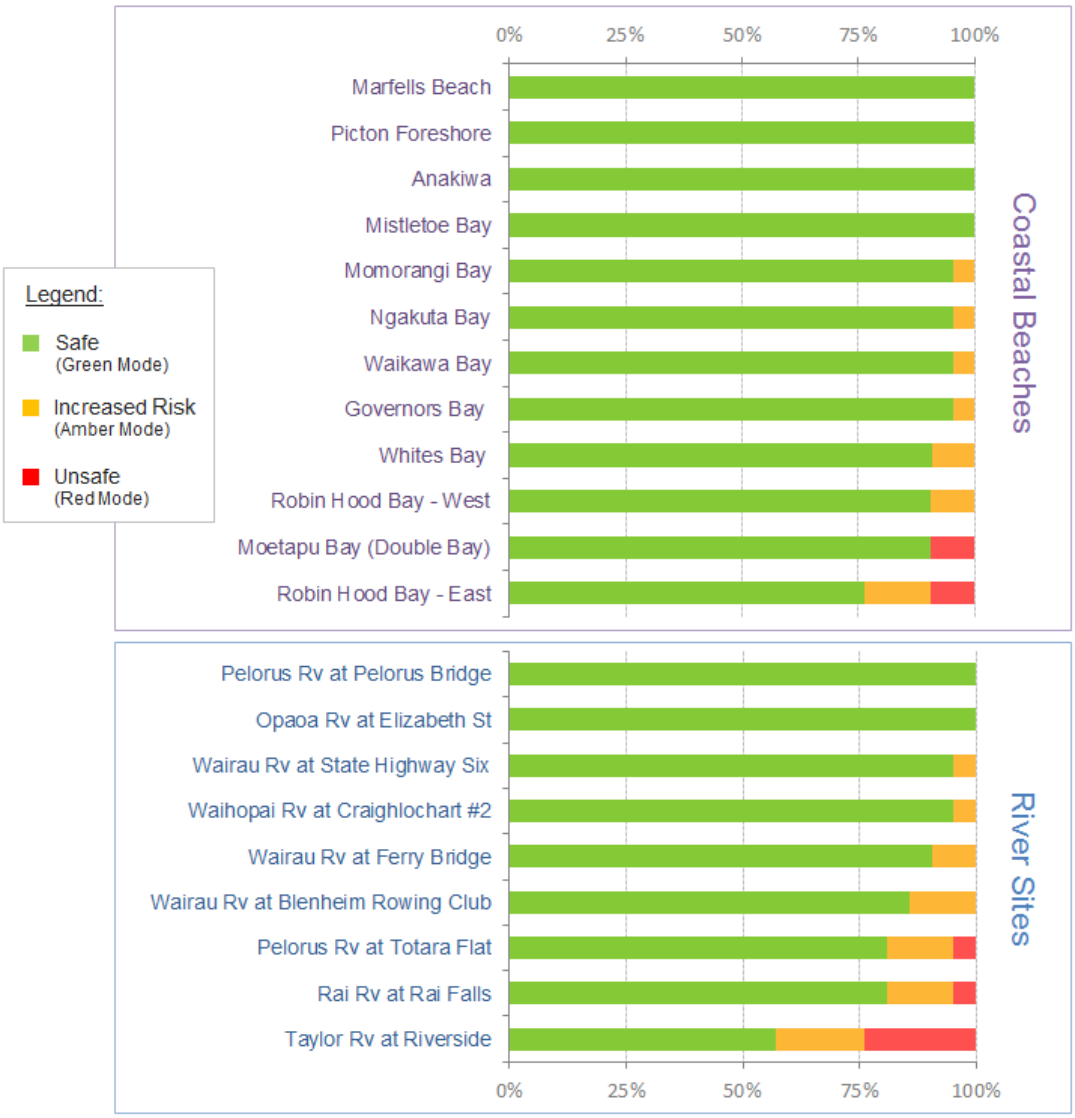


Figure 34: Percentage of routine samples within the different Modes for all sites sample during the 2016/17 summers season.

A similar phenomenon was observed at Moetapu Bay – Double Bay Reserve. Enterococci concentrations in this bay are generally highest during high tide. In the previous summer season bacteria concentration remained high for weeks after a flood event in the Te Hoiere/Pelorus River resulted in the deposition of fine sediment on the beach. This summer season again, Enterococci

concentrations were elevated during high tide, but it had been more than a month since the latest floods in the Te Hoiere/Pelorus River. Generally, there is a large amount of organic material such as drift wood, but most notably relatively small pieces such as leaves and twigs deposited in a thin layer at the upper high tide mark, together with the fine sediment deposits from the river floods. As at Robin Hood Bay – East, a small stream is flowing across the beach further improving conditions for bacterial growth. This means that Enterococci are possibly multiplying at the Moetapu Bay – Double Bay Reserve as well, although to a lesser extent.

Four coastal beaches had Enterococci concentrations below guideline level for the entire summer season. These include Mistletoe Bay. In recent years high faecal bacteria concentrations were regularly observed following relatively small rainfall events at this bay. Investigations had identified an old septic tank as the potential source and the tank was subsequently removed. The low Enterococci concentrations observed this summer indicate that this was indeed the source of contamination.

Whites Bay is one of six sites with at least one sample above the Alert Guideline, indicating an increased health risk. Two samples from this bay exceeded the Alert Guideline and although rainfall is the likely cause, such exceedances are unusual for this site with a SFR Grade of “Very Good”. A site usage survey, carried out in January 2017 showed that Whites Bay was the most popular beach of all sites surveyed. Therefore, should the elevated Enterococci concentrations observed this summer signal a change in recreational water quality, a large number of swimmers would be affected. This would results in a significant increase of the risk to public health. Thus, should similar exceedances occur next summer season, an investigation into the causes need to be carried out.

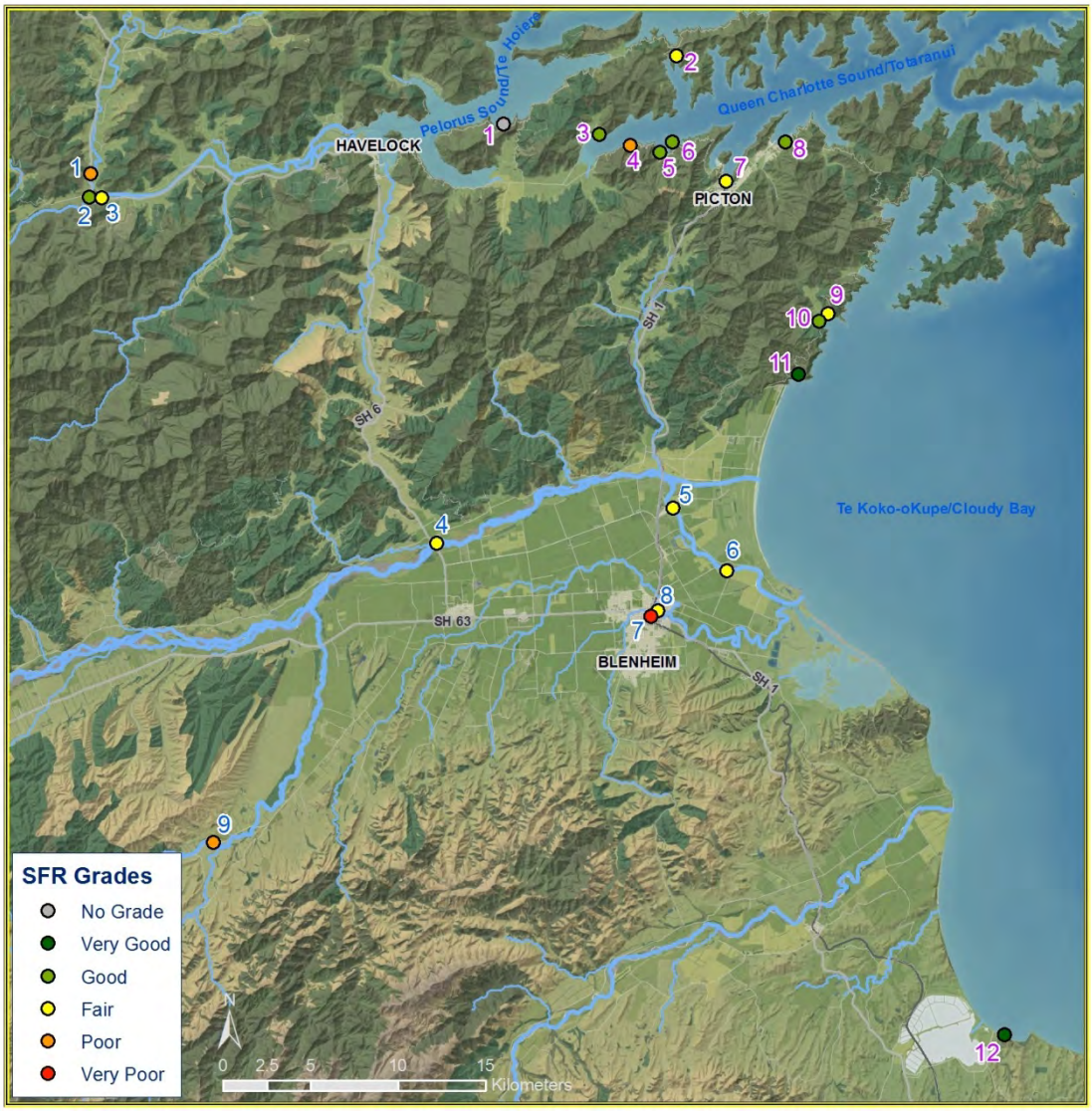
The Taylor River at Riverside had again the worst recreational water quality of all sites monitored as part of the program and is the only site with a SFR Grade of “Very Poor”. The lower Taylor River is an urban waterway and national monitoring of waterways has shown that E. coli concentrations are generally highest in waterways flowing through urban areas [Our Freshwater 2017]. Nevertheless, the long-term trend for the Taylor River shows some improvements. Although the frequency of guideline exceedances has not changed dramatically, the magnitude of the exceedances has decreased significantly. The lower E. coli numbers are likely a result of recent efforts to repair damaged stormwater and sewerage systems, resulting in a reduced contamination of stormwater. Although the Kaikoura Earthquake in January this year caused further damage to the network, it sparked the decision to replace all earthware pipe with more resistant PVC pipes which should result in a reduction of sewage contamination of stormwater and subsequently the Taylor River.

Flooding in the Rai River catchment early in the summer season resulted in the only samples with unsafe E. coli concentrations, taken at the Rai Falls and Totara Flat. However, there were no samples taken in the week following the Kaikoura Earthquake. A large flood event during that week would have resulted in samples with unsafe levels of faecal bacteria for a number of sites.

E. coli concentrations in the Wairau River were generally below unsafe levels, but three of the samples taken from the Blenheim Rowing Club had E. coli levels above the Alert Guideline. Surprisingly, only one of these samples coincided with exceedances at the other two Wairau River sites. In recent years, recreational water quality at the Blenheim Rowing Club had generally been better than at the other two sites, but the results from this summer indicate that this might not be the case anymore. This is reflected in a change of the SFR Grade for the Blenheim Rowing Club site from “Good” to “Fair”. All three Wairau River swimming sites now have a SFR Grade of “Fair”.

Overall, the majority of sites currently monitored as part of the Recreational Water Quality program have a SFR Grade of “Fair”, with the second highest number of sites grades as “Good” or “Very Good” and only a few sites with SFR Grades of “Poor” or “Very Poor” (Figure 35).

The grading of the recently introduces National Policy Statement for Freshwater Management (NPS-FM) presents a different grading system classifying rivers in bands ranging from A to D, with D representing unacceptable water quality. There is currently no NPS for coastal beaches. Proposed changes to the NPS-FM introduced this year add an additional E band and propose the use of different statics to calculate the state within the bands. Overall, the NPS-FM grading system appears to be more lenient when compared to the SFR Grades. Most river sites monitored are within the A or B Band.



Type	No.	Site	Easting	Northing	SIC (Sanitary Inspection Category)	MAC (Microbiological Assessment	SFR Grade (Suitability for Contact Recreation Grade)
Coastal Sites	1	Moetapu Bay	1671600	5432100	insufficiant data		
	2	Mistletoe Bay	1681470	5436007	Moderate	C	Fair
	3	Anakiwa	1677073	5431495	Moderate	B	Good
	4	Momorangi Bay	1678817	5430879	Moderate	D	Poor
	5	Ngakuta Bay	1680514	5430489	Low	B	Good
	6	Governors Bay**	1681310	5431030	Low	B	Good
	7	Picton Foreshore	1684298	5428815	Moderate	C	Fair
	8	Waikawa Bay	1687695	5431090	Low	B	Good
	9	Waikutakuta/Robin Hood Bay East*	1690115	5421285	Low	B	Fair
	10	Waikutakuta/Robin Hood Bay West*	1689595	5420930	Low	C	Good
	11	Pukatea/Whites Bay	1688425	5417793	Very Low	A	Very Good
	12	Marfells Beach	1700194	5380089	Very Low	A	Very Good
River Sites	1	Rai Rv at Rai Falls	1648018	5429266	Moderate	D	Poor
	2	Te Hoiere/Pelorus Rv at Pelorus Bridge	1648077	5428091	Low	B	Good
	3	Te Hoiere/Pelorus Rv at Totara Flat	1648262	5427731	Moderate	C	Fair
	4	Wairau Rv at State Highway Six*	1667780	5408150	Moderate	C	Fair
	5	Wairau Rv at Ferry Bridge	1681274	5410163	Moderate	C	Fair
	6	Wairau Rv at Blenheim Rowing Club	1684319	5406605	Moderate	C	Fair
	7	Taylor River at Riverside	1680023	5403987	High	D	Very Poor
	8	Ōpaoa River at Elizabeth St Bridge	1680393	5404310	Moderate	C	Fair
	9	Waihopai River at Craiglochart #2	1655029	5391098	Moderate	D	Poor

Figure 35: SFR Grades for the sites currently monitored.

7. References

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8. Appendices

8.1. Appendix 1: Results for the 2016/2017 summer season

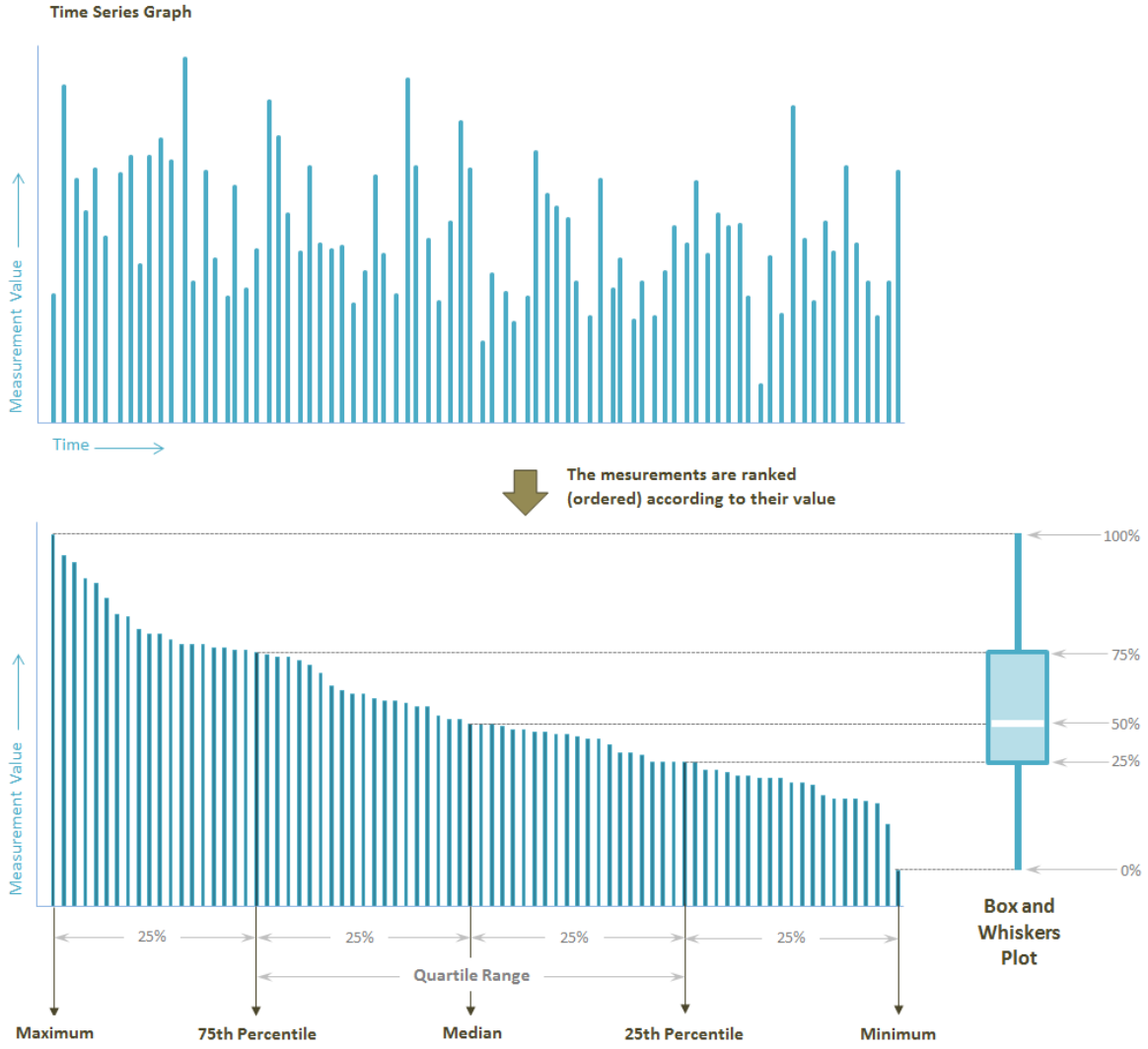
Results are Enterococci concentrations for coastal sites and E. coli concentrations for river sites, both in MPN/100mL

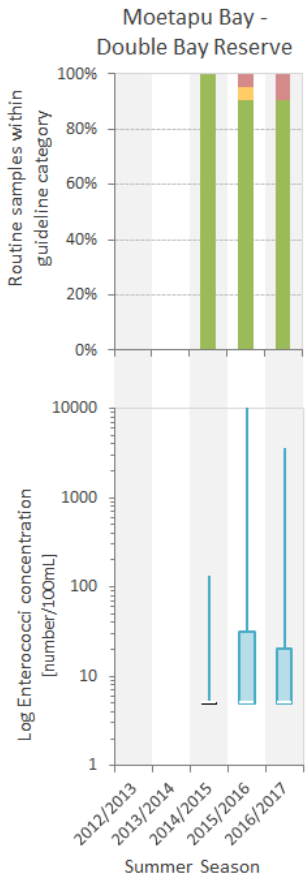
Site Type	Week	Sample Dates	Anakiwa	Mistletoe Bay	Moetapu - Doubel Bay	Momorangi Bay	Ngakuta Bay	Governors Bay	Picton Foreshore	Waikawa Bay	Pukatea/ Whites Bay	Waikutakuta/ Robin Hood Bay East	Waikutakuta/ Robin Hood Bay West	Marfells Beach
Coastal	1	01/02 Nov 2016	10	121	<10	52	52	<10	20	10	<10	<10	<10	<10
	2	07/08 Nov 2016	<10	<10	<10	<10	<10	<10	31	<10	10	216	20	<10
	3	21/22 Nov 2015	20	<10	10	<10	<10	10		<10	<10	<10	<10	<10
	Follow-up	23 Nov 2016							41					
	4	28/29 Nov 2015	<10	<10	31	<10	121	<10	<10	<10	20	10	10	<10
	5	05/06 Dec 2016	20	<10	<10	<10	<10	<10	41	<10	<10	<10	158	<10
	6	12/13 Dec 2016	<10	20	122	<10	173	<10	<10	<10	<10	<10	144	<10
	7	19/20 Dec 2016	30	20	<10	<10	10	40	10	<10	<10	<10	10	<10
	8	28/29 Dec 2016	63	20	20	<10	20	20	10	<10	<10	<10	<10	<10
	9	04/05 Jan 2017	<10	<10	<10	<10	<10	<10	<10	<10	10	20	<10	74
	10	09/10 Jan 2017	<10	<10	10	<10	<10	<10	<10	<10	10	10	20	<10
	11	16/17 Jan 2017	20	10	<10	10	74	<10	<10	160	<10	<10	<10	<10
	12	23/24 Jan 2017	<10	<10	31	10	10	<10	<10	<10	108	73	62	<10
	13	30/31 Jan 2017	<10	10	<10	10	<10	10	52	<10	<10	<10	<10	<10
	14	07/08 Feb 2017	<10	<10	<10	<10	<10	41	20	<10	<10	<10	<10	10
	15	13/14 Feb 2017	<10	<10	<10	10	10	10	<10	52	158	<10	40	41
	16	20/21 Feb 2017	<10	<10	<10	<10	<10	<10	10	<10	10	1274	20	<10
	17	27/28 Feb 2017	10	<10	340	160	10	85	20	<10	<10	<10	<10	10
	Follow-up	02 Mar 2017			41	41								
	18	06/07 Mar 2017	<10	<10	<10	10	<10	146	30	<10	<10	3260	41	10
	Follow-up	08 Mar 2017										24200		
	Follow-up	10 Mar 2017										20		
	19	13/14 Mar 2017	<10	<10	<10	31	<10	109	74	<10	185	253	109	<10
	20	20/21 Mar 2017	<10	<10	<10	10	10	<10	20	<10	<10	243	20	<10
	21	27/28 Mar 2017	20	<10	3650	<10	<10	10	31	10	<10	10	20	<10
	Follow-up	30 Mar 2017			<10									

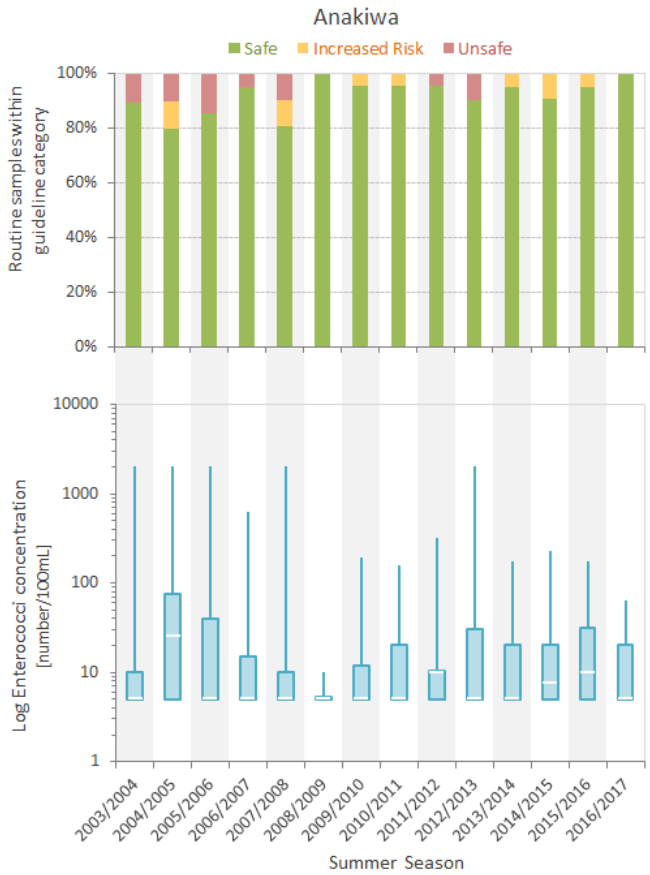
Site Type	Week	Sample Date	Rai Falls	Pelorus Rv at Pelorus Bridge	Pelorus Rv at Totara Flat	Waihopai Rv at Craiglochart #2	Wairau Rv at State Highway Six	Wairau Rv at Ferry Bridge	Wairau Rv at Blenheim Rowing Club	Taylor Rv at Riverside	Opaoa Rv at Elizabeth St
River	1	01/02 Nov 2016	1,670	20	594	20	20	10	20	148	97
	Follow-up	4 Nov 2016	98		74						
	2	07/08 Nov 2016	340	<10	146	41	52	52	30	201	97
	3	21/22 Nov 2015	441	10	122	85	10	41	41	269	52
	4	28/29 Nov 2015	63	20	86	160	132	146	98	450	
	5	05/06 Dec 2016	52	<10	<10	85	41	74	30	233	
	6	12/13 Dec 2016	52	10	63	20	20	85	31	187	
	7	19/20 Dec 2016	63	<10	31	213	<10	85	41	109	
	8	28/29 Dec 2016	145	20	10	41	10	52	41	327	
	9	04/05 Jan 2017	73	20	41	51	20	41	63	650	
	Follow-up	6 Jan 2017								146	
	10	09/10 Jan 2017	63	<10	20	20	<10	52	345	97	
	Follow-up	11 Jan 2017								109	
	11	16/17 Jan 2017	41	10	31	63	10	63	<10	130	31
	12	23/24 Jan 2017	161	41	160	457	364	331	450	638	197
	Follow-up	25 Jan 2017								428	
	Follow-up	27 Jan 2017								74	
	13	30/31 Jan 2017	86	10	63	20	10	40	63	107	85
	14	07/08 Feb 2017	158	20	52	134	30	52	63	697	134
	Follow-up	09 Feb 2017								148	
	15	13/14 Feb 2017	108	10	41	85	10	132	110	1,211	97
	Follow-up	15 Feb 2017								85	
	16	20/21 Feb 2017	98	<10	20	52	20	520	52	246	86
	17	27/28 Feb 2017	30	10	<10	63	<10	63	31	160	96
	18	06/07 Mar 2017	41	20	20	74	10	95	73	336	85
	19	13/14 Mar 2017	379	74	74	175	73	145	521	645	84
	Follow-up	30 Mar 2017								187	
	20	20/21 Mar 2017	52	<10	<10	63	31	73	31	223	98
	21	27/28 Mar 2017	197	52	31	185	97	63	52	145	52

8.2. Appendix 2: Levels of compliance and Box and Whiskers plots

The Plots were created from the results of the routine sampling only. The first figure shows how Box and Whiskers Plots are created. Note that concentrations in the Box and Whiskers Plots for the actual sample results are on a logarithmic scale and only sites with a minimum of 4 years of record are shown.




Moetapu Bay -
Double Bay Reserve
Routine samples within guideline category
100%
80%
60%
40%
20%
0%
Log Enterococci concentration [number/100mL]
10000
1000
100
10
1
2012/2013
2013/2014
2014/2015
2015/2016
2016/2017
Summer Season


Anakiwa
Safe
Increased Risk
Unsafe
Routine samples within guideline category
100%
80%
60%
40%
20%
0%
Log Enterococci concentration [number/100mL]
10000
1000
100
10
1
2003/2004
2004/2005
2005/2006
2006/2007
2007/2008
2008/2009
2009/2010
2010/2011
2011/2012
2012/2013
2013/2014
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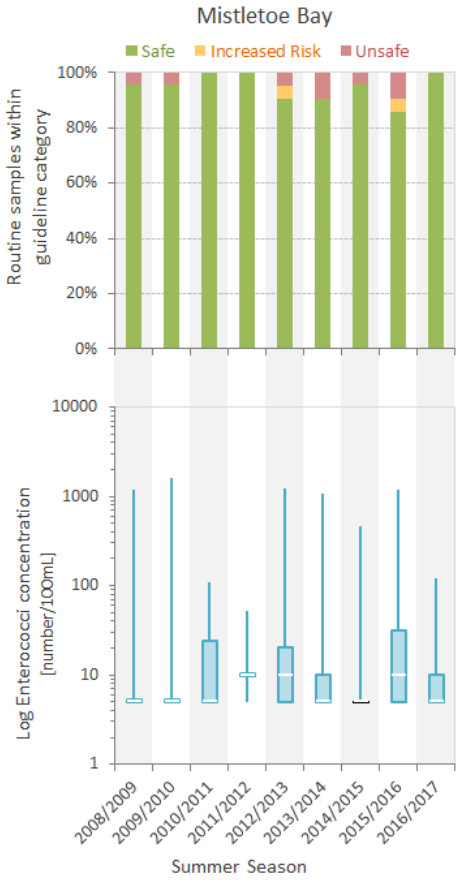
2015/2016
2016/2017
Summer Season


Mistletoe Bay
Safe
Increased Risk
Unsafe
Routine samples within guideline category
100%
80%
60%
40%
20%
0%
Log Enterococci concentration [number/100mL]
10000
1000
100
10
1
2008/2009
2009/2010
2010/2011
2011/2012
2012/2013
2013/2014
2014/2015
2015/2016
2016/2017
Summer Season


Momorangi Bay
Safe
Increased Risk
Unsafe
Routine samples within guideline category
100%
80%
60%
40%
20%
0%
Log Enterococci concentration [number/100mL]
10000
1000
100
10
1
2003/2004
2004/2005
2005/2006
2006/2007
2007/2008
2008/2009
2009/2010
2010/2011
2011/2012
2012/2013
2013/2014
2014/2015
2015/2016
2016/2017
Summer Season


Ngakuta Bay
Safe
Increased Risk
Unsafe
Routine samples within guideline category
100%
80%
60%
40%
20%
0%
Log Enterococci concentration [number/100mL]
10000
1000
100
10
1
2003/2004
2004/2005
2005/2006
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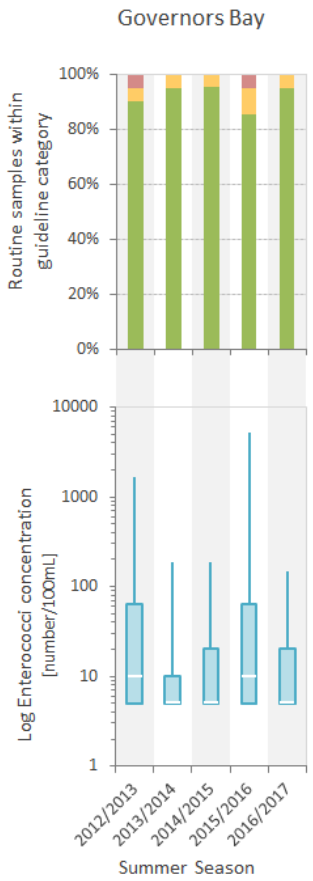
2012/2013
2013/2014
2014/2015
2015/2016
2016/2017
Summer Season


Governors Bay
Routine samples within guideline category
100%
80%
60%
40%
20%
0%
Log Enterococci concentration [number/100mL]
10000
1000
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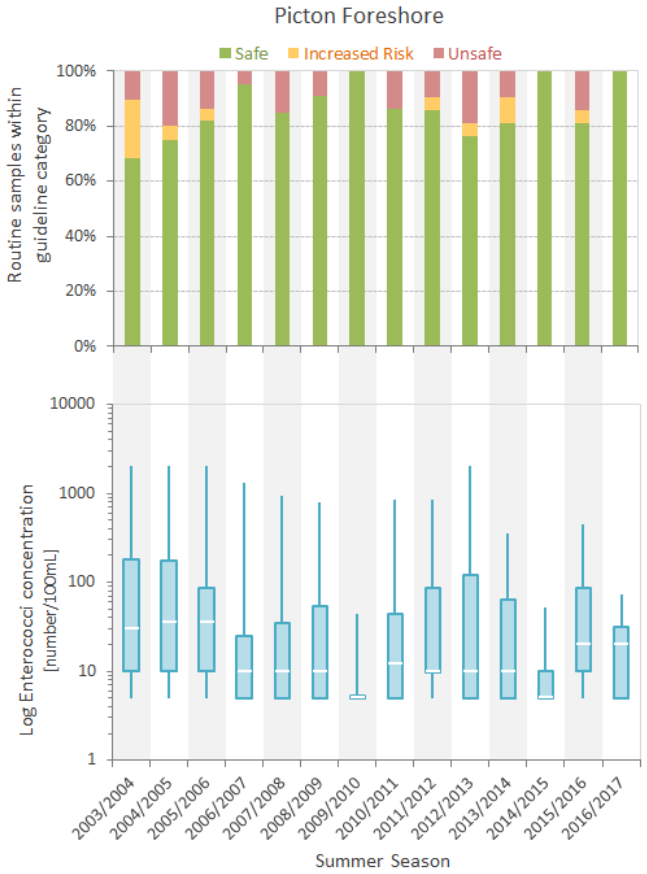
2012/2013
2013/2014
2014/2015
2015/2016
2016/2017
Summer Season


Picton Foreshore
Safe
Increased Risk
Unsafe
Routine samples within guideline category
100%
80%
60%
40%
20%
0%
Log Enterococci concentration [number/100mL]
10000
1000
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10
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2003/2004
2004/2005
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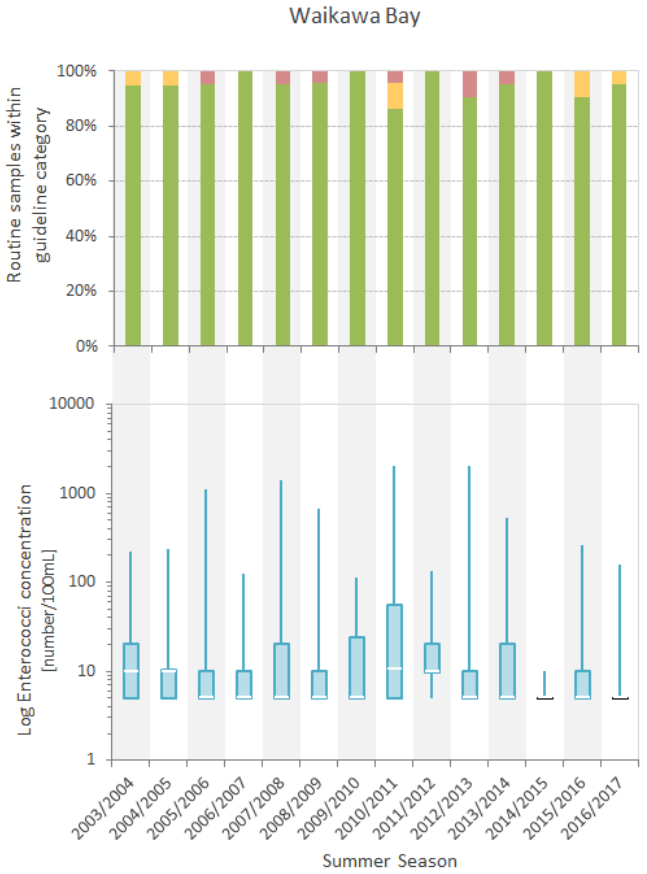
2014/2015
2015/2016
2016/2017
Summer Season


Waikawa Bay
Routine samples within guideline category
100%
80%
60%
40%
20%
0%
Log Enterococci concentration [number/100mL]
10000
1000
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10
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2003/2004
2004/2005
2005/2006
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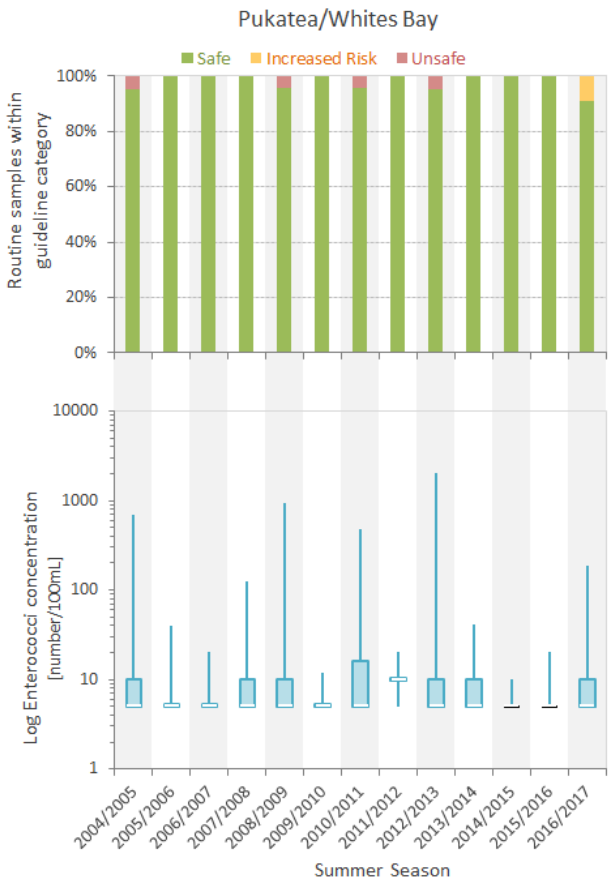
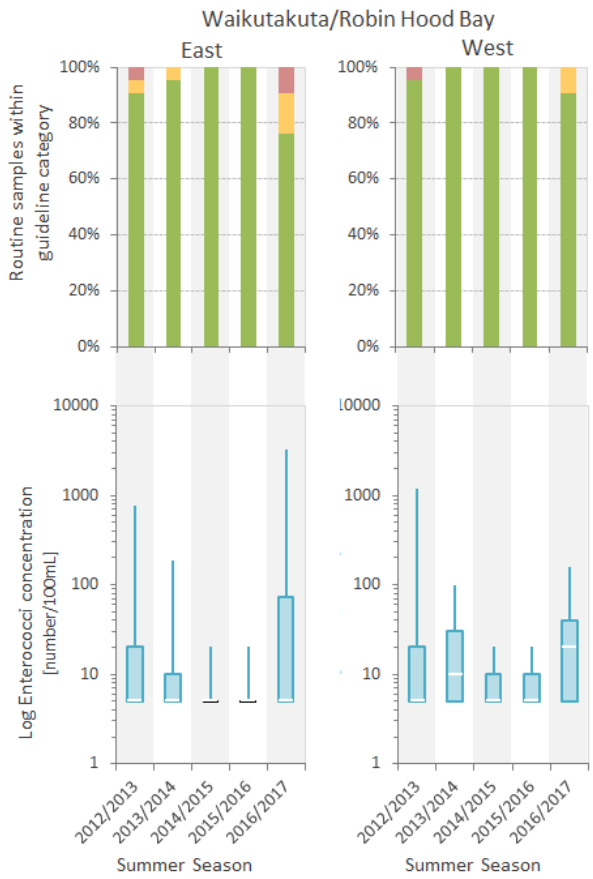
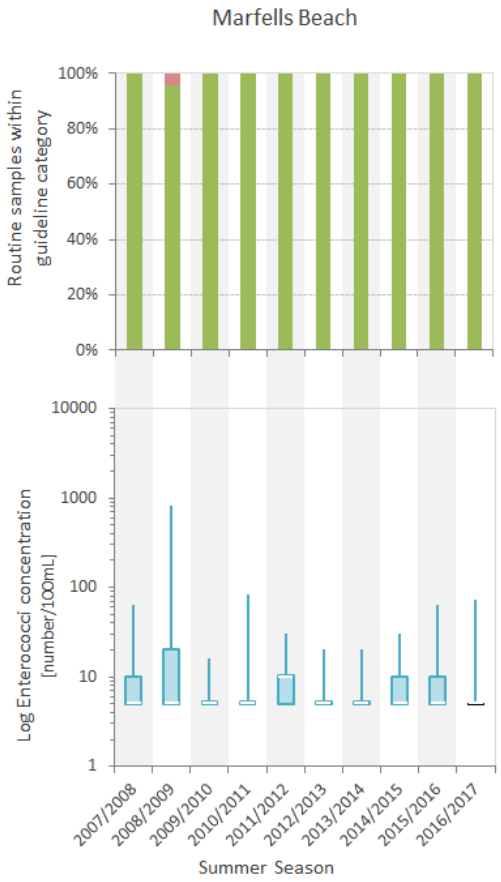
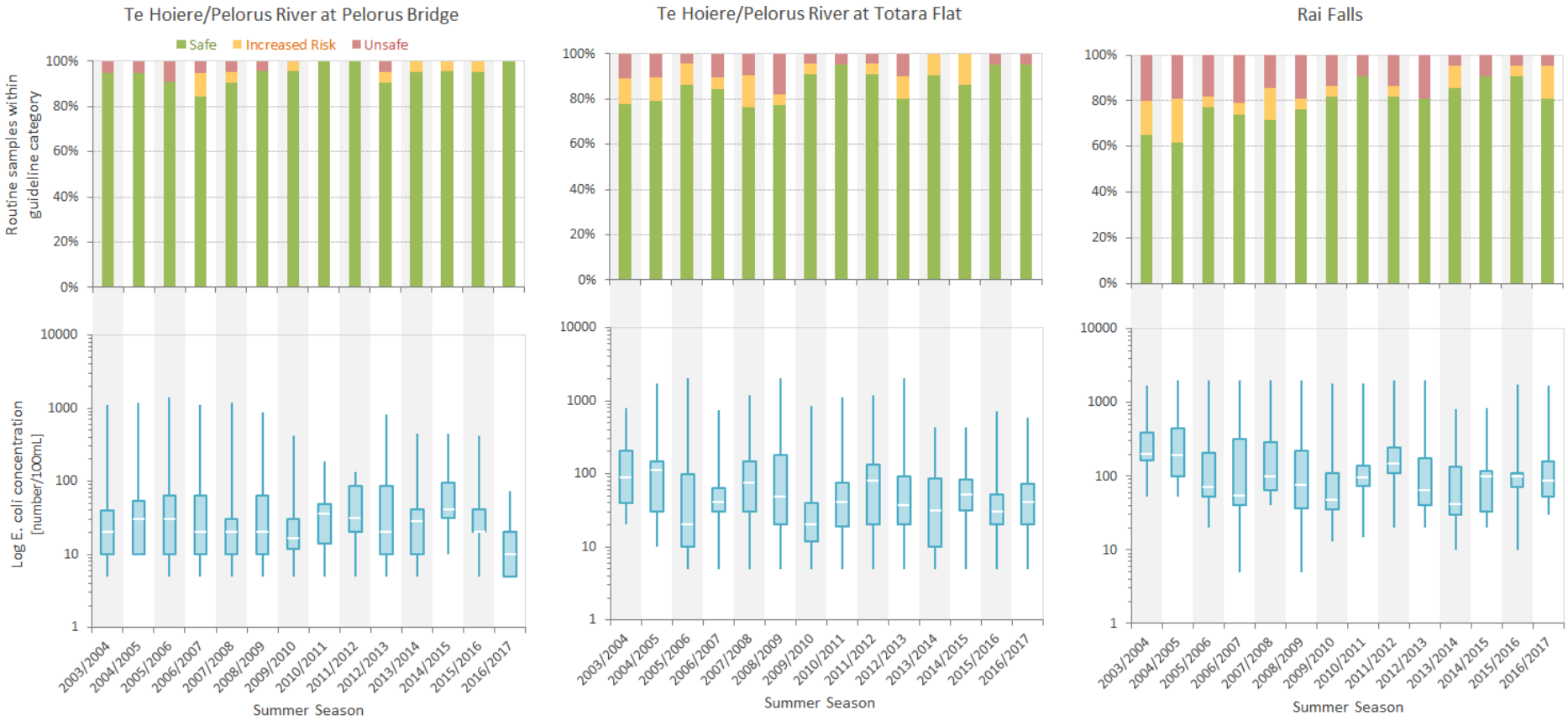
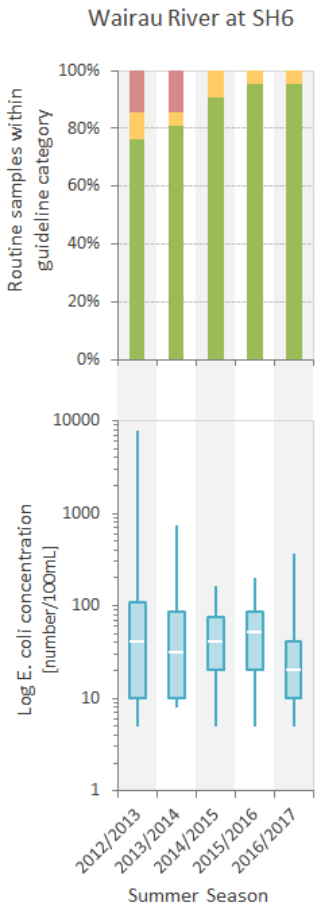
2012/2013
2013/2014
2014/2015
2015/2016
2016/2017
Summer Season

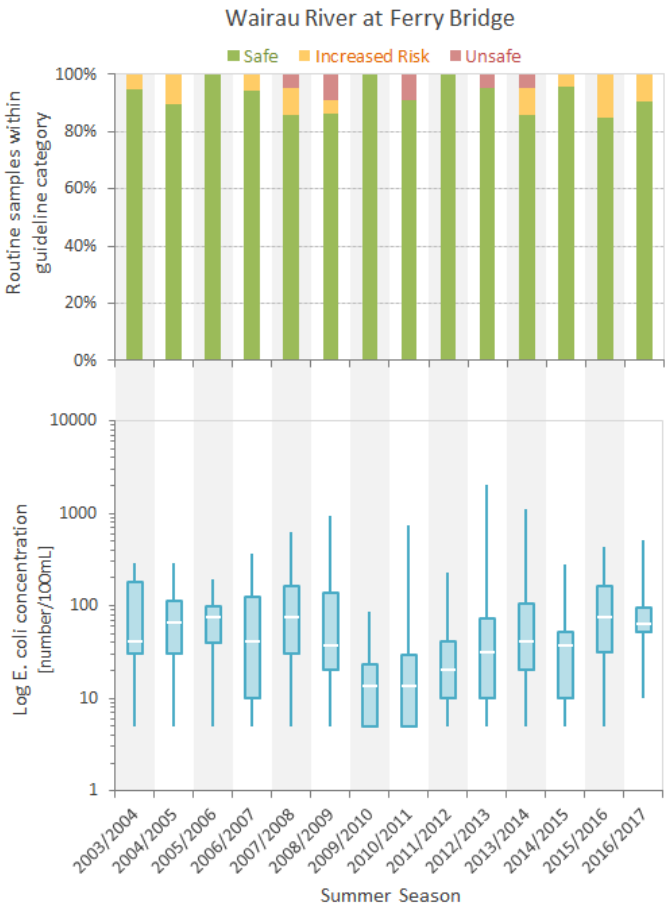

Pukatea/Whites Bay
Safe
Increased Risk
Unsafe
Routine samples within guideline category
100%
80%
60%
40%
20%
0%
Log Enterococci concentration [number/100mL]
10000
1000
100
10
1
2004/2005
2005/2006
2006/2007
2007/2008
2008/2009
2009/2010
2010/2011
2011/2012
2012/2013
2013/2014
2014/2015
2015/2016
2016/2017
Summer Season


Waikutakuta/Robin Hood Bay
East
West
Routine samples within guideline category
100%
80%
60%
40%
20%
0%
Log Enterococci concentration [number/100mL]
10000
1000
100
10
1
2012/2013
2013/2014
2014/2015
2015/2016
2016/2017
Summer Season

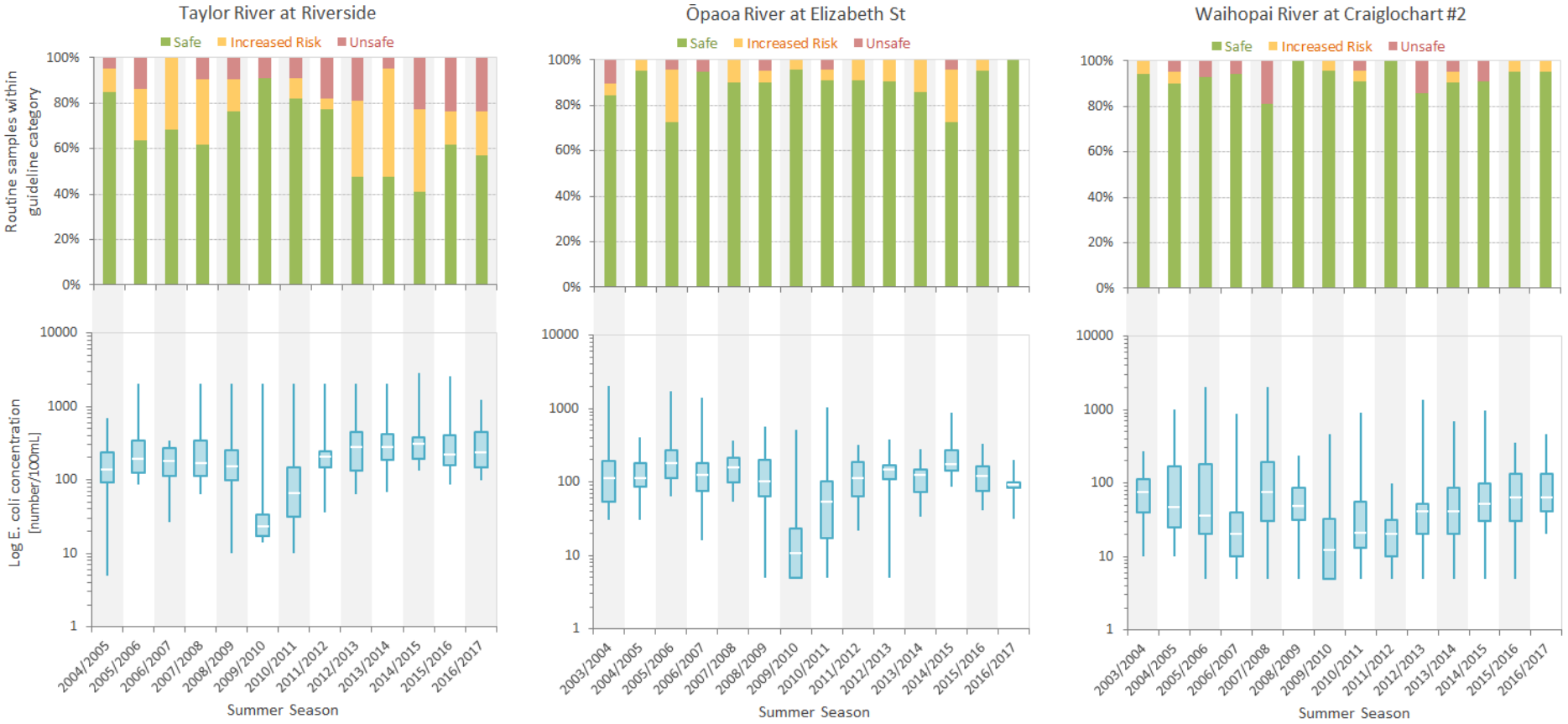

Marfells Beach
Routine samples within guideline category
100%
80%
60%
40%
20%
0%
Log Enterococci concentration [number/100mL]
10000
1000
100
10
1
2007/2008
2008/2009
2009/2010
2010/2011
2011/2012
2012/2013
2013/2014
2014/2015
2015/2016
2016/2017
Summer Season


Te Hoiere/Pelorus River at Pelorus Bridge
Safe
Increased Risk
Unsafe
Routine samples within guideline category
100%
80%
60%
40%
20%
0%
Log E. coli concentration [number/100mL]
10000
1000
100
10
1
2003/2004
2004/2005
2005/2006
2006/2007
2007/2008
2008/2009
2009/2010
2010/2011
2011/2012
2012/2013
2013/2014
2014/2015
2015/2016
2016/2017
Summer Season
Te Hoiere/Pelorus River at Totara Flat
Rai Falls


Wairau River at SH6
Routine samples within guideline category
100%
80%
60%
40%
20%
0%
Log E. coli concentration [number/100mL]
10000
1000
100
10
1
2012/2013
2013/2014
2014/2015
2015/2016
2016/2017
Summer Season


Wairau River at Ferry Bridge
Safe
Increased Risk
Unsafe
Routine samples within guideline category
100%
80%
60%
40%
20%
0%
Log E. coli concentration [number/100mL]
10000
1000
100
10
1
2003/2004
2004/2005
2005/2006
2006/2007
2007/2008
2008/2009
2009/2010
2010/2011
2011/2012
2012/2013
2013/2014
2014/2015
2015/2016
2016/2017
Summer Season


Wairau River at Blenheim Rowing Club
Safe
Increased Risk
Unsafe
Routine samples within guideline category
100%
80%
60%
40%
20%
0%
Log E. coli concentration [number/100mL]
10000
1000
100
10
1
2003/2004
2004/2005
2005/2006
2006/2007
2007/2008
2008/2009
2009/2010
2010/2011
2011/2012
2012/2013
2013/2014
2014/2015
2015/2016
2016/2017
Summer Season


Taylor River at Riverside
Safe
Increased Risk
Unsafe
Routine samples within guideline category
100%
80%
60%
40%
20%
0%
Log E. coli concentration [number/100mL]
10000
1000
100
10
1
2004/2005
2005/2006
2006/2007
2007/2008
2008/2009
2009/2010
2010/2011
2011/2012
2012/2013
2013/2014
2014/2015
2015/2016
2016/2017
Summer Season
Ōpaoa River at Elizabeth St
Safe
Increased Risk
Unsafe
2003/2004
2004/2005
2005/2006
2006/2007
2007/2008
2008/2009
2009/2010
2010/2011
2011/2012
2012/2013
2013/2014
2014/2015
2015/2016
2016/2017
Summer Season
Waihopai River at Craiglochart #2
Safe
Increased Risk
Unsafe
2003/2004
2004/2005
2005/2006
2006/2007
2007/2008
2008/2009
2009/2010
2010/2011
2011/2012
2012/2013
2013/2014
2014/2015
2015/2016
2016/2017
Summer Season

8.3. Appendix 3: Management procedure for exceedances of bathing water guidelines