MARLBOROUGH DISTRICT COUNCIL

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Recreational Water Quality Report 2022 - 2023

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Executive Summary

The recreational water quality programme evaluates the health risk to swimmers at 16 popular swimming location within the region, through the monitoring of Enterococci and E. coli levels.

At most sites, over 80% of samples had bacteria concentrations within safe limits for recreational activities. At three coastal beaches and two river swimming locations, all samples taken showed water quality suitable for swimming. Unsafe concentrations of bacteria were found in a small percentage of samples across six monitored sites.

Of the coastal site, both, Pukatea/Whites Bay and Waikutakuta/Robin Hood Bay showed consistently safe Enterococci concentrations. There has been a slightly increasing trend at Pukatea/Whites Bay in recent years, but it is now showing signs of reversal. Anakiwa had a single guideline exceedance, attributed to rainfall. The three popular bays Ngakuta Bay, Governors Bay, and Momorangi Bay presented a mixed picture with occasional high Enterococci concentrations, especially at Momorangi Bay. Notably, this year, Ngakuta Bay showed comparatively lower Enterococci levels, a positive shift from previous seasons.

Of the river sites, the Te Hoiere/Pelorus River at Pelorus Bridge had consistently low E. coli concentrations, securing its status as the best river site for recreational water quality in the region. Both lower Wairau River sites, at Ferry Bridge and the Blenheim Rowing Club, showed encouraging improvements in their SFR Grades and NPS-FM states (*Figure 1*).

The Taylor River at Riverside is currently the only site with a SFR Grade of "Very Poor" due to a large number of samples with higher E. coli concentrations, however, trend analysis showed decreasing bacteria levels over the last decade.

The swimming site on the Waihopai River showed an increasing trend in E. coli concentrations over the last 15 years, but additional sampling in the catchment allowed the area for improvement actions to be narrowed down.

Overall, the majority of sites have SFR Grades of “Good” or “Fair” (*Figure 1*).

			This Season			Previous Season	
	No.	Site	SFR Grade (Suitability for Contact Recreation)	NPS-FM state (National Policy Statement - Freshwater)		SFR Grade (Suitability for Contact Recreation)	NPS-FM state (National Policy Statement - Freshwater)
Beach Sites	1	Anakiwa	Good			Good	
	2	Momorangi Bay	Good			Good	
	3	Ngakuta Bay	Fair			Poor	
	4	Governors Bay	Fair			Fair	
	5	Picton Foreshore	Fair			Fair	
	6	Waikawa Bay	Fair			Fair	
	7	Waikutakuta/Robin Hood Bay East	Fair			Fair	
	8	Pukatea/Whites Bay	Good			Good	
River Sites	9	Rai Rv at Rai Falls	Poor	Poor	*	insufficient data	
	10	Te Hoiere/Pelorus Rv at Pelorus Bridge	Good	Good		Good	Good
	11	Te Hoiere/Pelorus Rv at Totara Flat	Poor	Poor		Poor	Poor
	12	Ohinemahuta Rv at Onamalutu Domain	Fair	Fair		Fair	Fair
	13	Wairau Rv at Ferry Bridge	Good	Good		Fair	Fair
	14	Wairau Rv at Blenheim Rowing Club	Good	Good		Fair	Fair
	15	Taylor Rv at Riverside	Very Poor	Poor		Very Poor	Poor
	16	Waihopai Rv at Craiglochart #2	Poor	Poor		Poor	Poor

* this site has been monitored less than 5 years and SFR Grade and NPS_FM state are therefore interim

Figure 1: Current and previous SFR Grades and NPS-FM states for the swimming sites monitored in the 2022/23 summer season. A thicker border around the grades from this season indicates changes from the previous season.

The Marlborough Environment Plan (MEP) has an Anticipated Environmental Result (AER) to measure effectiveness of the plan provisions for recreational water quality in rivers. Currently half of the river sites monitored meet this requirement, the other half currently fall short. The council has initiated several projects to improve the region's water quality.

Table of Contents

Table of figures

List of tables

1. Introduction

Enjoying a swim at the beach or cooling off in a river is a quintessential part of a Kiwi summer, and Marlborough is blessed with generally good water quality. However, there can be instances when the water contains microorganisms capable of causing illnesses in swimmers.

In New Zealand, the most frequent illness linked to recreational water activities is Campylobacteriosis. Other, less prevalent diseases include Cryptosporidiosis and Giardiasis. All three can induce symptoms such as vomiting, stomach cramps, and diarrhoea. Symptoms can take up to ten days to manifest, making it challenging to pinpoint the source of the infection.

The microorganisms responsible for these diseases thrive in warm, dark, and moist environments, such as the gut of warm-blooded animals. Consequently, their presence in water is often due to contamination from faecal material, such as animal droppings or human waste.

To assess the risk to water users, the council collects weekly water samples from the most frequented beaches and river sites during the summer months. Measuring the concentrations of all harmful microorganisms, or pathogens, in these samples is both complicated and costly. Instead, samples are analysed for indicator bacteria, which are easier to measure and typically coexist with harmful microorganisms. E. coli serves as the indicator bacteria for river samples, while Enterococci is the chosen indicator for coastal waters.

This report details the results from the samples taken during the 2022/2023 summer season. It provides recreational water quality assessments for the monitored swimming sites and examines changes in water quality over time.

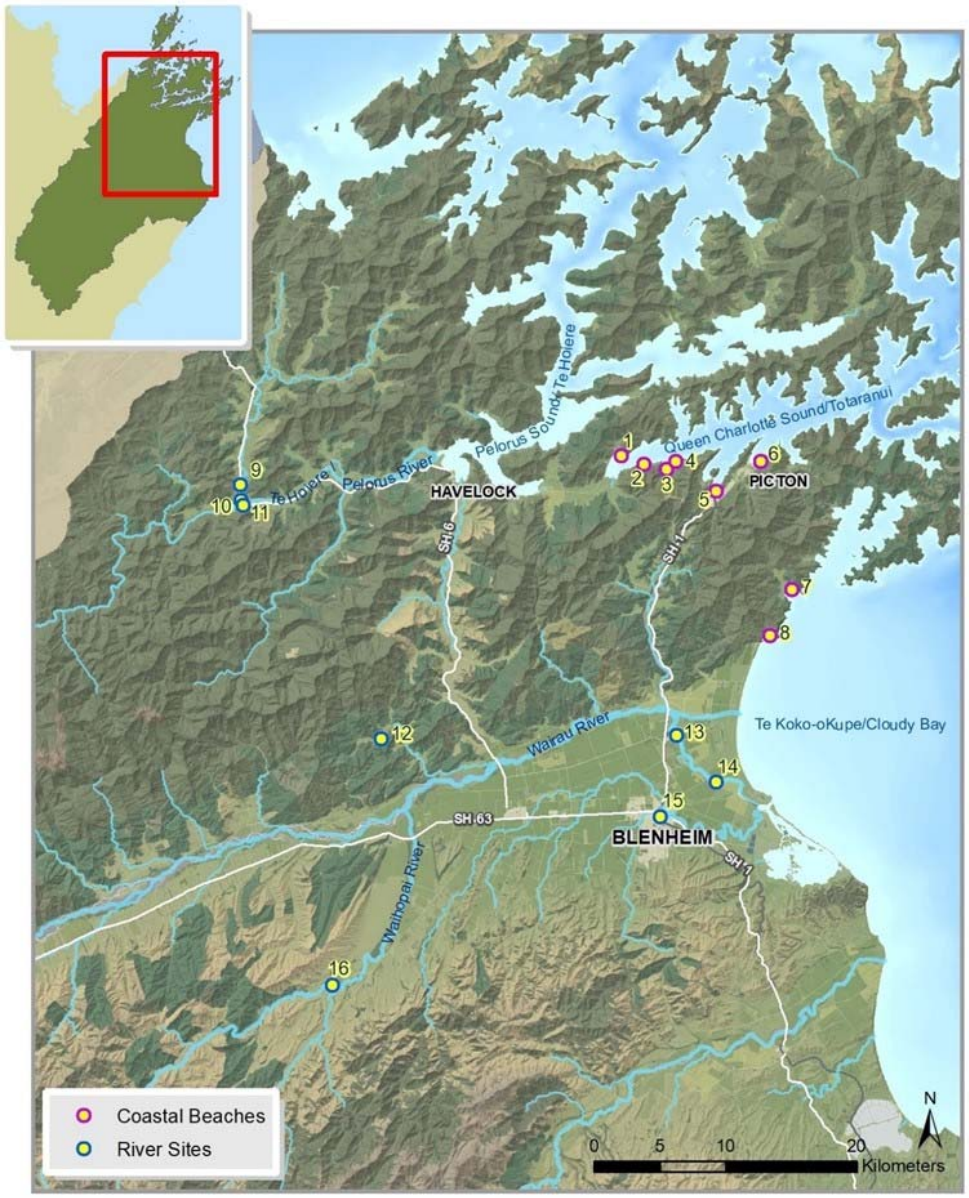
It is crucial to highlight that this report focuses solely on health risks associated with faecal contamination. The results presented offer only a partial reflection of overall water quality. Other potential risks to swimmers, such as the presence of toxic algae, high flows, or strong currents, are not covered in this report.

2. Recreational Water Quality Monitoring

Throughout the 2022/2023 summer season, council monitored eight coastal beaches and eight river sites, as shown in *Figure 2*. These sites were identified as the most frequented swimming locations from a site usage survey conducted in 2017 [5].

From November to March, when water temperatures are at their highest and swimming in natural waters is most prevalent, these 16 sites were monitored weekly. The monitoring process included field measurements, such as water temperature and conductivity, and the collection of water samples. Hill Laboratories in Blenheim analysed the water samples for faecal indicator bacteria. Enterococci bacteria levels were measured using the Enteroalert method, and E. coli levels were determined using the Colilert method. These methods require an incubation period of 18 to 24 hours before the analysis results become available.

Once analysis results were received, they were made accessible on the LAWA website (www.lawa.org.nz). LAWA serves as a platform for sharing environmental information collected by councils throughout New Zealand. Recreational water quality data can be found in the "Can I Swim Here" module of the website. LAWA also provides additional environmental information, including general water quality, water quantity, soil and air quality data.



	No.	Site	Easting	Northing
Coastal Beaches	1	Anakiwa	1677073	5431495
	2	Momorangi Bay	1678817	5430879
	3	Ngakuta Bay	1680514	5430489
	4	Governors Bay	1681310	5431030
	5	Picton Foreshore	1684298	5428815
	6	Waikawa Bay	1687695	5431090
	7	Waikutakuta/Robin Hood Bay East	1690115	5421285
	8	Pukatea/Whites Bay	1688425	5417793

	No.	Site	Easting	Northing
River Sites	9	Rai Rv at Rai Falls	1648018	5429266
	10	Te Hoiere/Pelorus Rv at Pelorus Bridge	1648077	5428091
	11	Te Hoiere/Pelorus Rv at Totara Flat	1648262	5427731
	12	Ohinemahuta Rv at Onamalutu Domain	1658791	5409896
	13	Wairau Rv at Ferry Bridge	1681274	5410163
	14	Wairau Rv at Blenheim Rowing Club	1684319	5406605
	15	Taylor River at Riverside	1680023	5403987
	16	Waihopai River at Craiglochart #2	1655029	5391098

Figure 2: Monitoring Sites of the Recreational Water Quality Programme.

The subsequent sections introduce the guidelines and limits used to evaluate the sampling results for recreational water quality. These guidelines are outlined in a document jointly produced by the Ministry for the Environment and the Ministry of Health in 2003 [9]. The National Policy Statement for Freshwater Management also includes limits for river swimming sites [12], which align closely with the 2003 guidelines.

3. Assessment of Monitoring Results

Our immune system can deal with small concentrations of most pathogens. Only if concentrations are too high do we become sick. There are many factors that influence the number of pathogens that are required to make us sick. One of these factors is the type of pathogen. In New Zealand, the most commonly notified disease caused by recreational water uses is Campylobacteriosis [3]. For this reason, guideline levels are based on the concentration of indicator bacteria that are present when persons contract Campylobacteriosis. However, some persons are more susceptible than others and the guideline values were set to protect roughly 99% of all users.

The risk to swimmers is particularly well studied for the indicator bacterium E. coli, which is used to assess the health risk in rivers. However, E. coli quickly die in saltwater and the risk for beach users might be underestimated. Therefore, the more robust indicator organism Enterococci is used for coastal beaches.

3.1. Guideline Values for Individual Samples

The 2003 Guideline document outlines two guideline values for each of the two indicator bacteria. Utilizing these guideline values, sample results are classified into three "Modes". Bacteria concentrations within the "Green Mode" suggest a low health risk to swimmers. If bacteria levels escalate to the "Alert mode", the risk of infection increases slightly. While swimming remains safe under these conditions, it serves as a signal for the council to investigate potential sources of heightened faecal pollution. When bacteria concentrations surpass the Action Guideline, the health risk is deemed unacceptable. **Error! Reference source not found.** displays the range of indicator bacteria concentrations for the "Modes" along with the corresponding guidelines.

Table 1: Modes in the Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas [9]

Mode	Freshwater E. coli/100mL	Coastal Enterococci/100mL	Meaning
Green Mode	<260	<140	**Safe** for contact recreation
Alert Guideline	260	140	
Alert Mode	260 - 550	140 - 280	**Increased risk** for health
Action Guideline	550	280	
Action Mode	>550	>280	**Unsafe** for conctact recreation

In Marlborough, most exceedances of the Action Guideline are triggered by rainfall. Rainfall that lands on the ground and fails to be absorbed by the soil ends up flowing over the surface, eventually making its way into the nearest stream or coastal area, a process referred to as surface run-off. If this water comes in contact with animal droppings, it becomes contaminated with microorganisms and other pollutants. Consequently, rivers and streams usually record higher faecal bacteria concentrations during periods of rainfall. Riparian buffer vegetation along stream banks can help mitigate some of this pollution. However, even streams running through native bush will carry some faecal bacteria during rainfall, largely originating from native birds and other wildlife.

In urban settings, most surfaces do not permit rainfall to infiltrate the ground. As such, a larger proportion of rainfall translates into surface run-off. The run-off is collected in stormwater pipes that

often discharge directly into streams and coastal waters. Alongside animal droppings, urban areas' primary contamination sources include sewer overflows and damage to the sewerage infrastructure.

In smaller residential areas, private sewage treatment systems can also contribute to faecal contamination. These private systems require regular inspections and maintenance to function efficiently. In Marlborough, it is the responsibility of the private landowner to ensure the optimal operation of their system.

The District Health Board and council have jointly issued a general recommendation to avoid swimming in waterways for up to 48 hours following heavy rainfall or if the water appears discoloured. This advisory is typically reinforced with a media release at the onset of each summer season.

3.2. Suitability for Contact Recreation Grades (SFR Grades)

The process of determining the concentration of indicator bacteria entails injecting a sub-sample into a growth medium and then incubating it. This fosters optimal conditions for the indicator bacteria to proliferate. Following 18 to 24 hours of incubation, bacterial colonies can be counted, and a concentration calculated.

Unfortunately, this analysis methods results in a delay of at least one day before the bacterial concentration in a sample can be known. This means by the time analysis results are received, the concentration of indicator bacteria has likely changed. Particularly rainfall can cause significant changes in water quality within minutes. This means that the latest sampling results should not be used to decide whether it is safe to swim or not. To overcome this problem, a grading system known as the SFR Grades was developed. Ranging from 'Very Good' to 'Very Poor', the SFR Grades offer a comprehensive assessment of recreational water quality, leveraging monitoring data collated over multiple summer seasons. **Error! Reference source not found.** outlines the five SFR Grades and their respective meanings.

Table 2: Suitability for Contact Recreation Grades (SFR Grades) and their meaning.

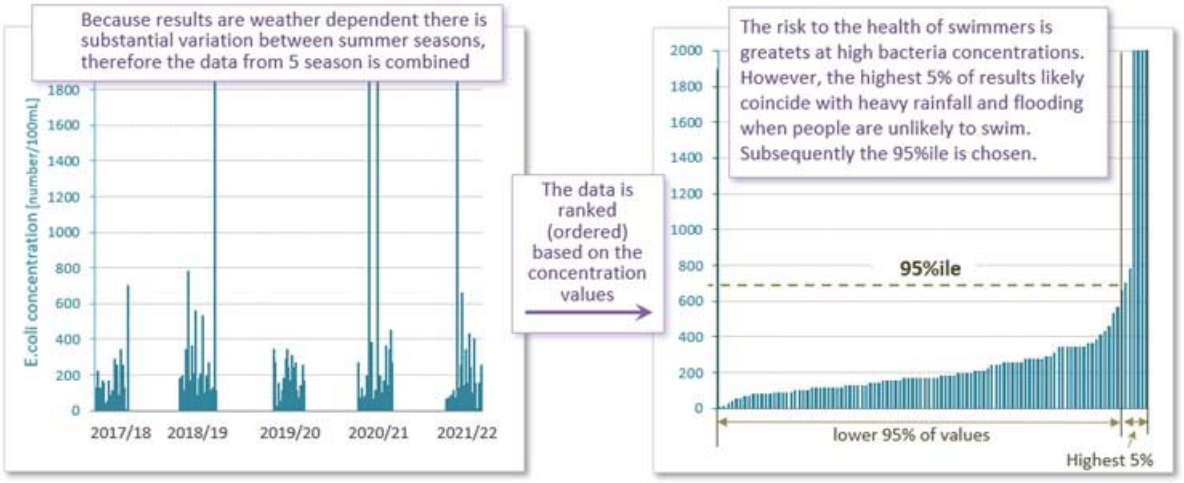
SFR Grade	Meaning
Very Good	Considered satisfactory for swimming at all times.
Good	Satisfactory for swimming most of the time with exceptions following rainfall.
Fair	Generally satisfactory for swimming. Caution should be taken during periods of high rainfall and swimming avoided if water is discoloured.
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.

The SFR Grade for a swimming site is determined in two parts. Initially, an assessment of the health risk from all possible faecal sources within the catchment is undertaken[1]. Following this assessment, sites are allocated one of five **Sanitary Inspection Categories (SICs)**, ranging from 'Very Low' to 'Very High' risk. While direct discharges into rivers and coastal areas are the most apparent sources of faecal contamination, a multitude of land-use activities can also contribute to faecal material entering water bodies. If a swimming spot is surrounded by native bush, the health risk from waterborne diseases is considered to be minimal and the site is given a SIC of 'Very Low'. Extensive sheep and beef farms cause a slightly greater risk of faecal contamination, particularly if livestock can

[1] A catchment is the land area from which all rainfall that falls onto it eventually flows to a river sampling site or into a coastal bay. It is also sometimes referred to as a drainage basin or watershed.

access streams. This results in a SIC of 'Low' or 'Moderate'. The highest health risk is generally associated with human sewage. Swimming spots influenced by urban development are therefore assigned a SIC of 'Moderate' to 'Very High'.

The second part of the SFR grading consists of the **Microbiological Assessment Category (MAC)**. Derived from bacteria concentrations in samples collected at a site over a five-year period, the MACs range from A to D, based on the upper 95th percentile (95%ile) calculated using the Hazen method (*Figure 3*).



2003 Guidelines

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

2020 NPS-FM

Attribute State	Limits - Rivers
	E. coli/100mL*
Excellent	<130
Good	>130 - ≤260
Fair	>260 - ≤540
Poor	>540

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

Figure 3: Calculation of the upper 95%ile, which is used to assign the Microbiological Assessment Category (MAC) and NPS-FM state based on the tables shown.

The MAC is also used to establish the attribute state for river swimming sites under the National Policy Statement for Freshwater Management (NPS-FM). The NPS-FM limits largely aligning with the MAC categories (*Figure 3*). The limit of 540 E. coli/100mL represent the "National Bottom Line", and rivers with MAC values above this limit require councils to take action to improve water quality.

The calculation of the MAC requires a minimum of 20 sample results per season over a period of five consecutive summer seasons. This means that it will take several years before new sites can be graded. On the LAWA website, the MAC is calculated using data from a shorter, three-year period, for all sites. This provides the advantage that changes to water quality are reflected in the grading earlier but can result in greater influence of rainfall patterns. The LAWA team have gone a step further, basing their grading on the MAC calculation only. In the 2003 national guidelines the SFR Grade combines the results from the SIC and MAC analysis (**Error! Reference source not found.**). The SIC allows adjustment of the grade based on the health risk from different sources of faecal contamination. For example, contamination from human sources generally presents a greater risk to swimmers than animal droppings. The MAC grading alone does not provide for this. The main argument against the inclusion of the SIC into the grading is that it introduces some subjectivity to the process. However, the use of genetic source tracking methods and site investigations allow the SIC category to be determined with greater certainty.

In this report, site grading is based on the 2003 guidelines using the MAC and SIC categories to determine the SFR Grade. The SFR Grades are updated after every summer season as new data becomes available.

Table 3: Assignment of SFR Grades from MAC and SIC results.

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)

3.3. Trend Analysis

Trends are changes over time. Analysis of trends was conducted using the Mann Kendall method, facilitated by the NIWA TimeTrends software[2].

Appropriate covariates (influential factors) were selected based on a spearman correlation analysis of potential candidates. These potential covariates included:

1. Flow rate at nearby sites
    a. Actual flow during sampling
    b. Daily flow rate

2. Rainfall data from nearby stations
    a. Total rainfall 12 hours, 24 hours, and 48 hours prior to sampling
    b. Daily rainfall totals

The correlation analysis was carried out in R Studio, and both untransformed and log-transformed data were tested. Log transformation generally did not enhance the correlation coefficients. Hence, only untransformed data was used.

Following this, the Mann Kendall trend analysis was applied using three different statistical adjustments: Generalised Additive Model (GAM), Locally Weighted Scatterplot Smoothing (LOEWESS), and Linear Covariant, based on the two covariates with the highest correlation coefficients. The fits from these three models were visually examined. The LOEWESS model, using spans of 0.7 or 0.9, often resulted in unrealistic fits. On the other hand, the GAM model, with 3 degrees of freedom, generally offered the most reliable fit to the data.

While correlation analysis was carried out using all data, for the actual trend analysis only routine data was used to avoid biasing the data by follow-up samples.

[2] The software is able to deal with values that are either below or above detection limits. Hence no conversion of these type of results to numerical values was required.

Table 4: Covariates used in the final trend results for the river sites and percentage of variation explained by the Generalised Additive Model (GAM)

Site	Covariate	**GAM explained variation** (15-year data)
Rai Rv at Rai Falls	Tunakino Rainfall - 12 hours prior	52.7%
Te Hoiere/Pelorus Rv at Totara Flat	Rai River at Rai Falls Flow	95.2%
Te Hoiere/Pelorus Rv at Pelorus Bridge	Tunakino Rainfall - 12 hours prior	46.3%
Wairau Rv at Ferry Bridge	Wairau at Barnetts Bank Flow	35.5%
Wairau Rv at Blenheim Rowing Club	Wairau at Barnetts Bank Flow	30.8%
Taylor Rv at Riverside	Blenheim Rainfall - 12 hours prior	13.1%
Waihopai Rv at Craiglochart #2	Spray Rainfall - 24 hours prior	34.7%

In addition to the p-value, the "Level of Confidence" (C) was calculated as recommended by Snelder et al. (2021) and applied to the trend direction confidence categories as defined by Choquette et al. (2019). It was decided that trends would only be reported if they fell within the "Highly likely" or "Very likely" categories.

In the case of coastal sites, a large proportion of bacteria concentration results were below the detection limit. This posed a limitation to the application of the Mann Kendall method for assessing trends. Consequently, trends were assessed by examining the changes in Microbial Assessment Category (MAC) values over time. While this method is somewhat less robust, it does provide a degree of insight into changes in bacteria concentrations over time.

4. Result Summary and Discussion

At the majority of sites over 80% of samples taken during the 2022/23 summer season had indicator bacteria concentrations safe for recreational activities (*Figure 4*). At three of the coastal beaches and two of the river swimming sites all samples taken were in the green mode, indicating recreational water quality safe for swimming. These sites included the two sites on the East Coast, Pukatea/Whites Bay and Waikutakuta/Robin Hood Bay as well as the two monitoring sites located on the lower Wairau River.

Unsafe bacteria levels were observed in a small number of samples at six of the sites monitored. Of the coastal sites Momorangi had the highest number of samples in the red mode, but Picton Foreshore had the largest number of samples with bacteria concentrations above at least one of the guidelines.

Of the river swimming locations, the Taylor River and Rai River had the highest number of guideline exceedances.

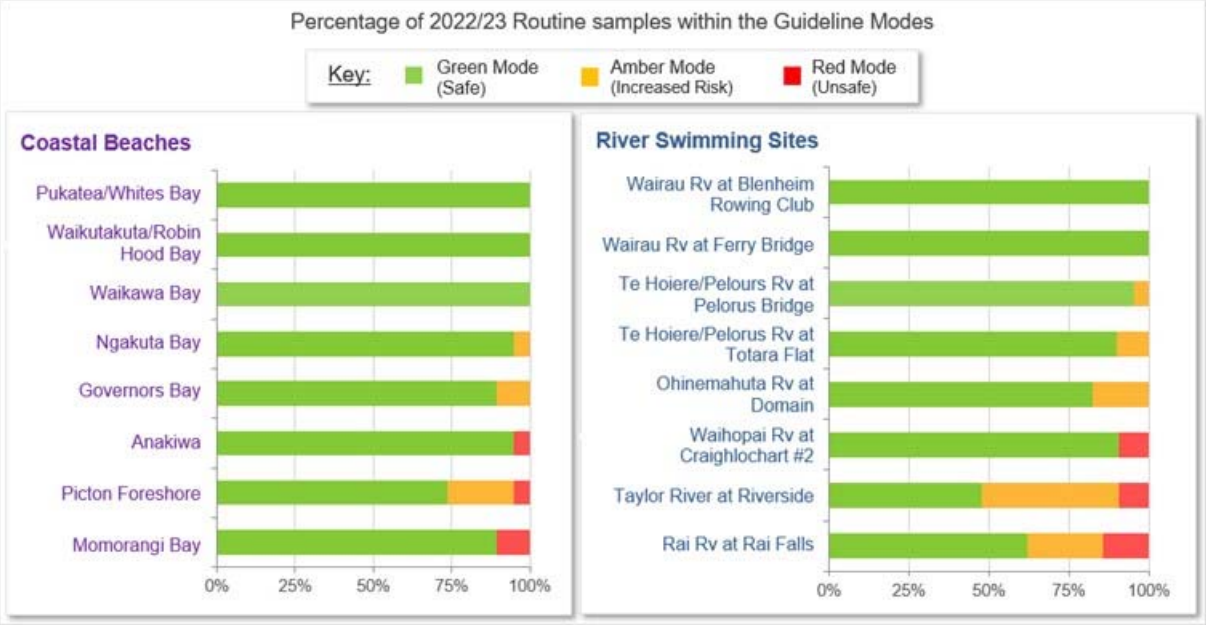


Figure 4: Percentage of routine samples within the recreational water quality modes for the 2022/23 summer season.

The subsequent two sections will provide a more detailed summary and analysis of the monitoring results for both coastal beaches and river sites. This will include an examination of trends over time and assessment of SRF Grades and NPS-FM states.

4.1. Coastal Beaches

As part of the recreational water quality programme, eight coastal beaches were monitored, using Enterococci levels as an indicator for potential health risks to swimmers.

A single exceedance, linked to rainfall, was observed at Anakiwa. MAC values for this site have been relatively stable over the past decade, resulting in a consistent SRF Grade of Fair,

At Pukatea/Whites Bay and Waikutakuta/Robin Hood Bay, all samples taken had Enterococci concentrations at levels safe for swimming. Though the MAC values for Whites Bay have displayed a slight upward trend in recent years, this seems to be reversing. Of the two, Waikutakuta/Robin Hood Bay generally has higher MAC values due to the influence of agricultural and residential activities within its catchment area. Exceptionally high MAC values were recorded between 2020-2021, linked to naturalized Enterococci in gorse that was washed onto the beach during a storm. Following gorse removal, Enterococci concentrations returned to safer levels, and the MAC has since reset to its initial value. Waikutakuta/Robin Hood Bay now has a SRF Grade of Fair, while Pukatea/Whites Bay is consistently graded as Good.

A trio of popular bays, Ngakuta Bay, Governors Bay, and Momorangi Bay are located in the southern part of the Tōtaranui/Queen Charlotte Sound between Picton and Linkwater. Of the three bays, Ngakuta Bay typically had the highest Enterococci concentrations in recent seasons. This season, however, saw comparatively low levels at Ngakuta Bay, with guideline exceedances exclusively observed at Momorangi Bay. At Momorangi one of the two samples with unsafe bacteria concentrations was taken during dry weather conditions and the cause is therefore unclear. If such occurrences persist in the next season, further investigation may be warranted. However, it is worth noting that the MAC values for Momorangi Bay have remained low since significant upgrades were

made to the campground sewage infrastructure in 2017/2018 and the site has had an SRF Grade of Good for the last three seasons.

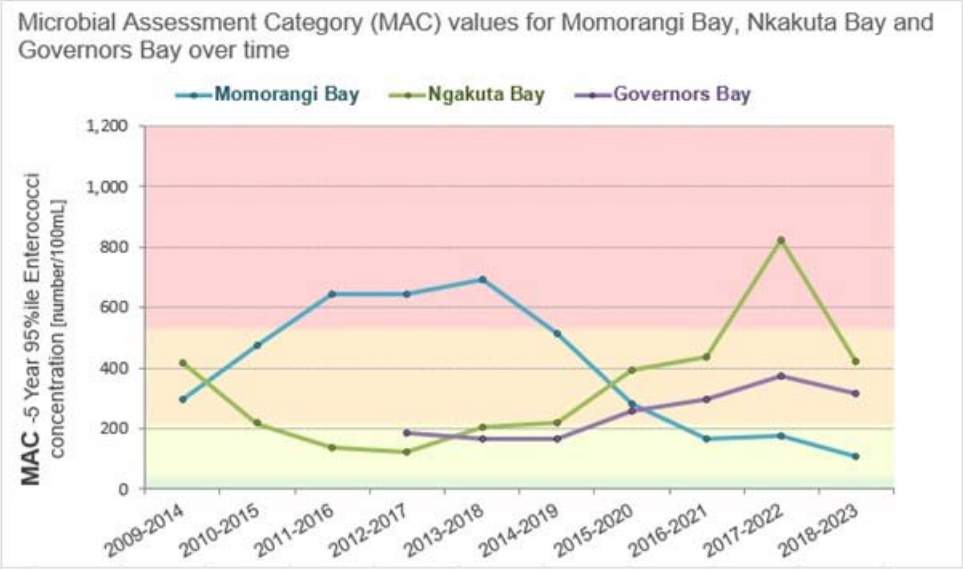


Figure 5: Changes in MAC values over the last ten seasons for Momorangi Bay, Ngakuta Bay and Governors Bay

The MAC values for Ngakuta Bay had been on the rise since 2019 due to elevated Enterococci concentrations during rainfall events. However, recent reductions in Enterococci concentrations have reversed this trend (*Figure 5*), prompting a change in the SFR Grade back from Poor to Fair.

MAC values for Governors Bay show a similar, but less pronounced pattern to that of neighbouring Ngakuta Bay (*Figure 5*). Occasionally, elevated Enterococci concentrations occur during dry weather at Governors Bay, but they rarely exceed guideline levels. No samples taken this season from Governors Bay had unsafe Enterococci concentrations for swimmers, and the site holds an SFR Grade of Fair.

While most beaches in the programme have residential development within their catchment, Picton Foreshore and Waikawa are the only two coastal beaches within urban development. With a larger population at Picton Foreshore, Enterococci concentrations are generally higher than those at neighbouring Waikawa Bay. This season, guideline exceedances were exclusively observed at Picton Foreshore, with high Enterococci levels typically associated with rainfall (*Figure 6*). In February, one sample exhibited an unusually high concentration. However, subsequent samples showed low bacterial levels, leaving the cause unclear. A possible explanation could be localised contamination from bird droppings, as a substantial number of seagulls are observed in and around the beach.

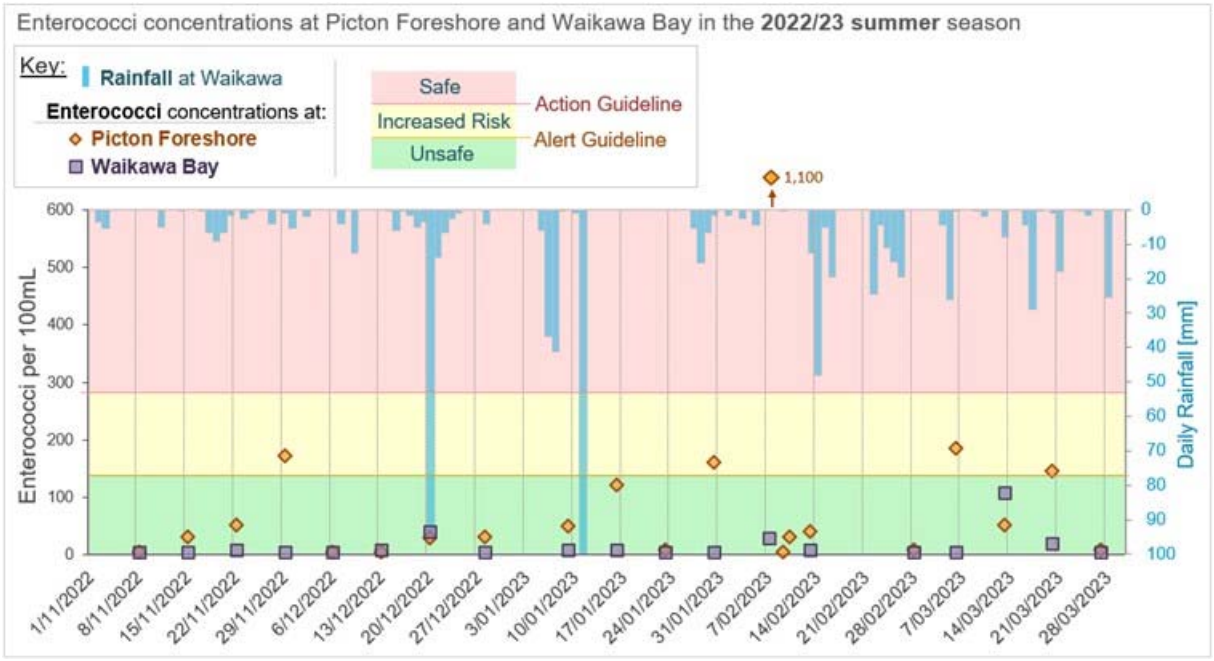


Figure 6: Enterococci concentrations at Picton Foreshore and Waikawa Bay during the 2022/2023 summer season. Shown is also the daily rainfall recorded at Waikawa at Boons Valley.

4.2. River Sites

The recreational water quality programme continued its monitoring of E. coli levels at eight river sites in the region.

Three of the sites are situated in the Te Hoiere/Pelorus catchment, namely, Pelorus Bridge and Totara Flat on the Te Hoiere/Pelorus River and the Rai Falls on the Rai River. As has been observed in previous seasons, the lowest E. coli concentrations were measured at the Pelorus Bridge, while the Rai Falls registered the highest bacteria levels. The elevated E. coli concentrations in the Rai River result in higher levels at Totara Flat, located downstream of the confluence of the Te Hoiere/Pelorus and Rai Rivers. Guideline exceedances were observed at all three sites.

While the Te Hoiere/Pelorus River monitoring sites only exceeded the Alert Guideline, multiple samples taken from the Rai Falls had E. coli concentrations unsafe for swimming. However, these were linked to rainfall and follow-up samples consistently showed a rapid decrease in bacterial concentrations following these high counts.

The Suitability for Recreation Grade (SFR) for the Te Hoiere/Pelorus River at Pelorus Bridge has remained 'Good' for a decade, making it the river site with the region's best recreational water quality. In contrast, Totara Flat and Rai Falls each hold an SFR Grade of 'Poor'. Trend analysis reveals little change in E. coli concentrations at the two Te Hoiere/Pelorus River sites, but a noticeable increase at Rai Falls over the last 10 years, with an average annual increase of 6 MPN/100mL (*Figure 7*). This equates to an overall increase of 60 MPN/100mL in the past decade. The Te Hoiere Project is aiming to improve overall river health in the catchment which will subsequently also result in lower E. coli concentrations at Rai Falls.

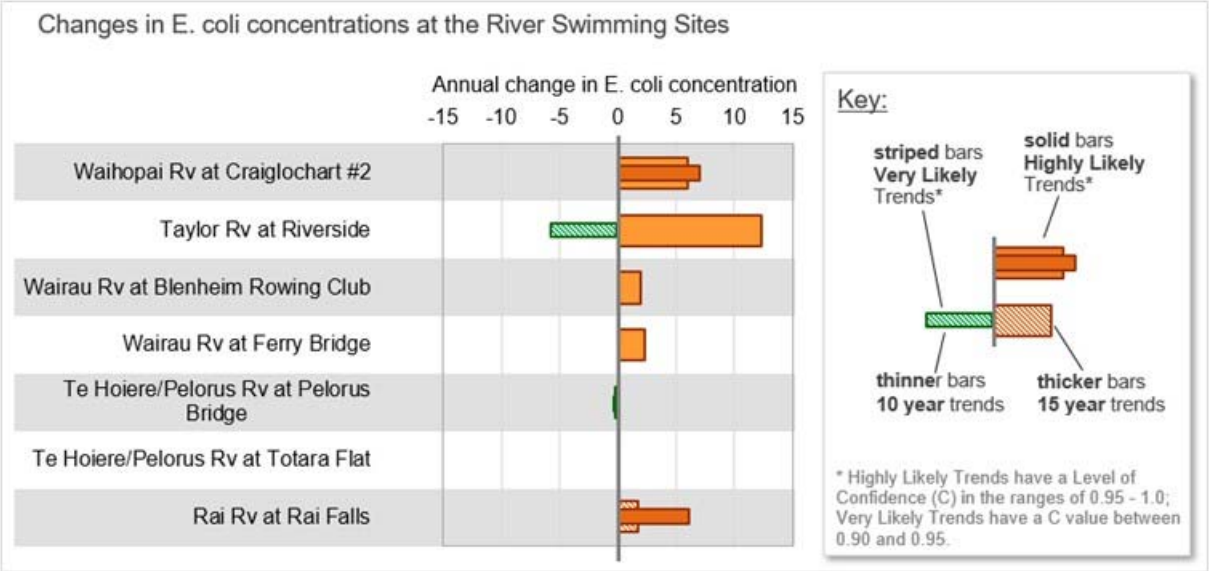


Figure 7: Annual changes in E. coli concentrations at the River Swimming Sites over the last 10 and 15 years. Trend analysis over the period of the most recent five years revealed no significant trends.

Two monitoring sites are located on the lower Wairau River, Wairau River at Ferry Bridge and Wairau River at Blenheim Rowing Club. E. coli concentrations were similar at both sites with all samples collected this season having E. coli levels below guideline thresholds. Trend analysis shows slight increases in E. coli concentrations over the past 15 years, but no significant trends in the previous decade (*Figure 7*). In fact, the Microbial Assessment Category (MAC) values for both sites have decreased resulting in an improvement grading from Fair to Good for both SFR Grades and NPS-FM states. As these changes are quite recent, they were not picked up by the trend analysis carried out. Should E. coli concentrations remain at lower levels this will also be reflected in future trend results.

Two additional sites in the programme, are popular swimming locations at the tributaries of the Wairau River. These are the Waihopai River at Craighlochart and the Ohinemahuta River at the Domain. The site on the Ohinemahuta River is the most recent addition to the programme. We now have sufficient data to assign a SFR Grade of 'Fair', but not enough data for trend analysis. The Waihopai River site, which has been monitored for as long as the two Wairau River sites, has a SRF Grade of 'Poor'. Trend analysis indicates increasing E. coli concentrations over the last 15 years, with slightly greater increases in the past decade.

Since 2022, additional monitoring within the Waihopai catchment has revealed comparatively low E. coli concentrations in the upper parts of the catchment and a significant increase in bacterial levels in the mid catchment, upstream of the swimming site[3] (*Figure 8*). This information will prove valuable in devising an action plan to reduce E. coli levels, aligning with Objective 15.1e of the regional plan requiring improvement of SFR Grades to 'Fair' or better.

[3] Samples at the swimming site and the additional sites were not taken at the same time. The additional sites are monitored monthly throughout the year. To allow comparison, results were filtered to ensure the same number of samples with similar flows and between November and March was used for the analysis for all of the sites.

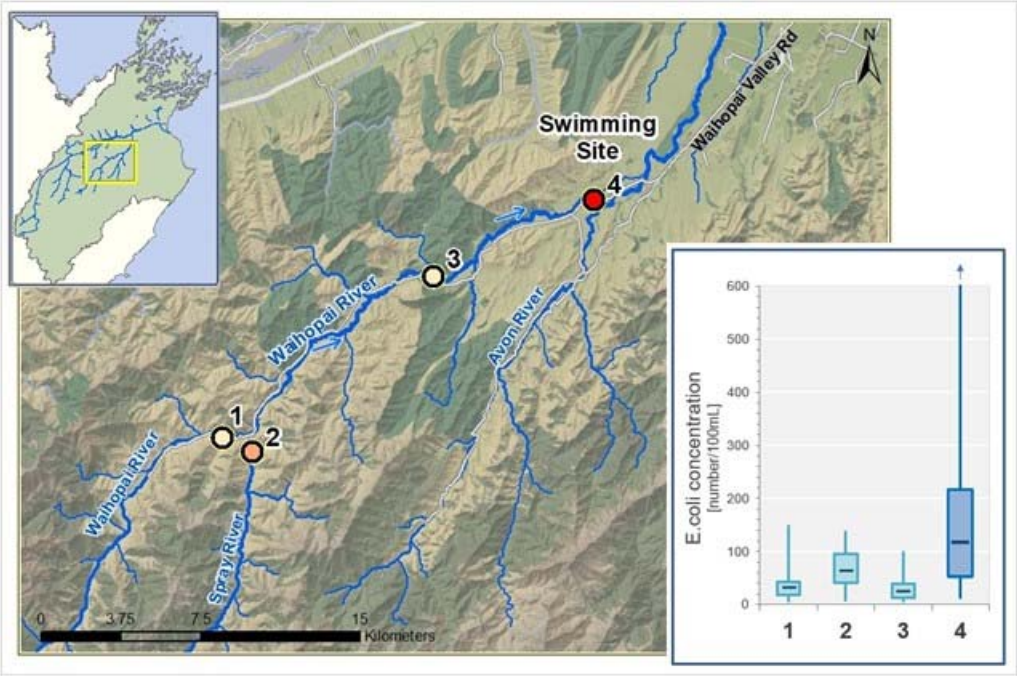


Figure 8: E. coli concentrations in the upper Waihopai River during the summer season. Site 4 is the site monitored for Recreational Water Quality.

The sole monitoring site classified with a SFR Grade of "Very Poor" is the Taylor River at Riverside, centrally situated in Blenheim near the new library building. Blenheim is the largest urban area within the region and national reporting has repeatedly shown waterways within urban catchments to have the poorest water quality [10, 11].

This season unsafe E. coli concentrations were associated with rainfall, but E. coli concentrations were generally higher than at the other river sites monitored. E. coli levels in the Taylor River frequently exceeded the Alert Guideline during dry weather conditions. Long term trends for the site show significant increases in E. coli concentrations over the last 15 years but decreasing E. coli concentrations in the last decade. This points to significant improvement in recent seasons. Since 2018, E. coli levels have dropped, with the lowest levels observed in the 2021/22 season. Nevertheless, in the most recent season (2022/23), E. coli concentrations increased again (*Figure 9*).

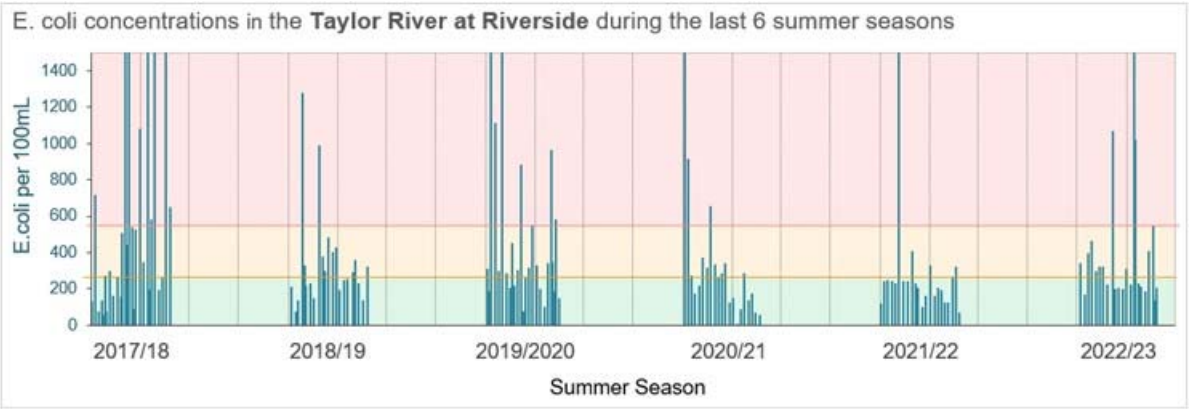


Figure 9: E. coli concentrations in the Taylor River at Riverside over the recent six summer seasons.

Over the past three seasons, E. coli concentrations have also been monitored at the Taylor River at Henry Street bridge, where most swimming activities take place. This site is situated approximately

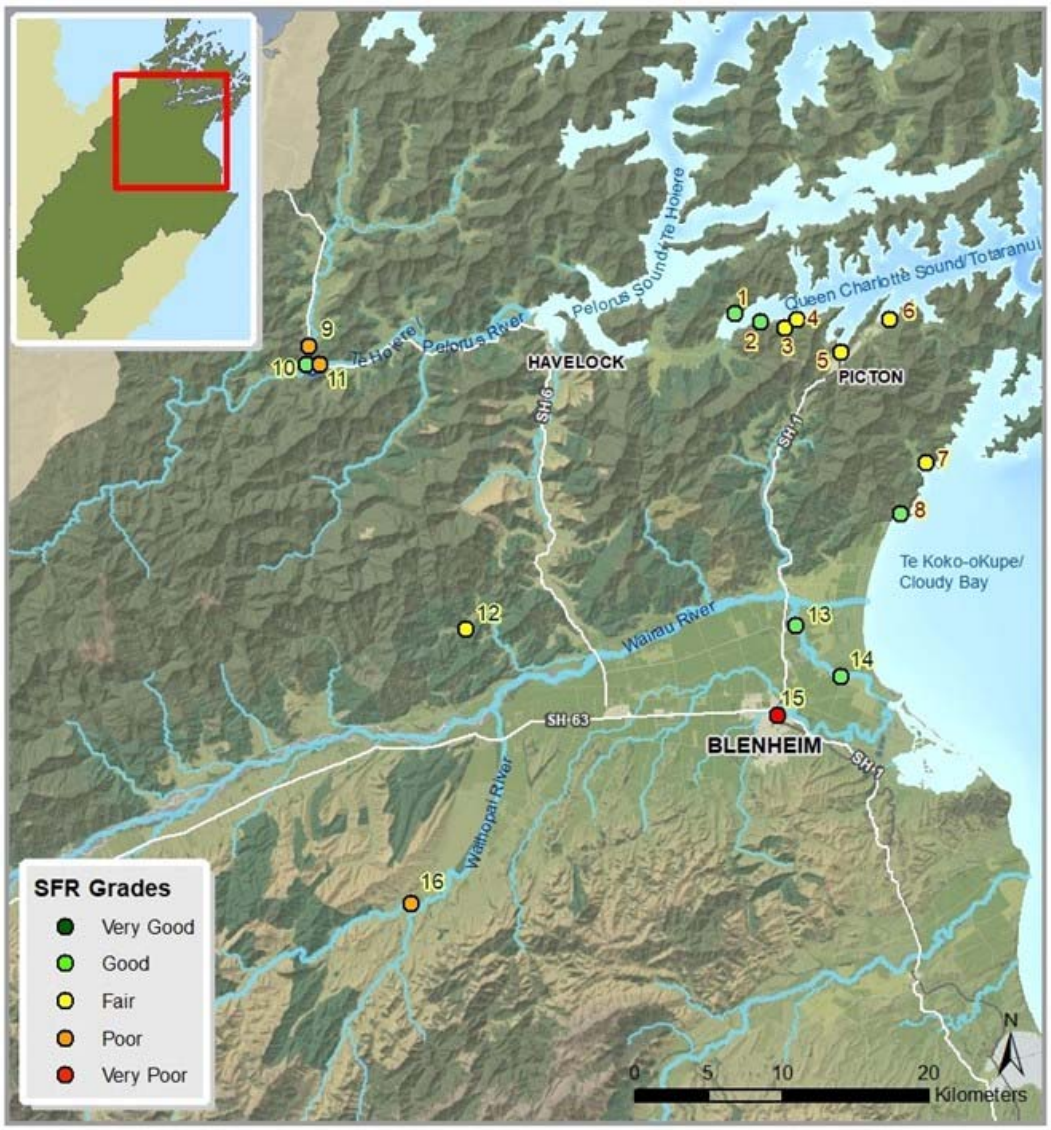
650 meters upstream of the Riverside monitoring site, and generally has slightly lower E. coli concentrations compared to the Riverside location.

The Marlborough Environment Plan (MEP) contains an Anticipated Environmental Result (AER) that relates to river water quality at recreational sites (**Error! Reference source not found.**). The AER, which is closely linked to the National Policy Statement for Freshwater Management (NPS-FM), mandates that river sites achieve an NPS-FM state better than the lowest state of 'Poor'. Of the monitored sites, four meet the AER, while four do not currently meet it. Council has several projects aiming to improve the region's water quality, including the Te Hoiere Project.

Table 5: Anticipated Environmental Result for River Swimming Sites in Marlborough.

AER (Anticipated Environmental result)	Monitoring effectiveness	Current progress	
		Achieved for	Not Achieved for
15.AER.1 Water quality in Marlborough's rivers, lakes and wetlands is suitable to support and sustain swimming, fishing, aquatic ecosystems and customary harvesting.	The 95th percentile E. coli level in waterbodies valued for primary contact recreation is <540 per 100 ml.	• Te Hoiere/Pelorus River at Pelorus Bridge • Wairau River at Ferry Bridge • Wairau River at Blenheim Rowing Club • Ohinemahuta River at Domain	• Te Hoiere/Pelorus River at Totara Flat • Taylor River at Riverside • Waihopai River at Craiglochart #2 • Rai River at Rai Falls

Figure 10 shows the SRF Grades and NPS-FM states for the swimming spots monitored in the 2022/23 summer season. Overall, the majority of sites is graded Good or Fair.



	No.	Site	Easting	Northing	SIC (Sanitary Inspection Category)	MAC (Microbiological Assessment Category)	SFR Grade (Suitability for Contact Recreation)	NPS-FM state (National Policy Statement - Freshwater)	
Beach Sites	1	Anakiwa	1677073	5431495	Moderate	B	Good		
	2	Momorangi Bay	1678817	5430879	Moderate	B	Good		
	3	Ngakuta Bay	1680514	5430489	Moderate	D	Fair		
	4	Governors Bay	1681310	5431030	Low	C	Fair		
	5	Picton Foreshore	1684298	5428815	Moderate	C	Fair		
	6	Waikawa Bay	1687695	5431090	Moderate	C	Fair		
	7	Waikutakuta/Robin Hood Bay East	1690115	5421285	Moderate	C	Fair		
	8	Pukatea/Whites Bay	1688425	5417793	Low	B	Good		
River Sites	9	Rai Rv at Rai Falls	1648018	5429266	Moderate	D	Poor	Poor	*
	10	Te Hoiere/Pelorus Rv at Pelorus Bridge	1648077	5428091	Low	B	Good	Good	
	11	Te Hoiere/Pelorus Rv at Totara Flat	1648262	5427731	Moderate	D	Poor	Poor	
	12	Ohinemahuta Rv at Onamalutu Domain	1658791	5409896	Moderate	C	Fair	Fair	
	13	Wairau Rv at Ferry Bridge	1681274	5410163	Moderate	B	Good	Good	
	14	Wairau Rv at Blenheim Rowing Club	1684319	5406605	Moderate	B	Good	Good	
	15	Taylor Rv at Riverside	1680023	5403987	High	D	Very Poor	Poor	
	16	Waihopai Rv at Craiglochart #2	1655029	5391098	Moderate	D	Poor	Poor	

* this site has been monitored less than 5 years and SFR Grade and NPS FM state are therefore interim

Figure 10: SFR Grades and NPS-FM states of Recreational Water Quality Sites monitored in the 2021/22 summer season.

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5. Appendices

5.1. Appendix 1: Results for the 2022/2023 summer season

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

Site Type	Week	Sample Date	Anakiwa	Momorangi Bay	Ngakuta Bay	Governors Bay	Picton Foreshore	Waikawa Bay	Whites Bay	Robin Hood Bay East
Coastal	1	07/08 Nov 2022	10	<10	10	148	<10	<10	<10	<10
	2	15 Nov 2022	<10	<10	63	31	31	<10	10	<10
	3	22 Nov 2022	10	20	275	<10	52	10	<10	<10
	4	29 Nov 2022	<10	<10	<10	10	173	<10	<10	<10
	5	6 Dec 2022	<10	20	74	<10	<10	<10	<10	<10
	6	13 Dec 2022	10	10	52	<10	<10	10	<10	<10
	7	20 Dec 2022	20	<10	52	<10	30	41	41	10
	8	28 Dec 2022	<10	<10	20	10	31	<10	20	10
	9	9 Jan 2023	96	52	10	160	51	10	31	10
	10	16 Jan 2023	41	10	20	10	122	10	<10	<10
	11	23 Jan 2023	<10	631	<10	41	10	<10	<10	<10
	12	30 Jan 2023	789	31	74	20	161	<10	<10	<10
	Follow-up	1 Feb 2023	20							
	Follow-up	2 Feb 2023	63							
	14	7 Feb 2023	10	20	10	122	1,112	30	<10	
	Follow-up	9 Feb 2023					<10			
	Follow-up	10 Feb 2023					31			
	17	13/15 Feb 2023	20	<10	<10	122	41	10	30	31
	18	28 Feb 2023	20	<10	<10	10	10	<10	<10	10
	19	6 Mar 2023	20	<10	<10	41	185	<10	41	20
	20	13 Mar 2023	20	723	<10	132	52	109	<10	<10
	Follow-up	15 Mar 2023		<10						
	18	20 Mar 2023	<10	30	10	121	146	20	10	<10
	19	27 Mar 2023	<10	<10	<10	10	10	<10	<10	10

Site Type	Week	Sample Date	Pelorus Rv at Pelorus Bridge	Rai Rv at Rai Falls	Pelorus Rv at Totara Flat	Waihopai Rv at Craiglochart #2	Ohinemahuta Rv at Onamalutu Domain	Wairau Rv at Ferry Bridge	Wairau Rv at Blenheim Rowing Club	Taylor Rv at Riverside
River	1	07/08 Nov 2022	10	292	41	20	10	31	20	336
	2	14 Nov 2022	20	146	98	1,076	30	31	20	166
	3	21 Nov 2022	63	933	295	231	161	98	195	395
	4	28 Nov 2022	31	309	171	20	31	10	<10	462
	Follow-up	30 Nov 2022		820						
	Follow-up	1 Dec 2022		404						
	Follow-up	2 Dec 2022		121						
	5	5 Dec 2022	20	30	41	74	20	31	20	292
	6	12 Dec 2022	20	637	74	41	52	20	71	317
	Follow-up	14 Dec 2022		41						
	7	19 Dec 2022	20	181	52	1,860	97	175	10	322
	8	27 Dec 2022	31	96	20	122	160	20	52	218
	9	5 Jan 2023	201	288	134	175	420	20	40	1,067
	10	09/10 Jan 2023	340	350	31	52	74	63	199	197
	11	17 Jan 2023	10	31	41	173	41	98	10	201
	12	24 Jan 2023	<10	31	31	41	30	52	213	195
	13	31 Jan 2023	63	122	31	213	97	171	41	309
	14	07/08 Feb 2023	31	281	85	110	86	52	122	218
	15	14 Feb 2023	31	97		148	74	52	63	9,800
	Follow-up	15 Feb 2023								183
	Follow-up	16 Feb 2023								1,019
	Follow-up	17 Feb 2023								16
	16	22 Feb 2023	31	31	20	132	161	74	52	226
	17	27 Feb 2023	20	171	74	189	41	175	148	209
	18	7 Mar 2023	<10	20	20	148	52	74	148	185
	19	14 Mar 2023	20	86	52	63	309	52	173	404
	20	21 Mar 2023	63	733	369	86	262	10	74	546
	Follow-up	23 Mar 2023		213						134
	21	28 Mar 2023	<10	122	64	31	146	20	63	201