Recreational water quality in the Wellington region

State and trends

Quality for Life

greater WELLINGTON
REGIONAL COUNCIL
Te Pane Matua Taiao

greater WELLINGTON
REGIONAL COUNCIL
Te Pane Matua Taiao

Recreational water quality in the Wellington region

State and trends

S Greenfield
A Ryan
JR Milne

Environmental Monitoring and Investigations Department

For more information, contact Greater Wellington:

Wellington
PO Box 11646

T 04 384 5708
F 04 385 6960
www.gw.govt.nz

Masterton
PO Box 41

T 06 378 2484
F 06 378 2146
www.gw.govt.nz

GW/EMI-T-12/142
ISBN: 978-1-927217-10-8 (print)
ISBN: 978-1-927217-11-5 (online)

May 2012

www.gw.govt.nz
info@gw.govt.nz

DISCLAIMER

This report has been prepared by Environmental Monitoring and Investigations staff of Greater Wellington Regional Council (Greater Wellington) and as such does not constitute Council policy.

In preparing this report, the authors have used the best currently available data and have exercised all reasonable skill and care in presenting and interpreting these data. Nevertheless, Greater Wellington does not accept any liability, whether direct, indirect, or consequential, arising out of the provision of the data and associated information within this report. Furthermore, as Greater Wellington endeavours to continuously improve data quality, amendments to data included in, or used in the preparation of, this report may occur without notice at any time.

Greater Wellington requests that if excerpts or inferences are drawn from this report for further use, due care should be taken to ensure the appropriate context is preserved and is accurately reflected and referenced in subsequent written or verbal communications. Any use of the data and information enclosed in this report, for example, by inclusion in a subsequent report or media release, should be accompanied by an acknowledgement of the source.

The report may be cited as:

Greenfield S, Ryan A and Milne JR. 2012. *Recreational water quality in the Wellington region: State and trends*. Greater Wellington Regional Council, Publication No. GW/EMI-T-12/142, Wellington.

Main cover photo: Kids at Paekakariki Beach (M Velde)

Executive summary

This report presents a comprehensive assessment of recreational water quality at 23 river and 77 coastal sites in the Wellington region, based largely on routine summer monitoring undertaken over the period November 2005 to March 2010. Compliance with the Ministry for the Environment/Ministry of Health (MfE/MoH 2003) microbiological water quality guidelines is assessed and Suitability for Recreation Grades (SFRGs) are presented for each site. At river monitoring sites, occurrence of nuisance periphyton and benthic cyanobacteria growth is also examined, along with temporal trends in flow-adjusted *E. coli* counts for the period 2001/02 to 2009/10. Assessment of trends in microbiological water quality at coastal sites is restricted to a comparison of Microbiological Assessment Category (MAC) grades against those reported in 2006.

Just over half of the 23 river swimming spots monitored met the MfE/MoH (2003) surveillance guideline (<260 *E. coli*/100mL) on 90% or more of sampling occasions over the five-year reporting period, with the majority (20) of sites meeting this threshold 85% of the time. Rivers with a high proportion of indigenous forest and scrub and little or no intensive agricultural or urban land use in the upstream catchment are the safest for swimming; these include the Otaki, Waiohine and Waingawa rivers. Based on 'dry weather' SFRGs (ie, modified grades which exclude wet weather/high river flow conditions when recreation is less likely to occur), 11 river swimming spots have SFRGs of 'good' or 'very good'. The other 12 sites have grades of 'fair' or 'poor'.

Very few river sites exceeded the MfE (2000) guidelines for aesthetic and recreational use on a regular basis. However, widespread growth of potentially toxic cyanobacteria in the Waikanae, Hutt and Waipoua rivers during periods of extended low or stable river flow resulted in parts of these rivers often being unsuitable for swimming and dog walking. Ten dogs died over the reporting period after coming into contact with toxins released from the cyanobacteria mats (nine from the Hutt River).

Microbiological water quality is generally very good across the region's beaches, with 67 out of the 77 sites monitored meeting the MfE/MoH (2003) surveillance guideline on 90% or more of routine sampling occasions over the 2005/06 and 2009/10 summer bathing seasons. This is reflected in a relatively high proportion (65%) of coastal swimming spots with a SFRG of 'good' or 'very good'.

Only four of the nine coastal sites where water quality for shellfish gathering is assessed regularly complied with the faecal coliform thresholds in the MfE/MoH (2003) guidelines. However, interpreting the suitability of recreational waters for shellfish gathering is problematic due to the conservatism of the guidelines and uncertainties surrounding their application.

Runoff from agricultural land use during heavy rain is considered to be a key source of microbiological contamination at many river swimming sites and some coastal sites. In dry weather, stock access is a source of faecal contamination in many of the region's rivers. Birdlife has also been identified as a potential source of contamination at a few sites.

Stormwater and sewer leaks/overflows are considered to be the main source of microbiological contamination at beaches in or near urban areas. Sewage contamination has been identified in the catchments of beach sites that frequently exceed the MfE/MoH (2003) guidelines, such as Porirua Harbour at Rowing Club and Owhiro Bay (Wellington south coast), and may affect some other urban beaches with SFRGs of 'fair' or worse. Infrastructure-related contamination may also contribute to poor grades at sites on the lower reaches of the Hutt River.

The influence of treated municipal wastewater discharges on microbiological water quality in the region is unclear and requires further investigation. This is particularly the case for popular swimming spots on the Ruamahanga River but also for sites along Paraparaumu Beach, Titahi Bay (Porirua), Lyall Bay (Wellington south coast) and the Eastbourne coast.

Improvements in microbiological water quality were observed at some sites, including Waikanae River at SH 1, Ruamahanga River at Double Bridges, and Oriental Bay and Hataitai Beach in Wellington city. While the reasons for improvements at freshwater sites are unclear, improvements at the two Wellington city sites may reflect work that has been undertaken to fix sewer faults and upgrade stormwater and sewer infrastructure in these catchments. Conversely, increased contamination from stormwater and sewer infrastructure may have contributed to the deterioration in microbiological water quality observed at some sites, notably Titahi Bay at South Beach Access Road, Owhiro Bay and Robinson Bay at HW Shortt Recreation Ground.

At both river and beach swimming and shellfish gathering spots, exceedances of the MfE/MoH (2003) guidelines coincided with significant rainfall in the majority of instances. For this reason swimming and collecting shellfish up to 48 hours after heavy rainfall carries with it a potentially high risk to human health.

Contents

1. Introduction

The Wellington region boasts an extensive coastline and many rivers that are highly valued for a wide range of contact recreation activities. Together with the region's territorial authorities, Greater Wellington Regional Council (Greater Wellington) monitors microbiological water quality at designated recreational sites across the region to identify risks to public health from disease-causing organisms and advise the public of these risks. People can then make informed decisions about where, when, and how they use rivers and the marine environment for recreation.

This report presents a comprehensive analysis of the results of summer recreational water quality monitoring undertaken in fresh and coastal waters in the Wellington region, focussing primarily on routine data collected over the period 1 November 2005 to 31 March 2010 inclusive. This monitoring forms part of Greater Wellington's larger programme of state of the environment monitoring, a specific requirement of regional councils under Section 35(2)(a) of the Resource Management Act (RMA) 1991.

1.1 Report purpose

This technical report is one of eight covering air, land and water resources prepared with the primary purpose of informing the review of Greater Wellington's five regional plans. These plans were established to sustainably manage the region's natural resources, including fresh and coastal waters. The current review of the regional plans follows the recently completed review of the overarching Regional Policy Statement (RPS) for the Wellington region (GWRC 2010).

The focus of the eight technical reports is on providing an up-to-date analysis of monitoring information on state and trends in resource health as opposed to assessing the effectiveness of specific policies in the existing RPS (WRC 1995) or regional plans. Policy effectiveness reports were prepared in 2006 following the release of Greater Wellington's last formal State of the Environment (SoE) report, *Measuring up* (GWRC 2005).

The last technical report supporting SoE reporting on recreational water quality was prepared by Milne (2005)[1] and focussed on recreational water quality over the 2001/02 to 2004/05 summers. A further report was released the following year (Milne & Wyatt 2006) that included an additional year's monitoring data and presentation of Suitability for Recreation Grades (SFRGs) for all of the region's recreation sites.

1.2 Report scope

The report assesses recreational water quality at approximately 100 fresh water and coastal recreation sites across the Wellington region based on routine weekly summer monitoring since summer 2005/06. Updated SFRGs are also presented for each of these sites, based on routine water quality data collected

[1] Greater Wellington also prepares annual summary reports documenting the results of summer recreational water quality monitoring. Refer to Morar and Warr (2011) for the most recent annual recreational water quality monitoring report.

over the 2006/07 to 2010/11 summers and a recent re-evaluation of microbiological risk factors undertaken in consultation with the region's territorial and public health authorities (Greenfield et al. 2012). These SFRGs effectively indicate the current *state* of recreational water quality. Trend analysis is largely focused on examining relationships between water quality and rainfall/river flow, with temporal trend analysis limited to freshwater sites where sufficient microbiological water quality and river flow data were available; at these sites trends are assessed on data collected over the 2001/02 to 2009/10 summer bathing seasons. Assessment of trends in microbiological water quality at coastal sites is restricted to a comparison of Microbiological Assessment Category (MAC) grades against those reported by Milne and Wyatt (2006).

1.3 Report outline

The report comprises six sections:

- Section 2 briefly outlines Greater Wellington's recreational water quality monitoring programme, including indicators and guidelines.
- Section 3 presents an analysis of microbiological water quality and nuisance periphyton and cyanobacteria cover at fresh water contact recreation sites across the region. SFRGs are also presented for each site.
- Section 4 assesses the microbiological water quality of the region's coastal waters, including microbiological water quality for recreational shellfish gathering purposes. SFRGs are also presented for each site.
- Section 5 discusses the main findings from Sections 3 and 4, and places these in a national context. The primary sources of microbiological contamination of the region's fresh and coast waters are discussed, and monitoring limitations and knowledge gaps are also outlined.
- Section 6 presents conclusions and recommendations.

2. Recreational water quality monitoring in the Wellington region

2.1 Background

Recreational water quality monitoring in the Wellington region dates back to the early 1990s and, for many years, was undertaken by both the regional council and several territorial authorities. However, since the start of the 2000/01 summer, recreational water quality monitoring in the Wellington region has been a joint effort involving Greater Wellington and its constituent local councils.

The rivers and beaches monitored (Appendix 1) are within areas designated to be managed for recreational purposes in Greater Wellington's Regional Freshwater Plan (WRC 1999) and Regional Coastal Plan (WRC 2000), respectively. The selected sites reflect their use by the public for a range of contact recreation activities, such as swimming, kayaking, rafting, surfing, boating and, in the case of coastal waters, shellfish gathering.

2.2 Monitoring objectives

The aims of Greater Wellington's recreational water quality monitoring programme are to:

1. Determine the suitability of selected sites in marine and fresh waters for contact recreation;
2. Determine the suitability of marine water in designated areas for the gathering of shellfish for human consumption;
3. Assist in safeguarding public health and the environment;
4. Provide a mechanism to determine the effectiveness of regional plans;
5. Provide information to assist in determining spatial and temporal changes in the environment (State of the Environment (SoE) monitoring); and
6. Provide information to assist in targeted investigations where remedial action or mitigation of poor water quality is desired.

2.3 Monitoring and reporting protocol

Recreational water quality monitoring and reporting are undertaken in accordance with the 2003[2] Ministry for the Environment (MfE) and the Ministry of Health (MoH) microbiological water quality guidelines for marine and freshwater recreational areas. These guidelines (often more simply referred to as the recreational water quality guidelines) use bacteriological indicators associated with the gut of warm blooded animals to assess the risk of faecal contamination and therefore the potential presence of harmful pathogens[3]. The indicators used are:

[2] The guidelines were published in June 2002 and updated in June 2003.

[3] Indicator bacteria are monitored because individual pathogenic organisms (eg, salmonella, campylobacter, cryptosporidium, giardia and viruses) are often present in very low numbers, can be hard to detect, and the analytical tests are expensive.

- Freshwater (including estuarine waters): *Escherichia coli (E. coli)*
- Marine waters: Enterococci
- Recreational shellfish-gathering waters: Faecal coliforms

Compliance with the MfE/MoH (2003) microbiological water quality guidelines should ensure that people using water for contact recreation are not exposed to significant health risks. The guideline values are outlined in Sections 3 (fresh waters) and 4 (marine and shellfish gathering waters) of this report. In essence, the guidelines are 'trigger' values to help water managers determine when management intervention is required. The 'trigger' values underpin a three-tier management framework analogous to traffic lights (Table 2.1).

Table 2.1: Three-tier management framework for recreational waters advocated by MfE/MoH (2003)

Mode	Management response
Green/Surveillance	Routine monitoring
Amber/Alert	Increased monitoring, investigation of source and risk assessment
Red/Action	Closure, public warnings, increased monitoring and investigation of source

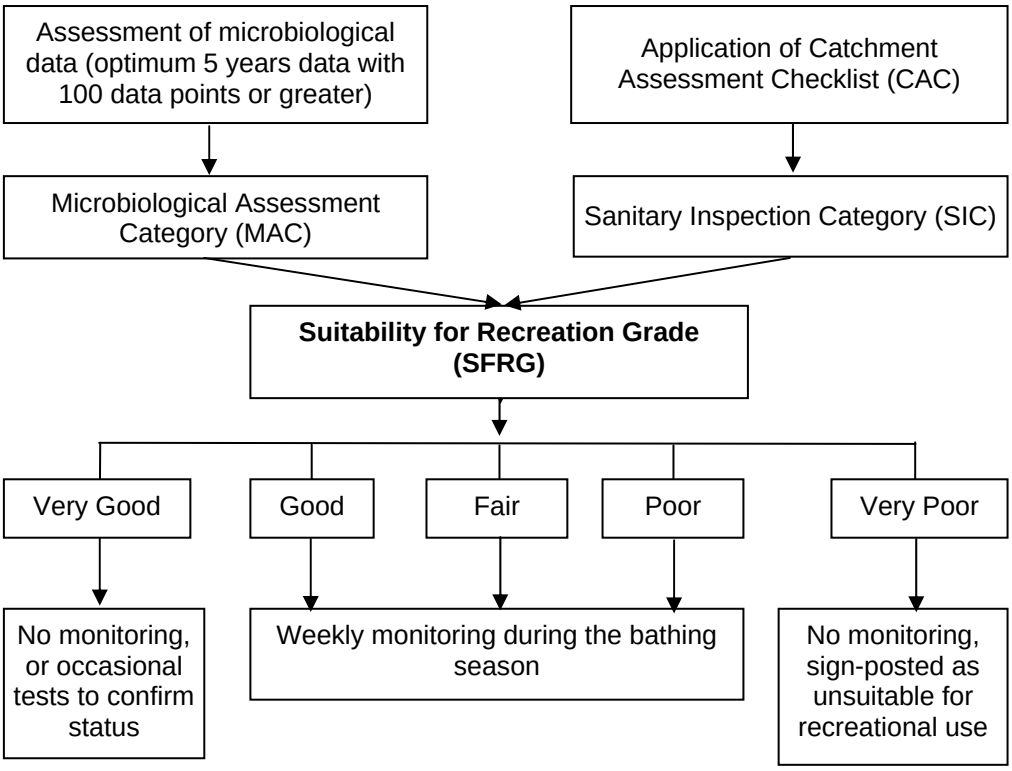
2.3.1 Suitability for Recreation Grades

In addition to the use of quantitative guideline values, the MfE/MoH (2003) guidelines advocate a risk-based approach to managing recreational waters. This involves combining a qualitative assessment of the susceptibility of a recreational site to faecal contamination and direct measurements of appropriate bacteriological indicators at the site to generate a 'Suitability for Recreation Grade' (SFRG) for the site (Figure 2.1).

The SFRG describes the general condition of the water at a site at any given time, based on both risk and indicator bacteria counts. This grade helps determine whether on-going monitoring is required, and provides the basis for advising people whether or not the water at a site is suitable for recreational use from a public health perspective. The risk of becoming sick from contact with the water at a site increases as the grading shifts from 'very good' to 'very poor' (Appendix 2). Conditions affecting water quality will vary the most for the middle range of grades ('good', 'fair', and 'poor'). For example, the water at 'good' sites will usually comply with the guidelines, but events such as high rainfall can increase the risk of microbiological contamination from run-off. Consequently, weekly water quality monitoring at these middle-range sites is recommended during the bathing season.

The two components providing a SFRG for the water at an individual site are:

- The Sanitary Inspection Category (SIC), which is a measure of the susceptibility of the water body to faecal contamination based on a Catchment Assessment Checklist (CAC); and
- The Microbiological Assessment Category (MAC), which is a measure of the actual water quality over time based on bacteriological test results.



(Source: Modified from MfE/MoH (2003), pC3)

Figure 2.1: Overview of the bathing site grading process and surveillance requirements

The SIC allows the principal source of faecal contamination (eg, sewage overflows, stormwater discharge, agricultural runoff, wildlife, etc.) to be identified and assigns a category according to risk. This category is 'very high', 'high', 'moderate', 'low', or 'very low', and is found for a specific water body by use of a SIC flow chart. The information used in the flow chart comes from a Catchment Assessment Checklist (CAC). The CACs completed for the majority of the 23 freshwater and 76 coastal monitoring sites in 2002 were reviewed in 2006 (Milne & Wyatt 2006) and again in 2011 (Greenfield et al. 2012). In 2011, new CACs were also completed for sites added to the programme since 2006.

The MAC value is established by taking the 95th percentile value from an existing or collected set of microbiological water quality data. The MfE/MoH (2003) guidelines state that ideally there should be 100 data points or greater, collected over the previous five years, although it is feasible to consider grading with a minimum of 20 data points collected over one full bathing season; in such cases the SFRG is deemed *interim* until five years of microbiological water quality data have been collected. The MAC values presented in this report are based on data collected during routine monitoring over the 2006/07 to 2010/11 summer bathing seasons. Any exceptions to this (eg, more recently established site for which there is less than five years of monitoring data) are noted in the presentation of the SFRGs in Sections 3 and 4.

2.3.2 Periphyton and cyanobacteria

In addition to microbiological indicators, nuisance periphyton and benthic cyanobacteria cover are also assessed at fresh water sites. Excessive amounts of periphyton and cyanobacteria can reduce the amenity value of waterways and, in the case of benthic cyanobacteria, can also pose a health risk. The guidelines used to assess periphyton and cyanobacteria cover are outlined in Section 3.1.2.

3. Recreational water quality in fresh waters

3.1 Introduction

Between 2005/06 and 2009/10, recreational water quality was monitored at 23 river sites across the Wellington region (Figure 3.1, Appendix 1). These sites were selected on the basis of their use by the public for contact recreation; in particular, swimming, canoeing and rafting. Four of the sites are located on the Kapiti Coast, seven in the Hutt Valley and Wainuiomata, and 12 in the Wairarapa.

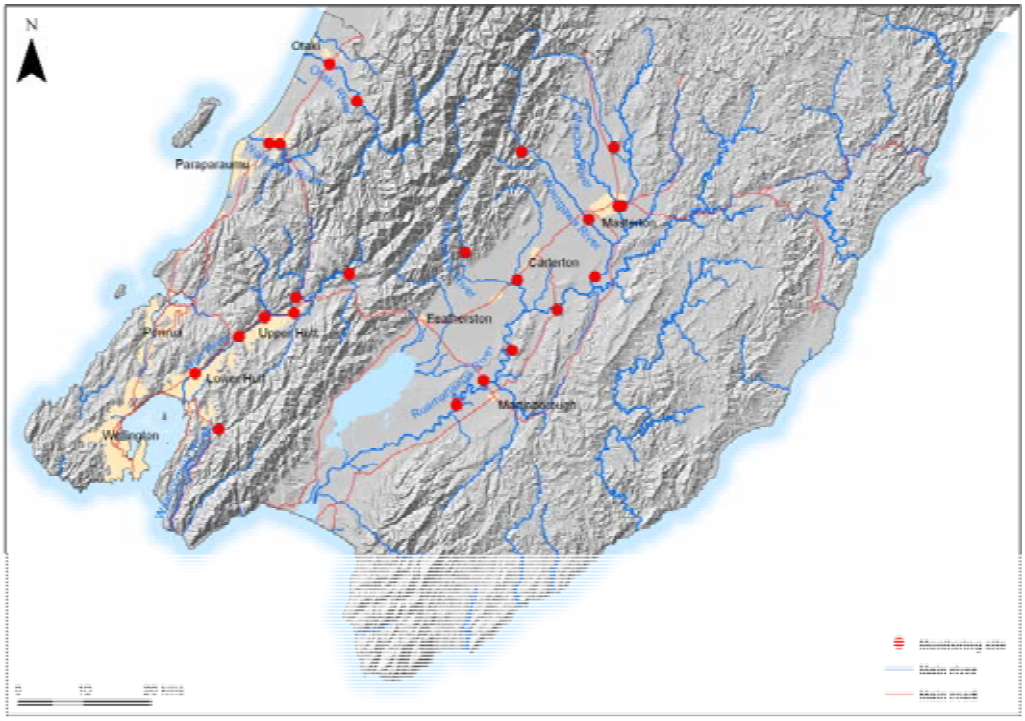


Figure 3.1: River recreational water quality monitoring sites in the Wellington region sampled between 2005/06 and 2009/10

This section provides a brief overview of the sampling protocols and guidelines used to monitor freshwater recreation sites in the Wellington region as well as the approach taken to assess and present monitoring results collected over the 2005/06 to 2009/10 summer bathing seasons. Microbiological water quality monitoring results and Suitability for Recreation Grades (SFRGs), along with periphyton and cyanobacteria monitoring results, are then presented for each of four groups of rivers: Otaki and Waikanae rivers; Hutt, Pakuratahi and Wainuiomata rivers; tributaries of the Ruamahanga River; and the Ruamahanga River itself. The section concludes with a synthesis of recreational water quality in the region's rivers.

3.1.1 Monitoring protocol

Sites are sampled weekly during the bathing season (1 November–31 March) for a minimum of 20 weeks, with the exception of the Otaki River at Pots and the Waiohine River at Gorge which, from November 2006, have been sampled monthly under Greater Wellington's Rivers State of the Environment (RSoE)

monitoring programme[4]. On each occasion a single water sample is collected 0.2 m below the surface in 0.5 m water depth and analysed for the indicator bacteria *Escherichia coli* (*E. coli*). Measurements of water temperature and turbidity, and visual estimates of periphyton (algae and cyanobacteria) cover, are also made at each river site (see Appendix 3 for methods).

3.1.2 Guidelines

(a) Microbiological guidelines

As outlined in Section 2.3, the MfE/MoH (2003) recreational water quality guidelines use bacteriological 'trigger' values to help water managers determine when management intervention is required. The 'trigger' values underpin a three-tier management framework analogous to traffic lights (Table 3.1).

Table 3.1: MfE/MoH (2003) surveillance, alert and action levels for fresh waters

Mode	Guideline *E. coli* (cfu/100mL)	Management response
Green/Surveillance	Single sample ≤260	Routine monitoring
Amber/Alert	Single sample >260 and ≤550	Increased monitoring, investigation of source and risk assessment
Red/Action	Single sample >550	Closure, public warnings, increased monitoring and investigation of source

When water quality falls into the 'surveillance mode', this indicates that the risk of illness from bathing is acceptable (for fresh waters the accepted level of risk is 8 in every 1,000 bathers). If water quality falls into the 'alert' category, this indicates an increased risk of illness from bathing, but still within an acceptable range. However, if water quality enters the 'action' category, then the water poses an unacceptable health risk from bathing (MfE/MoH 2003). At this point, warning signs are erected at the bathing site, and the public is informed that it is unsafe to swim at that site. The only time a warning is unlikely to be issued is when an action level result is preceded by rainfall. This is because it is widely known that rainfall and resultant increases in river flow often have a significant effect on river bacteria counts as contaminated runoff from farmland and urban areas is washed from the land into waterways. High river flows can also result in re-suspension of bacteria associated with river sediments into the water column. For this reason Greater Wellington and Regional Public Health advise avoiding swimming and other contact recreation activities in fresh waters during and for at least 48 hours after heavy rainfall.

[4] Historically these sites were sampled separately under two Greater Wellington water quality monitoring programmes; recreational water quality and RSoE water quality. As both river sites have a 'very low' to 'low' risk of microbiological contamination and a high level of compliance with recreational water quality guidelines, Milne and Wyatt (2006) recommended that routine weekly sampling under the recreational water quality monitoring programme cease; the monthly microbiological water quality results obtained from these sites under the RSoE monitoring programme are now used to assess recreational water quality.

(b) Suitability for Recreation Grades

The process to grade the suitability of recreational waters from a public health perspective was outlined in Section 2.3.1 and involves combining a qualitative assessment of the susceptibility of a recreational site to faecal contamination (the SIC component) with direct measurements of the appropriate bacteriological indicator at the site (the MAC component). The SIC and MAC categories used to identify SFRGs for fresh waters are shown in Table 3.2 and the five different SFRGs are explained in detail in Appendix 2.

Table 3.2: MfE/MoH (2003) Suitability for Recreation Grades (SFRGs) for fresh waters

Susceptibility to faecal influence		Microbiological Assessment Category (MAC)[1]			
		A ≤130 *E. coli*/100mL	B 131–260 *E. coli*/100mL	C 261–550 *E. coli*/100mL	D >550 *E. coli*/100mL
Sanitary Inspection Category (SIC)	Very Low	Very Good	Very Good	Follow Up[3]	Follow Up[3]
	Low	Very Good	Good	Fair	Follow Up[3]
	Moderate	Follow Up[2]	Good	Fair	Poor
	High	Follow Up[2]	Follow Up[2]	Poor	Very Poor
	Very High	Follow Up[2]	Follow Up[2]	Follow Up[2]	Very Poor

[1] 95th percentile value calculated using the Hazen percentile method from five years of data obtained from routine weekly monitoring during the bathing season.

[2] Indicates unexpected results requiring investigation (reassess SIC and MAC).

[3] Implies non-sewage sources of indicator bacteria that require verification.

During the establishment of SFRG grades for river sites in the Wellington region Milne and Wyatt (2006) identified that SFRGs for many sites were 'poor' or 'very poor' due to the influence of a small number of elevated *E. coli* results recorded following heavy rainfall. As such, SFRGs for these sites were considered to be more representative of wet weather conditions during which contact recreation was less likely to occur.

In the 2011 review of the SFRGs, Greenfield et al. (2012) excluded *E. coli* indicator counts associated with significant rain events when calculating the MAC value for each river site (refer Section 3.1.3(b) for details). The MfE/MoH (2003) guidelines allow for this exclusion if the modified SFRG grade better reflects the water quality conditions the public are usually exposed to and the modification is verified by the Regional Medical Officer of Health. The caveat is that modified grades should only be used where occasional and predictable contamination events are identified (eg, heavy rainfall) and interventions can be demonstrated to be effective in discouraging recreational use during these times. This requires adequate communication to river users of the increased risk of microbial contamination through measures such as signage at affected sites, media releases and website postings.

(c) Periphyton guidelines

In addition to microbiological guidelines, nuisance periphyton and benthic cyanobacteria guidelines are applied at freshwater sites. Methods used to

assess periphyton cover are provided in Appendix 3. Periphyton cover estimates from Kapiti and Hutt river sites in 2005/06 could not be compared to periphyton guidelines as only total periphyton cover was estimated.

(i) Nuisance periphyton guidelines

In fresh waters, excessive amounts of periphyton can reduce the amenity value of waterways by decreasing their aesthetic appearance, reducing visibility, and being a physical nuisance to swimmers.

The MfE (2000) periphyton guidelines provide two maximum thresholds for periphyton cover in gravel/cobble bed streams managed for aesthetic and recreational values: 30% filamentous algae >2 cm long, and 60% cover for diatoms/cyanobacteria >0.3 cm thick. These thresholds relate to the visible areas of stream bed only.

(ii) Interim cyanobacteria guidelines

Growth of benthic mat-forming cyanobacteria in rivers can pose a health risk. The most widespread mat forming genus in New Zealand is *Phormidium* (Heath et al. 2010), of which many species are known to produce natural toxins, known as cyanotoxins. These toxins are a health threat to humans and animals when consumed or when there is contact with contaminated water (MfE/MoH 2009; Wood & Young 2011).

Since the summer of 2008/09 the health risk from potentially toxic cyanobacteria has been managed using a three-tier warning system developed by Greater Wellington, territorial authorities and Regional Public Health for the Wellington region (Table 3.3). This system was subsequently adopted by the (MfE/MoH 2009) Interim New Zealand guidelines for cyanobacteria in recreational lakes and rivers released for trial by monitoring and health agencies in 2009[5]. Alert and action level signs used to warn the public of the risk from benthic cyanobacteria are shown in Figure 3.2.

Table 3.3: Alert-level framework for benthic cyanobacteria cover in rivers (Modified from MfE/MoH 2009)

Alert level	Guideline	Management action
Surveillance (green mode)	≤20% coverage of potentially toxic cyanobacteria attached to substrate.	Undertake routine monitoring
Alert (amber mode)	20–50% coverage of potentially toxic cyanobacteria attached to substrate.	Notify public health, erect signs with information on appearance of mats and potential risks and consider testing for cyanotoxins.
Action (red mode)	>50% cyanobacteria coverage or cyanobacteria are visibly detaching from substrate and accumulating on the river's edge or becoming exposed on river's edge and the river level drops.	Notify public health unit, notify the public of potential risk to health, and consider testing for cyanotoxins.

[5] The interim version of the cyanobacteria guidelines was to be trialled until the end of the 2011/12 summer – the guidelines are then to be revised based on feedback from practitioners and released as a final version.

Figure 3.2: Alert (left) and action (right) level warning signs used to inform the public of the health risk from cyanobacterial mats in rivers in the Wellington region

3.1.3 Data analysis and reporting

All results have been assessed in accordance with the MfE/MoH (2003) recreational water quality guidelines for fresh waters (Table 3.1) and the periphyton guidelines outlined earlier in this section. Although additional water samples are often collected following exceedances of the alert or action guidelines, only results from routine samples are presented here. These routine results are presented as an overall summary – see Appendix 4 for a breakdown of results by site and summer bathing season.

Prior to data analysis, *E. coli* counts below the laboratory detection limit were halved apart from those where the detection limit was <1 cfu/100mL (in which case a result of 1 cfu/100mL was used).

Box-and-whisker plots (box plots) are used to graphically summarise and compare the median and range of *E. coli* concentrations measured across different sampling sites. All plots were generated in Sigmaplot (v11.0), with the whiskers (error bars) above and below the box (interquartile range) set at the 90th and 10th percentiles, respectively (Figure 3.3).

The bulk of the fresh water analysis is based on monitoring results from the 2005/06 to 2009/10 summer bathing seasons. However, in order to present the most up-to-date SFRGs for the region, routine water quality data collected over the 2006/07 to 2010/11 summers were utilised, along with revised SIC grades from a recent re-evaluation of the microbiological risk factors undertaken in consultation with the region's territorial and public health authorities (Greenfield et al. 2012). As noted in Section 1.2, the updated SFRGs effectively indicate the current *state* of recreational water quality.

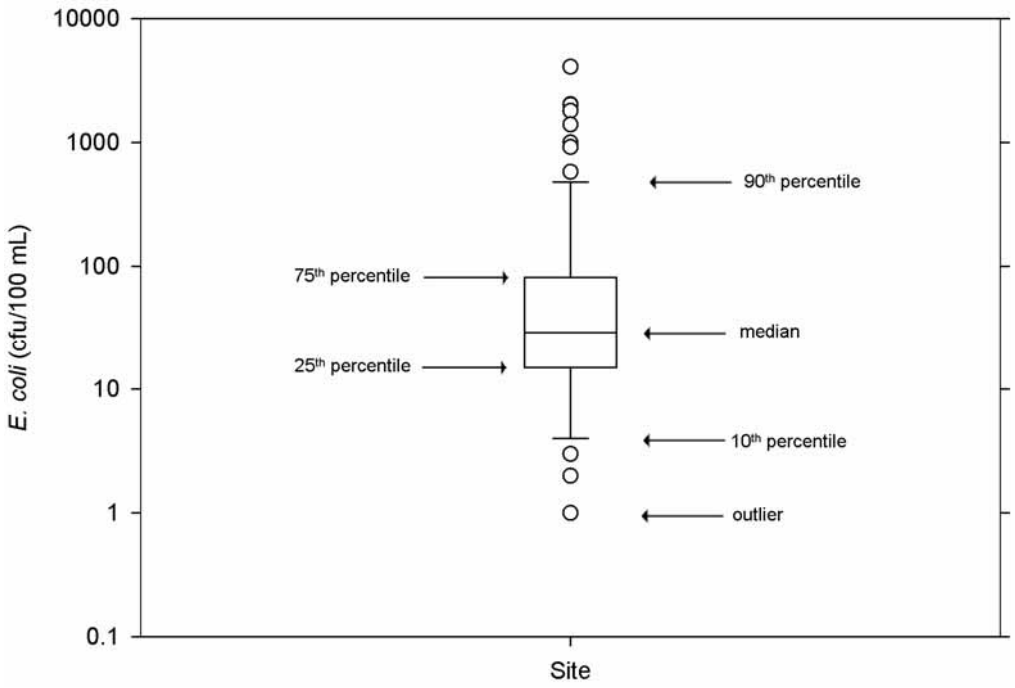


Figure 3.3: An example of a box-plot showing the various summary statistics

(a) Land cover information

Estimates of land cover in the catchment upstream of each river monitoring site were obtained from the interpretation of aerial photographs taken in 2008 and published by the Ministry for the Environment (2010).

(b) Rainfall and river flow analysis

E. coli data were assessed against an estimate of the daily rainfall in the catchment adjoining each site by obtaining records from the nearest rain gauge (Appendix 3). Where possible, an estimate of river flow at the time of sampling was also derived using data from flow sites either at the monitoring site or nearby (see Appendix 5 for methods).

E. coli sample results were assigned into one of four estimated river flow categories: less than half median, half median to median, median to three times median, and greater than three times median flow. Only *E. coli* results recorded from sampling events at or below median flow were used to derive the 'dry weather' SFRGs presented in later sections of this report; this approach, documented in Greenfield et al. (2012), is consistent with the approach of Ausseil and Clark (2007) who considered that primary contact recreation in the Wanganui-Manawatu region was most likely to occur at or below median river flows.

(c) Temporal trend analysis

Where sufficient *E. coli* and river flow data were available, trend analysis was undertaken on data collected over summer bathing seasons between 2001/02 and 2009/10. Trend analysis was only undertaken on data from sites with five years or more of monitoring data. In addition, trend analysis was only undertaken at sites where <5% of routine sampling results were below the

detection limit. *E. coli* data were flow-adjusted using LOWESS (LOcally WEighted Scatterplot Smoothing) with a 30% span. Every data point in the record was adjusted depending on the value of flow as outlined by Smith et al. (1996):

adjusted value = raw value – smoothed value + median value
(where the 'smoothed value' is that predicted from the flow using LOWESS)

The non-parametric Mann Kendall Sen slope estimator (Sen 1968) was used to assess the magnitude and direction of trends in both flow-adjusted and non-flow adjusted *E. coli* data for each site. Values were divided by the raw data median for each site to give a percent change per year. A Mann-Kendall test was then used to assess the statistical significance of the trend with a *p*-value of <0.5 used to represent statistical significance.

Flow adjustment and trend analysis were carried out using NIWA's Time Trends software (version 3.1.1).

3.2 Otaki and Waikanae rivers

Recreational water quality monitoring is undertaken on two rivers in the Kapiti Coast district: the Otaki and the Waikanae (Figure 3.4).

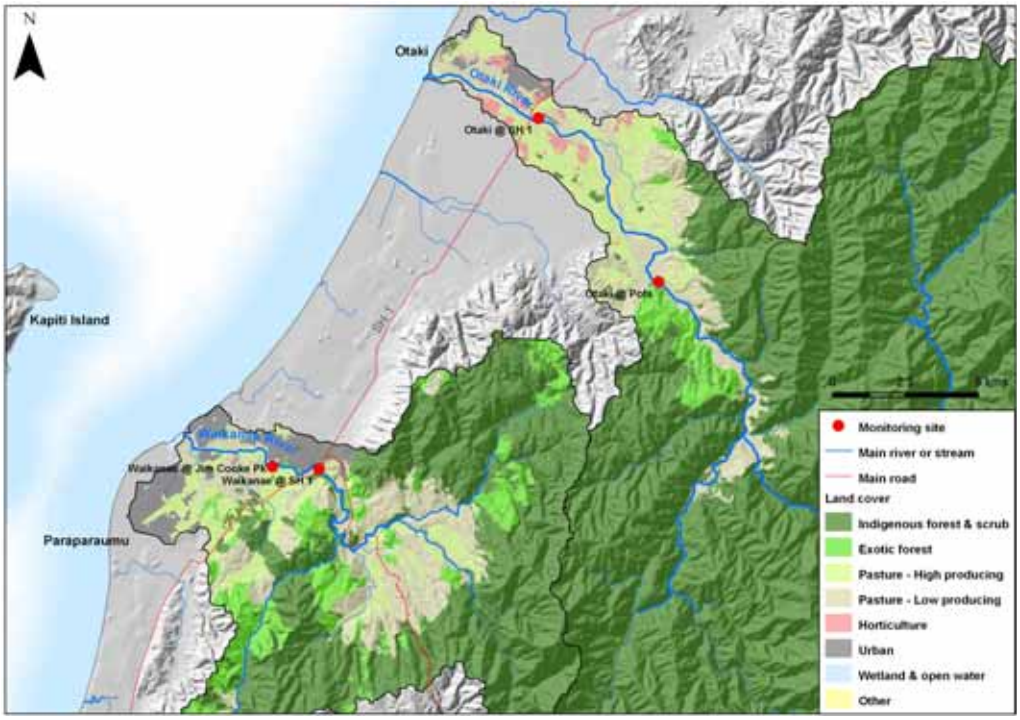


Figure 3.4: Location and catchment land cover of recreational water quality monitoring sites on the Otaki and Waikanae rivers

3.2.1 Catchment land use and impacts

The Otaki River has a catchment area of 350 km^2 and drains the central portion of the Tararua Range before exiting onto the coastal plain. Land cover within the catchments of both Otaki River monitoring sites is predominantly indigenous forest (96% and 89% above the Pots and SH 1, respectively),

although small areas of high and low-producing pasture and horticulture occur within the catchment of the site at SH 1 (Figure 3.4, Appendix 6).

The Waikanae River catchment is much smaller (153 km^2) and drains a south-western portion of the Tararua Range before exiting onto the coastal plain. The catchments of the two Waikanae River monitoring sites are dominated by indigenous forest cover (69% and 68% above SH 1 and Jim Cooke Park, respectively). However, significant areas of exotic forestry and low-producing pasture also occur within the catchments of both sites (Figure 3.4, Appendix 5).

From a recreational water quality perspective, the most significant point source discharge in the Otaki and Waikanae river catchments is treated sewage from the Paraparaumu Wastewater Treatment Plant; this plant, which services the townships of Waikanae, Paraparaumu and Raumati South (estimated combined population of 23,000), discharges into the lower reaches of the Waikanae River via the Mazengarb Drain. However, the effect of the discharge on the Waikanae River is not captured in the freshwater component of Greater Wellington's recreational water quality monitoring programme as the confluence of the Mazengarb Drain with the Waikanae River is downstream of both river monitoring sites.

The other principal discharge to surface water in the Otaki and Waikanae river catchments is urban stormwater which enters both rivers at multiple locations (both directly and indirectly via tributary streams or drains). However, three of the four monitoring sites are upstream of urban areas, meaning only the site on the Waikanae River at Jim Cooke Park is likely to receive any notable quantity of urban stormwater.

Greater Wellington exercises resource consents to undertake flood protection works in the flood plains of the Otaki and Waikanae rivers. At times, these works involve extensive instream works which can affect water quality (notably water clarity).

3.2.2 *E. coli* counts and trends

Median *E. coli* counts were low at all four Kapiti river monitoring sites during the 2005/06 to 2009/10 summer bathing seasons, ranging from just 6 cfu/100mL in the Otaki River at Pots to 70 cfu/100mL in the Waikanae River at SH 1 (Figure 3.5). The maximum *E. coli* count recorded at these sites ranged from 230 cfu/100mL in the Otaki River at Pots on 8 March 2006 to 1,810 cfu/100mL at Waikanae River at SH 1 on 23 March 2010.

No significant trends in *E. coli* counts were detected in routine weekly data collected at Otaki River at Pots or Otaki River at SH 1 during summer bathing seasons between 2001/02 and 2009/10. Analysis of data collected over the same period at Waikanae River at SH 1 showed a statistically significant ($p<0.05$) decreasing trend of 3.6 *E. coli* (4.6%) per year in flow-adjusted counts. There were insufficient data to undertake trend analysis of *E. coli* counts at Waikanae River at Jim Cooke Park.

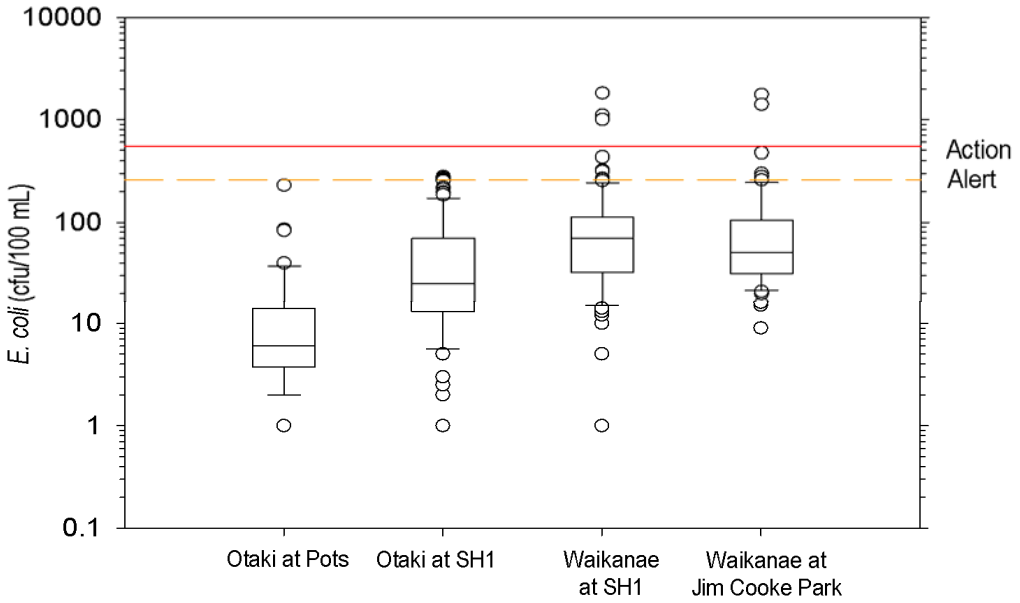


Figure 3.5: Box plot summarising the range of *E. coli* counts recorded at recreational water quality monitoring sites on the Otaki and Waikanae rivers during routine weekly sampling over the 2005/06 to 2009/10 summer bathing seasons. Note the logarithmic scale on the *y*-axis.

No significant trends in *E. coli* counts were detected in routine weekly data collected at Otaki River at Pots or Otaki River at SH 1 during summer bathing seasons between 2001/02 and 2009/10. Analysis of data collected over the same period at Waikanae River at SH 1 showed a statistically significant ($p<0.05$) decreasing trend of 3.6 *E. coli* (4.6%) per year in flow-adjusted counts. There were insufficient data to undertake trend analysis of *E. coli* counts at Waikanae River at Jim Cooke Park.

3.2.3 Compliance with national microbiological water quality guidelines

Based on the results of routine summer sampling between 2005/06 and 2009/10, compliance with the MfE/MoH (2003) surveillance guideline (≤ 260 cfu/100mL) ranged from 91% at Waikanae River at SH 1 to 100% at Otaki River at Pots (Table 3.4). Only the Waikanae River sites exceeded the MfE/MoH (2003) action guideline; the site at SH 1 exceeded the action guideline on three occasions while two exceedances were recorded at Waikanae River at Jim Cooke Park (monitored from 2007/08 onwards). All of these exceedances coincided with significant rainfall prior to sampling, resulting in river flows that were at or above median flow (Figure 3.6).

Table 3.4: Number and percentage of routine weekly sample results coinciding with the surveillance, alert and action modes of the MfE/MoH (2003) guidelines at recreational water quality monitoring sites on the Otaki and Waikanae rivers over the 2005/06 to 2009/10 summer bathing seasons

Site	*n*	Surveillance		Alert		Action	
		No.	%	No.	%	No.	%
Otaki R @ Pots	42[1]	42	100	0	0	0	0
Otaki R @ SH 1	105	102	97.1	3	2.9	0	0
Waikanae R @ SH 1	105	96	91.4	6	5.7	3	2.9
Waikanae R @ Jim Cooke Park	62[2]	57	91.9	3	4.8	2	3.2

[1] From November 2006 onwards sampling at this site was reduced from weekly to monthly.
[2] Sampling at this site began in 2007/08 (replacing the former site downstream at Greenaway Road).

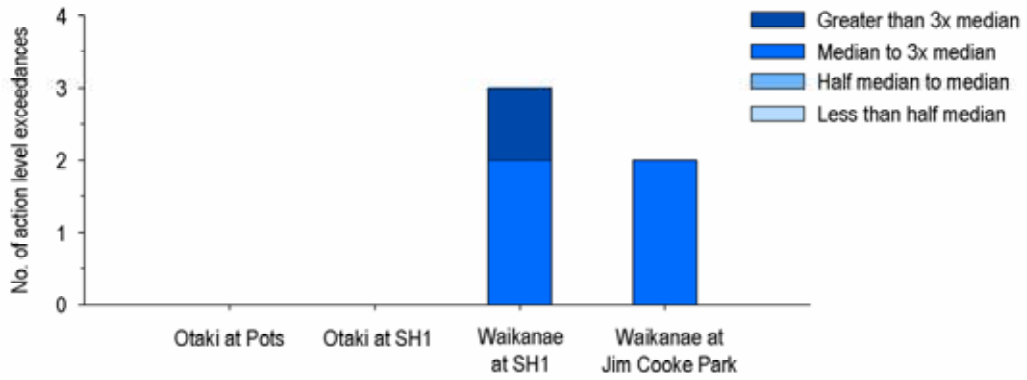


Figure 3.6: Summary of flow categories within which action level exceedances occurred at recreational water quality monitoring sites on the Otaki and Waikanae rivers between the 2005/06 and 2009/10 summer bathing seasons

3.2.4 Suitability for Recreation Grades

When all routine monitoring results under all river flow conditions were considered, SFRGs for Otaki and Waikanae river sites ranged from 'fair' at Waikanae River at SH 1 and Jim Cooke Park to 'very good' at Otaki River at Pots (Table 3.5). The removal of *E. coli* results recorded from sampling at above median river flow conditions resulted in the MAC grades for both Waikanae River sites improving from a 'C' to a 'B', and, subsequently, 'dry weather' SFRGs of 'good' (Table 3.6).

Table 3.5: SFRGs for Otaki and Waikanae river monitoring sites, with MAC grades based on *E. coli* counts from routine sampling under all river flows over the 2006/07 to 2010/11 summer bathing seasons

Site	SIC grade	MAC grade		SFRG
		95th%-ile value	*n*	
Otaki R @ Pots	Low	A (85)[1]	111	Very Good[1]
Otaki R @ SH 1	Moderate	B (234)	103	Good
Waikanae R @ SH 1	Moderate	C (353)	103	Fair
Waikanae R @ Jim Cooke Park	Moderate	C (370)[2]	82	Fair[2]

[1] Based on routine summer data collected weekly between 2002/03 and 2005/06, and monthly between 2006/07 and 2010/11.
[2] Interim MAC grade and SFRG based on 4 years of data.

Table 3.6: 'Dry weather' SFRGs for Otaki and Waikanae river monitoring sites, with MAC grades based on *E. coli* counts from routine sampling at or below median river flows over the 2006/07 to 2010/11 summer bathing seasons

Site	SIC grade	MAC grade		SFRG
		95th%-ile value	*n*	
Otaki R @ Pots	Low	A (44)[1]	69	Very Good[1]
Otaki R @ SH 1	Low	B (220)	70	Good
Waikanae R @ SH 1	Low	B (183)	65	Good
Waikanae R @ Jim Cooke Park	Low	B (208)[2]	55	Good[2]

[1] Based on summer data collected weekly between 2002/03 and 2005/06, and monthly between 2006/07 and 2010/11.
[2] Interim MAC grade and SFRG based on 4 years of data.

3.2.5 Algae and cyanobacteria

(a) Compliance with national periphyton guidelines

There was a high degree of compliance with national periphyton guidelines between 2005/06 and 2009/10. Only one of the four sites, the Otaki River at SH 1, exceeded the MfE (2000) aesthetic guideline threshold for filamentous algae of 30% cover (on two occasions). None of the sites exceeded the 60% cover threshold for mat algae (Table 3.7).

Table 3.7: Number of exceedances of the MfE (2000) nuisance periphyton guidelines for filamentous (F) and mat (M) algae cover recorded at monitoring sites on the Otaki and Waikanae rivers during routine weekly assessments over the 2005/06 to 2009/10 summer bathing seasons

Monitoring site	2005/06		2006/07		2007/08		2008/09		2009/10		Total	
	F	M	F	M	F	M	F	M	F	M	F	M
Otaki R @ Pots	*	*	0	0	0	0	0	0	0	0	0	0
Otaki R @ SH 1	*	*	1	0	0	0	1	0	0	0	2	0
Waikanae R @ SH 1	*	*	0	0	0	0	0	0	0	0	0	0
Waikanae R @ Jim Cooke Park	Not monitored				0	0	0	0	0	0	0	0

* Periphyton cover estimates could not be compared to periphyton guidelines because only total periphyton cover was estimated.

(b) Cyanobacteria

Patches of potentially toxic cyanobacteria growth were observed on the bed of the Otaki River at SH 1 in 2005/06 and 2006/07 prompting KCDC to put up general health warning signs in the area.

Moderate growth of cyanobacteria has been recorded on the bed of the Waikanae River at Jim Cooke Park every bathing season since monitoring began there in 2007/08[6]. Moderate cyanobacteria growth was also recorded in the Waikanae River at SH 1 during 2008/09 and 2009/10, prompting alert level health warning signs to be put in place at key public access points around these sites. Prior to this, general health warning signs were issued.

No cyanobacteria related dog deaths or human illness were reported from Kapiti rivers during the 2005/06 to 2009/10 period.

[6] Prior to 2007/08, monitoring occurred further downstream at Greenaway Road. This site was also affected by benthic cyanobacteria growths (Milne 2007).

3.3 Hutt, Pakuratahi and Wainuiomata rivers

Recreational water quality monitoring is undertaken at six sites in the Hutt River catchment; one on the Pakuratahi River and five on the main stem of the Hutt River (Figure 3.7). A single site is monitored on the Wainuiomata River.

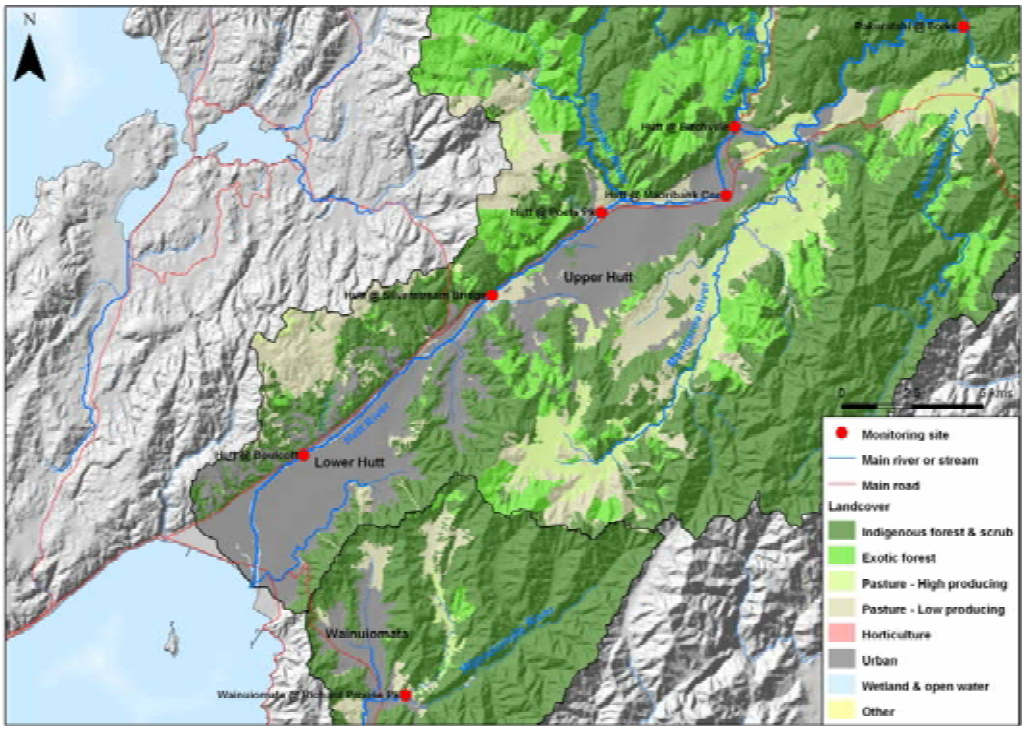


Figure 3.7: Location and catchment land cover of recreational water quality monitoring sites on the Pakuratahi, Hutt and Wainuiomata rivers

3.3.1 Catchment land use and impacts

The Hutt River is a gravel bed river that rises in the southern end of the Tararua Range and traverses the entire length of the Hutt Valley before ultimately discharging into Wellington Harbour. The river drains a total catchment area of 638 km^2.

The headwaters of the Hutt River are within steep, forested greywacke country. In its mid reaches the Hutt River receives flow inputs from four major tributaries: the Pakuratahi, Mangaroa, Akatarawa and Whakatikei rivers. Landcover within these tributary catchments is largely indigenous forest or scrub apart from the Mangaroa River which is dominated by high and low producing pasture as well as exotic forestry (Figure 3.8). In its mid and lower reaches the Hutt River flows through a large urbanised flood plain taking in the cities of Upper Hutt and Lower Hutt.

In contrast with the Hutt, the Wainuiomata River has a total catchment area of 134 km^2 and flows from its headwaters in the Rimutaka Range to its mouth at the open coast near Baring Head. A large proportion (91%) of the land cover in the catchment upstream of the monitoring site at Richard Prouse Park is indigenous forest and scrub, with much of this lying within a public water supply catchment zone. Landcover within the rest of the catchment includes high (2%) and low producing (4%) pasture as well as exotic forestry (2%), most of which occurs in

the catchment of the Wainuiomata Stream which enters the Wainuiomata River immediately upstream of the monitoring site at Richard Prouse Park.

From a recreational water quality perspective, the most significant point source discharge in the Hutt and Wainuiomata river catchments is urban stormwater which enters both rivers at multiple locations (both directly and indirectly via tributary streams or drains). In addition, Hutt City Council (HCC) has a resource consent to discharge un-treated sewage into both rivers (at Silverstream and Moera on the Hutt, and at the Coast Road storm tank on the Wainuiomata) during heavy rainfall events when the capacity of the sewer and stormwater network is exceeded. Such discharges are most unlikely to occur at times when people would use the rivers for recreation.

Greater Wellington also exercises resource consents to undertake flood protection works in the Hutt and Wainuiomata rivers as they flows through the flood plain. At times, these works involve extensive instream works which can affect water quality (notably water clarity).

3.3.2 *E. coli* counts and trends

Based on routine weekly monitoring between the 2005/06 and 2009/10 summer bathing seasons, median *E. coli* counts were low at Hutt, Pakuratahi and Wainuiomata river monitoring sites, ranging from 45 cfu/100mL in the Hutt River at Poets Park to 92 cfu/100mL in the Wainuiomata River at Richard Prouse Park (Figure 3.8). However, maximum *E. coli* counts recorded at these

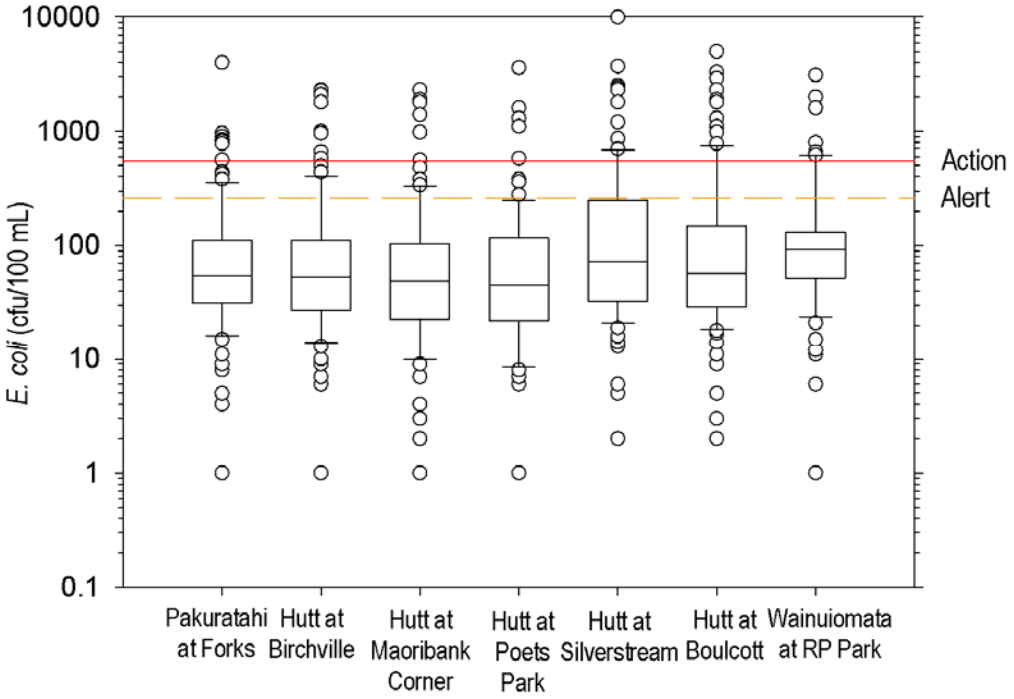


Figure 3.8: Box plot summarising the range of *E. coli* counts recorded at Pakuratahi, Hutt and Wainuiomata river sites during routine weekly sampling over the 2005/06 to 2009/10* summer bathing seasons. Note the logarithmic scale on the *y*-axis.

* Monitoring at Wainuiomata River at Richard Prouse Park only commenced in November 2007.

sites were high, ranging from 2,300 cfu/100mL in the Hutt River at Birchville and Maoribank sites (on 14 March 2006 and 16 December 2010, respectively) to 10,000 cfu/100mL at Hutt River at Silverstream on 20 December 2005.

No significant trends in *E. coli* counts were detected in routine weekly data collected at Hutt or Pakuratahi river monitoring sites during summer bathing seasons between 2001/02 and 2009/10. There were insufficient data to undertake trend analysis of *E. coli* counts at Wainuiomata River at Richard Prouse Park.

3.3.3 Compliance with national microbiological water quality guidelines

Compliance with the MfE/MoH (2003) surveillance guideline at Hutt and Pakuratahi river sites during routine summer sampling between 2005/06 and 2009/10 ranged from 76% at Hutt River at Silverstream to 90% at Hutt River at Poets Park (Table 3.8). The number of exceedances of the MfE/MoH (2003) action guideline ranged from five at Hutt River at Poets Park to 14 at Hutt River at Silverstream. The Wainuiomata River at Richard Prouse Park exceeded the action guideline on seven occasions between 2007/08 and 2009/10.

Table 3.8: Number and percentage of routine weekly sample results coinciding with the surveillance, alert and action modes of the MfE/MoH (2003) guidelines at recreational water quality monitoring sites on the Pakuratahi, Hutt and Wainuiomata rivers over the 2005/06 to 2009/10 summer bathing seasons

Site	*n*	Surveillance		Alert		Action	
		No.	%	No.	%	No.	%
Pakuratahi R @ Forks	104	92	88.5	6	5.8	6	5.8
Hutt R @ Birchville	104	93	89.4	3	2.9	8	7.7
Hutt R @ Maoribank Corner	104	92	88.5	3	2.9	9	8.7
Hutt R @ Poets Park	104	94	90.4	5	4.8	5	4.8
Hutt R @ Silverstream	104	79	76.0	11	10.6	14	13.5
Hutt R @ Boulcott	104	81	77.9	10	9.6	13	12.5
Wainuiomata R @ RP Park	62[1]	54	87.1	1	1.6	7	11.3

[1] Data from 2007/08–2009/10.

With only a few exceptions, all exceedances of the action guideline at Pakuratahi River at Forks and the three northern-most Hutt River sites coincided with heavy rainfall and above median river flows (Figure 3.9). In contrast, five out of the 14 action exceedances at Hutt River at Silverstream and four out of 13 exceedances at Hutt River at Boulcott occurred during low flows – indicating non-rainfall related contamination. Both of these sites also exceeded the alert guideline (260 cfu/100mL) on numerous occasions (11 and 10 at Silverstream and Boulcott, respectively), with most of these exceedances occurring at less than half median river flow.

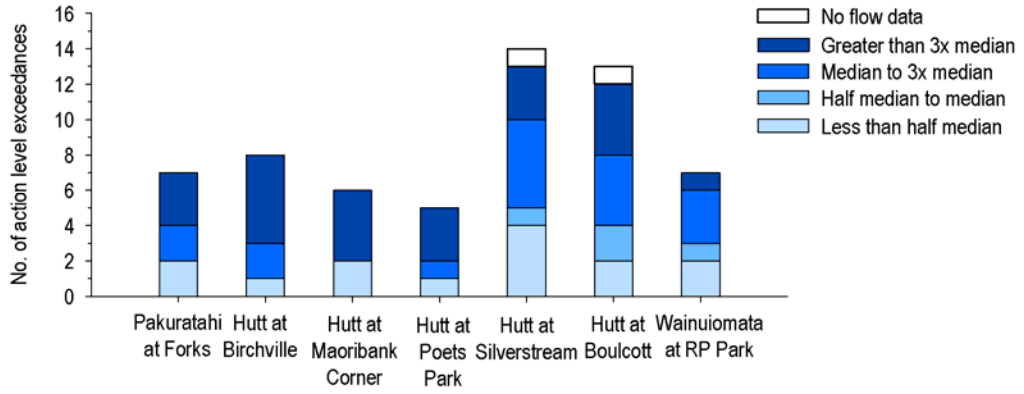


Figure 3.9: Summary of flow categories within which action level exceedances occurred at recreational water quality monitoring sites on the Hutt, Pakuratahi and Wainuiomata rivers during summer bathing seasons between 2005/06 and 2009/10. Note that no flow data were available on two sampling occasions where action level exceedances occurred

There are several possible contributing sources to the high number of action guideline exceedances at the two sites on the lower reaches of the Hutt River. Microbial source tracking tests performed on weekly samples taken from Hutt River at Silverstream between 15 February 2011 and 8 March 2011 inclusive suggested contamination from ruminants in two out of the four samples (Cornelisen et al. 2011). However, *E. coli* counts were low (maximum count of 114 cfu/100mL) on all sampling occasions suggesting that these four samples may not represent the conditions in which contamination had occurred at this site in the past. Although there are no known problems with stormwater or sewer infrastructure in urban areas around Silverstream and Boulcott, contaminated discharges may occur on occasion, particularly during very wet weather. Bird sources may also contribute to the exceedances, particularly during dry weather; large populations of seagulls are often present at Hutt River at Silverstream and the Mawaihakona Stream, which discharges to the Hutt River approximately 600 m upstream of Silverstream, is known to support a large duck population where the stream passes through Heretaunga Park. Guideline exceedances at Hutt River at Boulcott also often coincided with observations of ducks upstream. In addition, two action and two alert exceedances at this site coincided with observations of diggers or bulldozers working in the river upstream as part of flood protection works. These works may contribute to elevated indicator bacteria counts through re-suspension of bacteria and pathogens associated with bottom sediments. This requires further investigation.

The action guideline was exceeded on numerous occasions at Wainuiomata River at Richard Prouse Park, despite this site having only been monitored since November 2007. Seven exceedances were recorded at this site between 2007/08 and 2009/10, three of which occurred at median flows or less – indicating non-rainfall related contamination. The source of this contamination is not certain but is likely to lie within the Wainuiomata Stream catchment which enters the Wainuiomata River approximately 60 m upstream of the monitoring site at Richard Prouse Park. Land use along the length of this stream includes both high and low producing pasture; as such, contaminated diffuse runoff as well as direct contamination through stock access to the stream are likely. In addition, it is possible that on-site wastewater treatment

systems in the Wainuiomata Stream catchment are also contributing to contamination at the Richard Prouse Park site. Hutt City Council has identified a number of poorly performing systems in the Moores Valley area and is undertaking further investigations of these (G. George[7], pers. comm. 2012).

3.3.4 Suitability for Recreation Grades

Based on routine monitoring results collected over the 2006/07 to 2010/11 summers, all Pakuratahi, Hutt and Wainuiomata river sites have a SFRG of 'poor'. The only exception is the Hutt River at Poets Park which has a SFRG of 'fair' (Table 3.9). The higher grade for Poets Park reflects the dilution effect provided by higher quality water discharging upstream of the site from the Whakatikei River (see Greenfield et al. 2012 for more details).

The removal of *E. coli* sample results recorded during above median river flow conditions resulted in improved MAC grades and SFRGs for six of the eight sites (Table 3.10); SFRGs for the Hutt River at Boulcott and Wainuiomata River at Richard Prouse Park remained 'poor' regardless of flow, indicating that the SFRGs for these sites are applicable in both 'dry' and 'all weather' conditions.

Table 3.9: SFRGs for Pakuratahi, Hutt and Wainuiomata river monitoring sites, with MAC grades based on *E. coli* counts from routine sampling under all river flows over the 2006/07 to 2010/11 summer bathing seasons

Site	SIC grade	MAC grade		SFRG
		95th%-ile value	*n*	
Pakuratahi R @ Forks	Moderate	D (637)	103	Poor
Hutt R @ Birchville	Moderate	D (779)	103	Poor
Hutt R @ Maoribank Corner	Moderate	D (1,127)	103	Poor
Hutt R @ Poets Park	Low	C (422)	103	Fair
Hutt R @ Silverstream	Moderate	D (860)	101	Poor
Hutt R @ Boulcott	Moderate	D (1,345)	101	Poor
Wainuiomata R @ RP Park	Moderate	D (716) [1]	82	Poor[1]

[1] Interim MAC grade and SFRG based on 4 years of data.

Table 3.10: 'Dry weather' SFRGs for Pakuratahi, Hutt and Wainuiomata river monitoring sites, with MAC grades based on *E. coli* counts from routine sampling at or below median river flows over the 2006/07 to 2010/11 summer bathing seasons

Site	SIC grade	MAC grade		SFRG
		95th%-ile value	*n*	
Pakuratahi R @ Forks	Low	C (271)	84	Fair
Hutt R @ Birchville	Moderate	B (181)	69	Good
Hutt R @ Maoribank Corner	Low	B (240)	70	Good
Hutt R @ Poets Park	Low	B (140)	70	Good
Hutt R @ Silverstream	Moderate	C (320)	70	Fair
Hutt R @ Boulcott	Moderate	D (594)	71	Poor
Wainuiomata R @ RP Park	Moderate[1]	D (585)	65	Poor[1]

[1] Interim MAC grade and SFRG based on 4 years of data.

[7] Gordon George, Manager Trade Waste, Hutt City Council.

3.3.5 Algae and cyanobacteria

(a) Compliance with national periphyton guidelines

No exceedances of the MfE (2000) aesthetic guidelines for filamentous algae or mat cover were recorded at Pakuratahi River at Forks or at the three northern most Hutt River sites during routine weekly monitoring between 2005/06 and 2009/10 (Table 3.11). In contrast, the sites on the lower reaches of the Hutt River at Silverstream and Boulcott both exceeded guidelines for filamentous algae and mat algae cover on one or more occasions. The Wainuiomata River at Richard Prouse Park exceeded the guideline for filamentous algae cover on five occasions and the guideline for mat algae cover on two occasions.

Table 3.11: Number of exceedances of the MfE (2000) nuisance periphyton guidelines for filamentous (F) and mat (M) algae cover recorded at Pakuratahi, Hutt and Wainuiomata river sites during routine weekly assessments over the 2005/06 to 2009/10 summer bathing seasons

Site	2005/06		2006/07		2007/08		2008/09		2009/10		Total	
	F	M	F	M	F	M	F	M	F	M	F	M
Pakuratahi R @ Forks	*	*	0	0	0	0	0	0	0	0	0	0
Hutt R @ Birchville	*	*	0	0	0	0	0	0	0	0	0	0
Hutt R @ Maoribank Corner	*	*	0	0	0	0	0	0	0	0	0	0
Hutt R @ Poets Park	*	*	0	0	0	0	0	0	0	0	0	0
Hutt R @ Silverstream	*	*	1	0	0	3	0	0	0	0	1	3
Hutt R @ Boulcott	*	*	1	2	0	0	0	0	2	0	3	2
Wainuiomata R @ RP Park	Not monitored				2	0	0	0	3	2	5	2

* Periphyton cover estimates could not be compared to periphyton guidelines as only total periphyton cover was estimated.

(b) Cyanobacteria

Moderate to high cover of potentially toxic benthic cyanobacteria was recorded at Hutt River monitoring sites during every summer bathing season between 2005/06 and 2009/10. Cyanobacteria cover was generally greatest at Hutt River at Silverstream (Figure 3.10) and Hutt River at Boulcott. However, moderate to high cover was also recorded at the other three Hutt River sites at times.

At least five dogs died after coming into contact with cyanobacteria mats in the Hutt River in November and December 2005. During this period and for much of the 2005/06 summer bathing season there was thick cyanobacteria growth in Hutt River in the Boulcott/Avalon area. This extensive cyanobacteria growth coincided with an unusually low number of 'flushing flows' and sustained low flow conditions during spring 2005 (Milne & Watts 2007).

In the 2007/08 summer bathing season, during which an extended period of lower than average flows occurred in the Hutt River, cyanobacteria growth was widespread from the Hutt River at Birchville downstream for much of the season. Three dogs died after coming into contact with cyanobacteria mats in the Silverstream/Kennedy Good Bridge area in early January 2008.

Figure 3.10: Cyanobacterial mats along the left bank of the Hutt River at Silverstream in autumn 2009

Alert level warning signs were in place along the Hutt River at, and downstream of, Birchville for much of the 2008/09 and 2009/10 summer bathing seasons. In 2008/09 an action level warning was put in place at, and downstream of, the Belmont area (including the Boulcott site) from late January until mid February. Prior to this, general health warning signs or website warnings were issued each bathing season.

Moderate growth (up to 48% cover) of cyanobacteria mats was recorded in the Wainuiomata River at Richard Prouse Park in 2007/08 and 2008/09. No significant cyanobacteria mat growth was recorded at Pakuratahi River at Forks between 2005/06 and 2009/10.

3.4 Ruamahanga River tributaries

Recreational water quality is monitored on three tributaries of the Ruamahanga River: the Waipoua, Waingawa and Waiohine rivers (Figure 3.11). One site is monitored on the Waipoua River while two sites are monitored on each of the Waingawa and Waiohine rivers.

3.4.1 Catchment land cover and impacts

All three rivers have their headwaters in the Tararua Range before flowing through low-lying farmland into the Ruamahanga River. Indigenous forest and scrub cover is close to 100% upstream of the Waingawa River at Kaituna and Waiohine River at Gorge sites (Figure 3.11). Indigenous forest and scrub are also the dominant vegetation cover in the catchments of the lower reach sites on these two rivers there is considerable high and low producing pasture in the lower reaches.

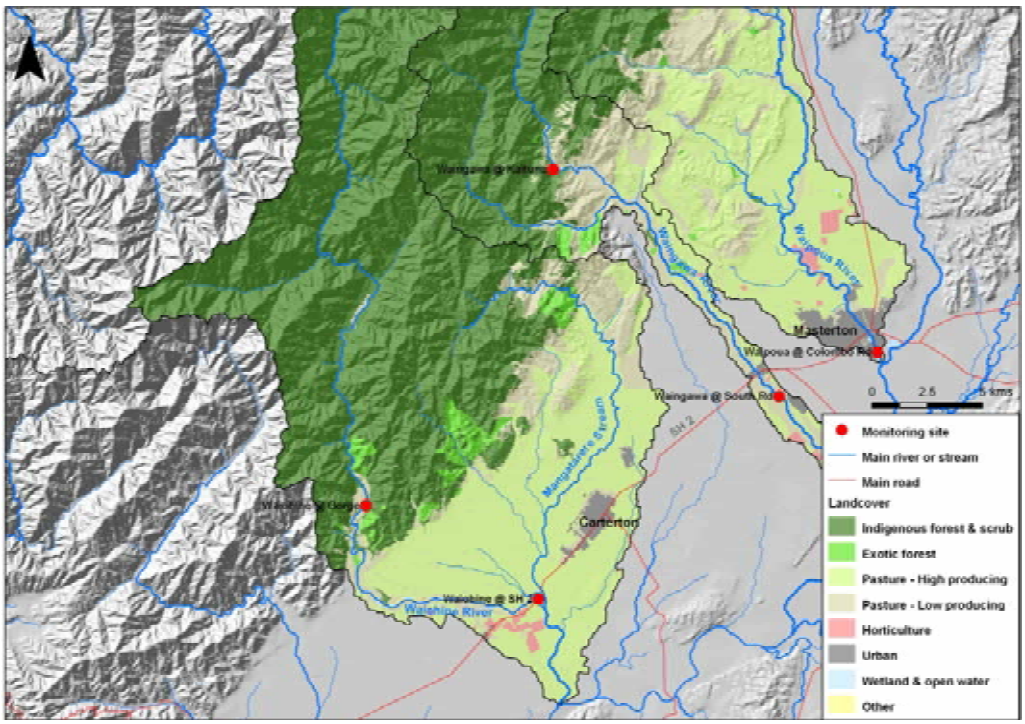


Figure 3.11: Location and catchment land cover of recreational water quality monitoring sites on the Waipoua, Waingawa and Waiohine rivers

Although land cover upstream of Waipoua River at Colombo Road is dominated by high (48%) and low producing pasture (24%), the river is also influenced by urban land use as it flows through Masterton township. For example, Masterton District Council (MDC) exercises a resource consent to discharge stormwater into the lower reaches of the Waipoua River via a number of outfalls, including from the Queen Elizabeth Park which discharges to the river approximately 400 m upstream of the Colombo Road site. These stormwater discharges are considered to be protected from sewage contamination in all but extreme rainfall events (D. John[8], pers. comm. 2011). MDC also holds a consent to discharge untreated sewage to a trench system near the Waipoua River at the Colombo Road bridge during extreme weather events. In the past there have been discharges from this system to the river but recent upgrades to the sewerage infrastructure in this area means that such discharges are now highly unlikely to occur (D. John, pers. comm. 2011) – and certainly not at times when people would use the river for recreation.

Waiohine River at SH 2, the lower monitoring site on the Waiohine River, is immediately upstream of the confluence of the Mangatarere Stream. Therefore this site is not impacted by the poor water quality of this stream which arises from a combination of extensive agricultural activities and municipal wastewater and stormwater discharges from Carterton township.

As well as agriculture, one activity that may at times impact on recreational water quality in the mid to lower reaches of all three rivers is instream works, particularly works undertaken by Greater Wellington for flood protection purposes. The principal impact when these works are being undertaken is reduced water clarity arising from sediment disturbance.

[8] David John, Environmental Services Manager, Masterton District Council.

3.4.2 *E. coli* counts and trends

Based on the results of routine water quality monitoring over the 2005/06 to 2009/10 summer bathing seasons, median *E. coli* counts were low at Waipoua, Waingawa and Waiohine river monitoring sites, ranging from just 4 cfu/100mL at Waiohine River at Gorge to 71 cfu/100mL at Waipoua River at Colombo Road (Figure 3.12). Maximum *E. coli* counts recorded at these sites ranged from 86 cfu/100mL at Waiohine River at Gorge (21 February 2006) to 8,100 cfu/100mL at Waipoua River at Colombo Road (21 December 2005).

No significant trends in *E. coli* counts were detected in routine weekly data collected at either of the Waingawa River sites or at Waiohine at SH 2 during summer bathing seasons between 2001/02 and 2009/10. A lack of flow data prior to 2007 for Waipoua River at Colombo Road meant that there were insufficient data to undertake trend analysis at this site. In addition, trend analysis was not undertaken on *E. coli* data collected from Waiohine River at Gorge due to the high proportion of results (12%) that were below the detection limit.

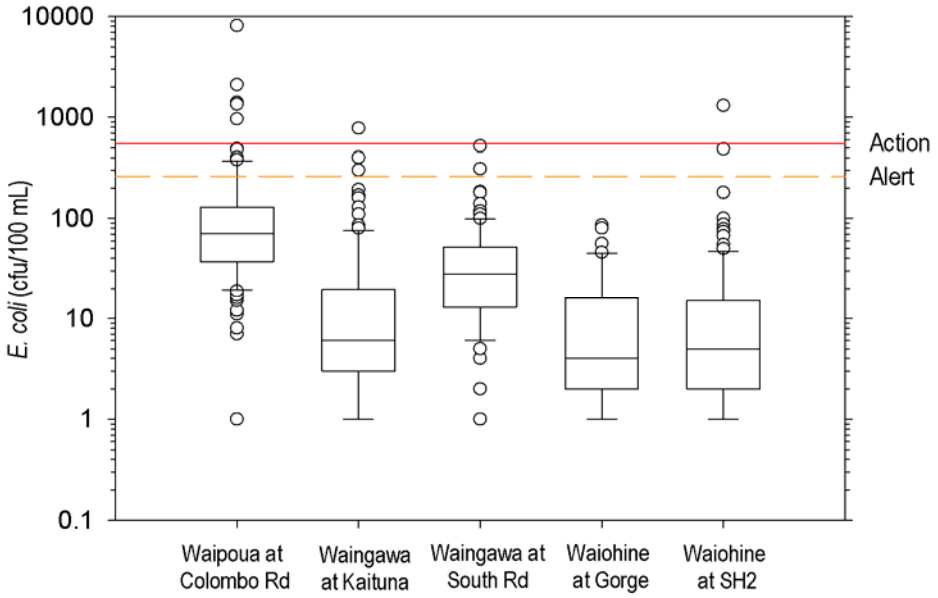


Figure 3.12: Box plot summarising the range of *E. coli* counts recorded at Waipoua, Waingawa and Waiohine river sites during routine weekly sampling over the 2005/06 to 2009/10 summer bathing seasons. Note the logarithmic scale on the *y*-axis.

3.4.3 Compliance with national microbiological water quality guidelines

Compliance with the MfE/MoH (2003) surveillance guideline at Waipoua, Waingawa and Waiohine river sites during routine weekly sampling over the 2005/06 and 2009/10 summer bathing seasons ranged from 89% at Waipoua River at Colombo Road to 100% at Waiohine River at Gorge. The Waipoua River at Colombo Road was the only site to exceed the MfE/MoH (2003) action guideline on more than one occasion over this five-year period (Table 3.12). All recorded action level exceedances, aside from one at the Waipoua River site, coincided with heavy rainfall and flows at or above median (Figure 3.13).

Table 3.12: Number and percentage of routine weekly sample results coinciding with the surveillance, alert and action modes of the MfE/MoH (2003) guidelines at recreational water quality monitoring sites on the Waipoua, Waingawa and Waiohine rivers over the 2005/06 to 2009/10 summer bathing seasons

Site	*n*	Surveillance		Alert		Action	
		No.	%	No.	%	No.	%
Waipoua R @ Colombo Rd	104	92	88.5	7	6.7	5	4.8
Waingawa R @ Kaituna	104	101	97.1	2	1.9	1	1.0
Waingawa R @ South Rd	104	102	98.1	2	1.9	0	0
Waiohine R @ Gorge	41[1]	41	100	0	0	0	0
Waiohine R @ SH 2	104	102	98.1	1	1.0	1	1.0

[1]From November 2006 onwards sampling at this site was reduced from weekly to monthly.

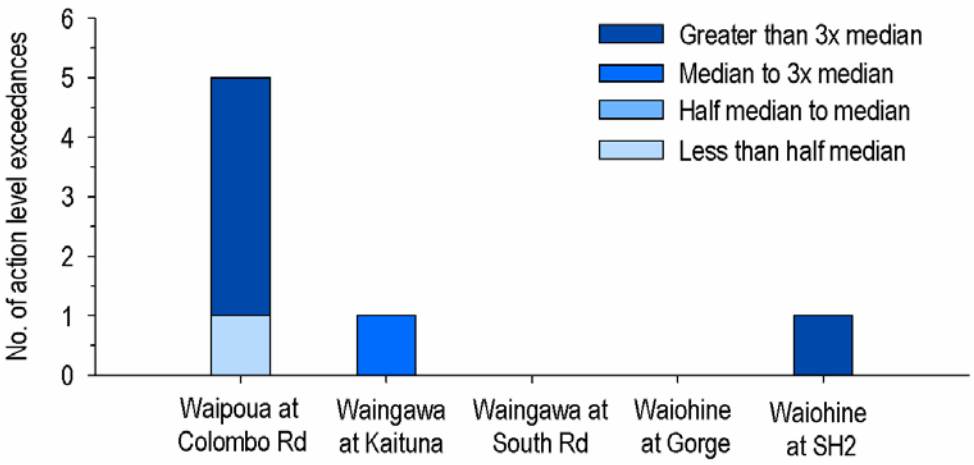


Figure 3.13: Summary of flow categories within which action level exceedances occurred at recreational water quality monitoring sites on the Waipoua, Waingawa and Waiohine rivers between the 2005/06 and 2009/10 summer bathing seasons

3.4.4 Suitability for Recreation Grades

When all routine water quality monitoring results collected over the 2006/07 to 2010/11 summer periods were considered, SFRGs for Waipoua, Waingawa and Waiohine river monitoring sites were 'very good' or 'good' at Waingawa and Waiohine river sites and 'very poor' at Waipoua River at Colombo Road (Table 3.13). The removal of *E. coli* results recorded from samples collected above median river flows improved the MAC grades for both Waingawa River at Kaituna and Waipoua River at Colombo Road, translating into improved SFRGs for these two sites (Table 3.14). In the case of the Waipoua River site, the improvement was two grades, from 'very poor' to 'fair', reflecting both the improved MAC grade as well as the revised SIC grading (see Greenfield et al. 2012 for SIC grading information).

Table 3.13: SFRGs for Waipoua, Waingawa and Waiohine river monitoring sites with MAC grades based on *E. coli* counts from routine sampling under all river flows over the 2006/07 to 2010/11 summer bathing seasons

Site	SIC grade	MAC grade		SFRG
		95th%-ile value	*n*	
Waipoua R @ Colombo Rd	High	D (775)	103	Very poor
Waingawa R @ Kaituna	Moderate	B (171)	103	Good
Waingawa R @ South Rd	Low/moderate	A (113)	103	Good
Waiohine R @ Gorge	Low	A (87)[1]	108	Very good[1]
Waiohine R @ SH 2	Low/moderate	A (76)	103	Good

[1] Based on summer data collected weekly between 2002/03 and 2005/06, and monthly between 2006/07 and 2010/11.

Table 3.14: 'Dry weather' SFRGs for Waipoua, Waingawa and Waiohine river monitoring sites, with MAC grades based on *E. coli* counts from routine sampling at or below median river flows over the 2006/07 to 2010/11 summer bathing seasons

Site	SIC grade	MAC grade		SFRG
		95th%-ile value	*n*	
Waipoua R @ Colombo Rd	Moderate	C (325)	75	Fair
Waingawa R @ Kaituna	Low	A (65)	70	Very good
Waingawa R @ South Rd	Low	A (110)	70	Very good
Waiohine R @ Gorge	Low	A (50)[1]	67	Very good[1]
Waiohine R @ SH 2	Low	A (47)	69	Very good

[1] Based on summer data collected weekly between 2002/03 and 2005/06, and monthly between 2006/07 and 2010/11.

3.4.5 Algae and cyanobacteria

(a) Compliance with national periphyton guidelines

The MfE (2000) aesthetic guideline for mat algae cover was exceeded on six occasions at Waipoua River at Colombo Road during routine weekly monitoring between 2005/06 and 2009/10 (Table 3.15). All six of these exceedances occurred during the 2006/07 summer bathing season, coinciding with an extended period of below average rainfall and river flows (Watts & Gordon 2007). Algal mats in the Waipoua River are generally dominated by benthic cyanobacteria (see Section 3.4.5(b)).

Table 3.15: Number of exceedances of the MfE (2000) nuisance periphyton guidelines for filamentous (F) and mat (M) algae cover recorded at Waipoua, Waingawa and Waiohine river sites during routine weekly assessments over the 2005/06 to 2009/10 summer bathing seasons

Site	2005/06		2006/07		2007/08		2008/09		2009/10		Total	
	F	M	F	M	F	M	F	M	F	M	F	M
Waipoua R @ Colombo Rd	0	0	0	6	0	0	0	0	0	0	0	6
Waingawa R @ Kaituna	0	0	0	0	0	0	0	0	0	0	0	0
Waingawa R @ South Rd	0	0	0	0	0	0	0	0	0	0	0	0
Waiohine R @ Gorge	0	0	0	0	0	0	0	0	0	0	0	0
Waiohine R @ SH 2	0	0	1	0	0	0	1	0	0	0	2	0

The only other site to record periphyton cover above guideline values was the Waiohine River at SH 2; this site exceeded the guideline for filamentous algae cover on two occasions.

(b) Cyanobacteria

Although there are no records of benthic cyanobacteria cover reaching more than 5% at sites on the Waiohine and Waingawa rivers, widespread benthic cyanobacteria cover has been recorded in the Waipoua River at Colombo Road during every bathing season since 2005/06. The 2006/07 bathing season was particularly bad with up to 97% cyanobacteria coverage recorded on the river bed in March 2007 when the river flows were very low.

Action level warning signs were put in place along the Waipoua River (in urban Masterton) from early January onwards in both 2008/09 and 2009/10. Prior to this general health warning signs or website warnings were issued each bathing season.

In January 2009 a report of gastrointestinal illness after swimming was linked to cyanobacteria toxins in the upper reaches of the Waipoua River at Kiriwhakapapa. Concentrations of homo-anatoxin-a of up to 230 µg/kg measured in samples of cyanobacteria mats taken from the site were considered high enough to cause human illness (S. Wood[9], pers comm. 2009). In February 2010 a dog died after coming into contact with cyanobacteria mats at Bentley Street, approximately 1.3 km upstream of the Colombo Road site (Ryan & Warr 2010).

3.5 Ruamahanga River

Recreational water quality is monitored at seven sites on the Ruamahanga River from Double Bridges in the north to Bentleys Beach in the south (Figure 3.14).

3.5.1 Catchment land use and impacts

The Ruamahanga River is the largest river in the Wellington region and has a total catchment area of 3,418 km^2. The river rises in the northern Tararua Range and flows the length of the Wairarapa Valley before reaching the sea at Palliser Bay. The Ruamahanga River has several large tributaries, including the Waipoua, Waingawa and Waiohine rivers that drain the Tararua Range and the Kopuaranga, Whangaehu, Taueru, Huangarua and Tauanui rivers that drain the eastern Wairarapa hill country and the Haurangi Range.

Double Bridges is the only Ruamahanga River monitoring site that has a high proportion of indigenous vegetation and scrub in the upstream catchment (69%). At all other sites, pasture is the dominant upstream land cover (Figure 3.14), making up approximately 70% of land cover (equally represented by high and low producing pasture) (Appendix 5).

[9] Dr Susie Wood, Research Scientist, Cawthron Institute.

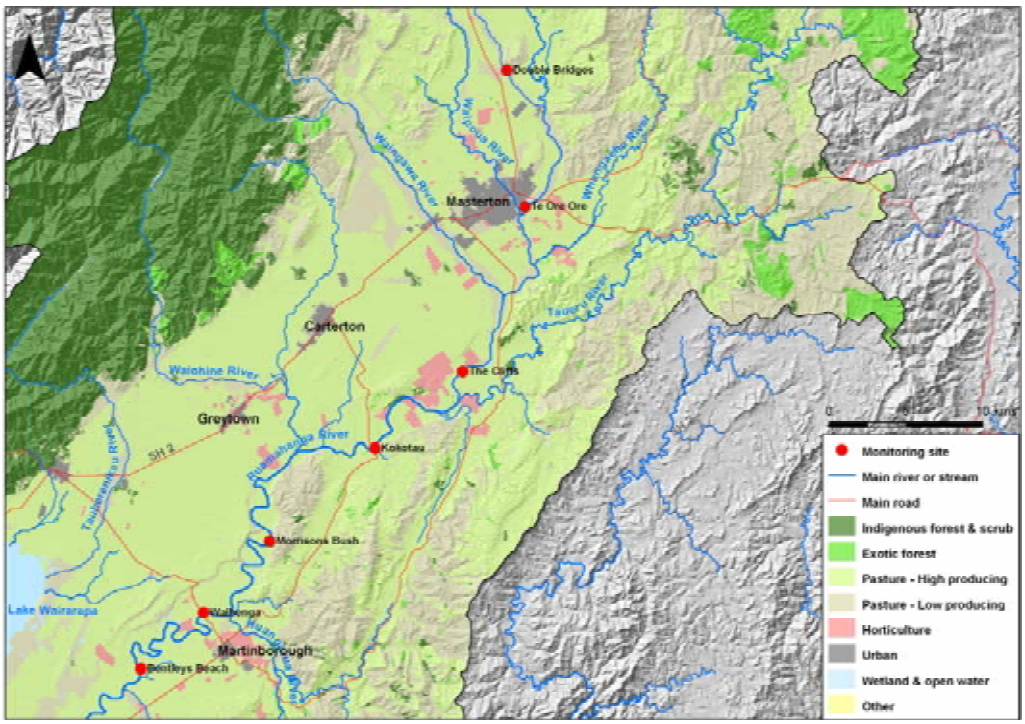


Figure 3.14: Location and catchment land cover of recreational water quality monitoring sites on the Ruamahanga River

As well as agricultural land use impacts, the Ruamahanga River receives treated wastewater from a number of townships either directly or indirectly via tributary rivers or streams as follows:

- Masterton: Treated wastewater is discharged into the Makoura Stream, which flows a short distance prior to entering the Ruamahanga River above Wardell's Bridge.

- Carterton: Treated wastewater is discharged into the Mangatarere Stream which flows into the Waiohine River below SH 2. During December to March the wastewater is required to be discharged to land, except where high inflows to the WWTP prevent this.

- Greytown: Treated wastewater is discharged into the Papawai Stream, approximately 1.5 km from its confluence with the Ruamahanga River upstream of Morrisons Bush.

- Martinborough: Treated wastewater is discharged directly into the Ruamahanga River, approximately 2.5 km downstream of Waihenga Bridge.

In 2009, MDC's resource consent to discharge treated wastewater from Masterton was renewed with the requirement that from 2013 onwards, wastewater must be progressively discharged to land. Furthermore, from December 2014, no wastewater can be discharged to the Ruamahanga River during periods of less than median river flow during summer (1 November to 30 April) and less than half median flow during winter (1 May to 31 October).

Although no new consent requirements are in place as yet, the current river-based discharges from the Carterton, Greytown and Martinborough WWTPs are all in the process of being assessed by the relevant territorial authorities for their long-term viability. Similar approaches to that of Masterton are being explored, the aim being to ensure wastewater is only discharged to land when stream and river flows are low.

In addition to the municipal WWTP discharges, Rathkeale College has consent to discharge treated wastewater to a tributary of the Ruamahanga River approximately 7 km upstream of the Ruamahanga River at Te Ore Ore.

Urban stormwater is likely to impact on recreational water quality in the Ruamahanga River at times, principally at Te Ore Ore where stormwater discharged into Henley Lake subsequently discharges into the river. Water race discharges are also likely to contribute to instream faecal contamination, particularly in dry summer weather. This is because many water races are unfenced, allowing stock direct access to them.

3.5.2 *E. coli* counts and trends

Based on routine weekly water quality monitoring between the 2005/06 and 2009/10 summer bathing seasons, median *E. coli* counts ranged from 21 cfu/100mL at Ruamahanga River at Morrison's Bush to 93 cfu/100mL at Ruamahanga River at Te Ore Ore (Figure 3.15). Maximum *E. coli* counts recorded ranged from 1,560 cfu/100mL at Ruamahanga River at Waihenga (5 January 2006) to 7,600 cfu/100mL at Ruamahanga River at Te Ore Ore (21 December 2005).

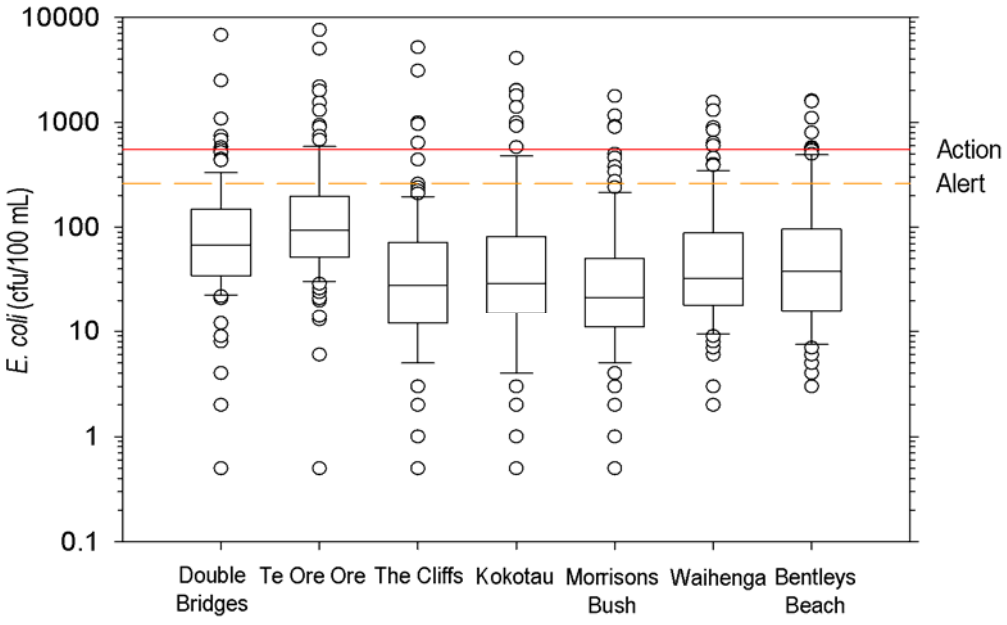


Figure 3.15: Box plot summarising the range of *E. coli* counts recorded at Ruamahanga River sites during routine weekly sampling over the 2005/06 to 2009/10 summer bathing seasons. Note the logarithmic scale on the *y*-axis.

A significant (p<0.05) decrease in flow-adjusted *E. coli* counts was detected in routine weekly data collected at Ruamahanga River at Double Bridges during summer bathing seasons between 2001/02 and 2009/10. It is estimated that flow-adjusted *E. coli* counts have decreased by 9 cfu/100mL (11%) per bathing season over this time period. The cause of this decrease is unclear, but it represents an improvement in water quality. No significant trends in flow-adjusted *E. coli* counts were found over the same time period at any other Ruamahanga River monitoring site.

3.5.3 Compliance with national microbiological water quality guidelines

Compliance with the MfE/MoH (2003) surveillance guideline at Ruamahanga River sites based on routine weekly sampling between 2005/06 and 2009/10 ranged from 82% at Te Ore Ore to 94% at The Cliffs (Table 3.16). The number of exceedances of the action guideline recorded at Ruamahanga River sites during this period ranged from four at Morrisons Bush to ten at Te Ore Ore.

Table 3.16: Number and percentage of routine weekly sample results coinciding with the surveillance, alert and action modes of the MfE/MoH (2003) guidelines at recreational water quality monitoring sites on the Ruamahanga River over the 2005/06 to 2009/10 summer bathing seasons

Site	*n*	Surveillance		Alert		Action	
		No.	%	No.	%	No.	%
Ruamahanga R @ Double Bridges	104	94	90.4	4	3.8	6	5.8
Ruamahanga R @ Te Ore Ore	104	85	81.7	9	8.7	10	9.6
Ruamahanga R @ The Cliffs	104	98	94.2	1	1.0	5	4.8
Ruamahanga R @ Kokotau	104	89	85.6	6	5.8	9	8.7
Ruamahanga R @ Morrisons Bush	104	95	91.3	5	4.8	4	3.8
Ruamahanga R @ Waihenga	104	93	89.4	4	3.8	7	6.7
Ruamahanga R @ Bentleys Beach	104	90	86.6	6	5.8	8	7.7

At most sites the majority of action guideline exceedances occurred following significant rainfall; this resulted in river flows that were at or above median indicating contamination from diffuse runoff (Figure 3.16). The exception was Ruamahanga River at Double Bridges where four out of six action guideline exceedances occurred at flows of median or less. The cause of these exceedances is unclear but could be related to contamination from stock access to small tributaries that flow into the Ruamahanga River immediately upstream of the Double Bridges site.

In addition to the ten action guideline exceedances at Ruamahanga River at Te Ore Ore, nine exceedances of the alert guideline were recorded at this site. While the majority of action guideline exceedances occurred at or above median flow, six out of the nine alert guideline exceedances occurred below median flow. A possible source of contamination at this site is the discharge from Henley Lake which enters the Ruamahanga River approximately 100 m upstream. Henley Lake receives stormwater from Masterton township and during the summer months supports a large wildfowl population.

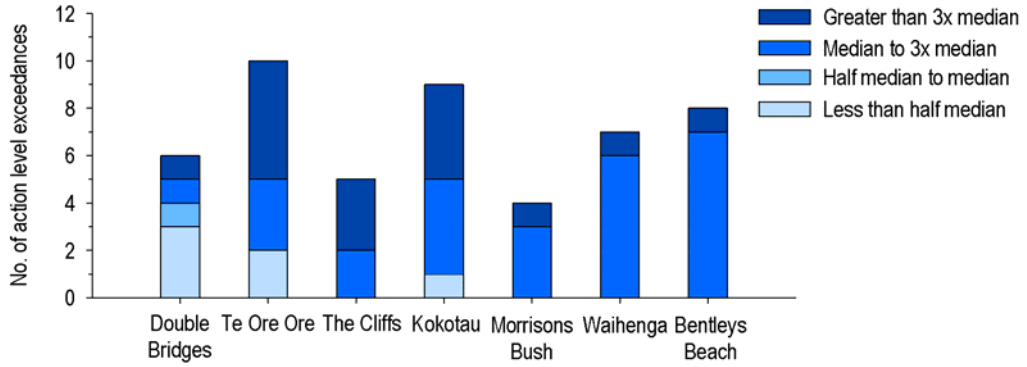


Figure 3.16: Summary of flow categories within which action level exceedances occurred at recreational water quality monitoring sites on the Ruamahanga River between the 2005/06 and 2009/10 summer bathing seasons

3.5.4 Suitability for Recreation Grades

When all routine summer monitoring results collected over the 2006/07 to 2010/11 period were considered, SFRGs for all seven Ruamahanga River monitoring sites were either 'poor' or 'very poor' (Table 3.17). However, when *E. coli* sample results recorded during above median river flow conditions were removed from the data set, MAC grades improved at all but one site (Table 3.18).

Table 3.17: SFRGs for Ruamahanga River monitoring sites, with MAC grades based on *E. coli* counts from routine sampling under all river flows over the 2006/07 to 2010/11 summer bathing seasons

Site	SIC grade	MAC grade		SFRG
		95th%-ile value	*n*	
Ruamahanga R @ Double Bridges	Moderate	C (326)	103	Fair
Ruamahanga R @ Te Ore Ore	High	D (1,066)	103	Very Poor
Ruamahanga R @ The Cliffs	High	C (523)	103	Poor
Ruamahanga R @ Kokotau	High	D (1,000)	103	Very Poor
Ruamahanga R @ Morrisons Bush	High	C (500)	103	Poor
Ruamahanga R @ Waihenga	High	D (614)	103	Very Poor
Ruamahanga R @ Bentleys Beach	High	D (567)	103	Very Poor

Table 3.18: 'Dry weather' SFRGs for Ruamahanga River monitoring sites, with MAC grades based on *E. coli* counts from routine sampling at or below median river flows over the 2006/07 to 2010/11 summer bathing seasons

Site	SIC grade	MAC grade		SFRG
		95th%-ile value	*n*	
Ruamahanga R @ Double Bridges	Moderate	C (526)	68	Fair
Ruamahanga R @ Te Ore Ore	Moderate	C (476)	74	Fair
Ruamahanga R @ The Cliffs	High[1]	A (85)	72	Poor[1]
Ruamahanga R @ Kokotau	Moderate	B (140)	72	Fair[1]
Ruamahanga R @ Morrisons Bush	Moderate	A (99)	76	Fair[1]
Ruamahanga R @ Waihenga	Moderate	A (116)	75	Fair[1]
Ruamahanga R @ Bentleys Beach	High[1]	B (152)	74	Poor[1]

[1] Interim grades altered to reflect the uncertainty associated with the effects of upstream municipal wastewater treatment plant discharges on public health.

The combination of improved MAC grades and/or revised SIC grades (see Greenfield et al. 2012 for details)[10] translated to 'dry weather' SFRGs of 'fair' at Double Bridges and Te Ore Ore, respectively (Table 3.18). In the case of the other five Ruamahanga River sites, despite a significant improvement in their respective MAC grades, Greenfield et al. (2012) exercised caution when revising their dry weather SFRGs due to the presence of multiple municipal wastewater inputs to the river; wastewater treatment processes often effectively reduce microbial indicators such as *E. coli* but are less effective at removing pathogens such as viruses – which can result in pathogens being present even when indicator bacteria counts are low (MfE/MoH 2003). For this reason Greenfield et al. (2012) conservatively assigned SIC grades of 'high' and dry weather SFRGs of 'poor' for The Cliffs and Bentley Beach sites, which are located a relatively short distance downstream of the Masterton and Martinborough WWTP discharges, respectively. For the remaining sites (Kokotau, Morrisons Bush and Waihenga), Greenfield et al. (2012) set the SIC values to 'moderate'[10] and assigned dry weather SFRGs of 'fair' (Table 3.18). The 'poor' SFRGs for The Cliffs and Bentley Beach are considered *interim* until further information is available on pathogen risk or the discharges are removed from the river during summer low flows (as noted in Section 3.5.1, this is expected in 2014 for The Cliffs). Refer to Greenfield et al. (2012) for further discussion.

3.5.5 Algae and cyanobacteria

(a) Compliance with national periphyton guidelines

At least one exceedance of the MfE (2000) aesthetic guideline for filamentous algae cover was recorded at each of the Ruamahanga River sites during routine weekly monitoring between 2005/06 and 2009/10 (Table 3.19). Growth of filamentous algae was greatest in the lower reaches of the river with three exceedances recorded at Morrisons Bush and four exceedances each recorded at Waihenga and at Bentleys Beach. No exceedances of the guideline for mat algae cover were recorded apart from during the 2006/07 summer bathing season when one exceedance was recorded at Kokotau and two exceedances were recorded at Waihenga and at Bentleys Beach. As noted in Section 3.4.5, the 2006/07 summer coincided with an extended period of below average rainfall and river flows in much of the Wairarapa.

(b) Cyanobacteria

Growth of potentially toxic cyanobacterial mats was generally minimal (<20% cover) at Ruamahanga River sites during routine monitoring over the 2005/06 to 2009/10 summer bathing seasons. The exception was during 2006/07 when extensive mat coverage was recorded on the bed at each of the Ruamahanga River sites apart from Ruamahanga River at Morrisons Bush. A general health warning was posted on Greater Wellington's website when this occurred.

[10] During less than median river flows, Greenfield et al. (2012) concluded that stock access in tributary streams was the primary microbiological risk factor at these Ruamahanga River sites. According to the MfE/MoH (2003) guidelines, this risk equates to a 'moderate' SIC grade.

Table 3.19: Number of exceedances of the MfE (2000) nuisance periphyton guidelines for filamentous (F) and mat (M) algae cover recorded at Ruamahanga River sites during routine weekly assessments over the 2005/06 to 2009/10 summer bathing seasons

Site	2005/06		2006/07		2007/08		2008/09		2009/10		Total	
	F	M	F	M	F	M	F	M	F	M	F	M
Ruamahanga R @ Double Br	0	0	1	0	0	0	0	0	1	0	2	0
Ruamahanga R @ Te Ore Ore	0	0	0	0	2	0	0	0	0	0	2	0
Ruamahanga R @ The Cliffs	1	0	1	0	0	0	0	0	0	0	2	0
Ruamahanga R @ Kokotau	0	0	1	1	0	0	0	0	0	0	1	1
Ruamahanga R @ Morrisons B	1	0	1	0	0	0	0	0	1	0	3	0
Ruamahanga R @ Waihenga	0	0	0	2	3	0	0	0	1	0	4	2
Ruamahanga R @ Bentleys B	0	0	2	2	0	0	1	0	1	0	4	2

3.6 Synthesis

3.6.1 Compliance with national microbiological water quality guidelines

Microbiological water quality was generally good at popular river swimming sites across the Wellington region over the 2005/06 to 2009/10 summer bathing seasons; 20 of the 23 sites complied with the MfE/MoH (2003) surveillance guideline 85% or more of the time.

The Otaki, Waiohine and Waingawa rivers were the safest for swimming, with 95% or more of routine samples collected from these rivers complying with the surveillance guideline (Figure 3.17). These sites have a high proportion (>75%) of indigenous forest and scrub and little or no intensive agricultural or urban land use in their respective upstream catchments; this results in very low levels of microbiological contamination in these rivers, even during heavy rainfall.

The sites with the poorest microbiological water quality were Hutt River at Silverstream and Hutt River at Boulcott. While these sites still complied with the surveillance guideline 76 and 78% of the time, respectively, they incurred the highest number of action guideline exceedances of all river monitoring sites across the region, many of which occurred in the absence of rainfall. The cause of faecal contamination at these sites requires further investigation but may be due to a number of different sources, including discharges from stormwater or sewerage infrastructure, bird/waterfowl populations, and possibly sediment re-suspension from instream flood protection works.

Diffuse runoff from areas of intensive agricultural land use is likely to be a key source of faecal contamination at sites on the Wainuiomata, Pakuratahi, Ruamahanga and Waipoua rivers; these sites generally complied with microbiological guidelines during dry weather but frequently experienced very high indicator bacteria counts during or just after heavy rain. In dry weather, stock access to upstream tributaries may contribute to alert and action guideline exceedances, particularly in the Ruamahanga River at Double Bridges and the Wainuiomata River at Richard Prouse Park. Contamination from on-site wastewater treatment systems may also be an issue at the latter site.

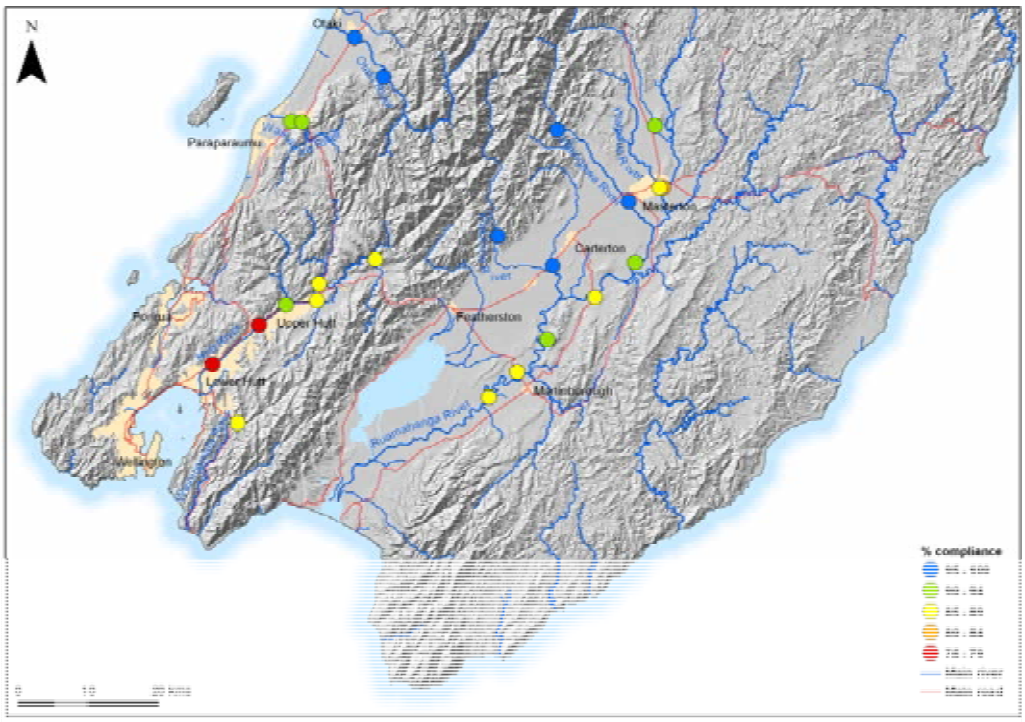


Figure 3.17: Percent compliance of river recreational water quality monitoring sites in the Wellington region with the MfE/MoH (2003) surveillance guideline during routine weekly summer sampling between 2005/06 and 2009/10

3.6.2 Temporal trends

Trend analyses conducted on data collected over the last 10 summer bathing seasons revealed no significant trends in *E. coli* counts at the majority of sites. The two exceptions were the Waikanae River at SH 1 and Ruamahanga River at Double Bridges where *E. coli* counts decreased. The reasons for the improvement in water quality at these sites are unclear; it is possible that a reduction in stock access in one or more upstream tributaries may account for the reduction in *E. coli* counts at Double Bridges.

3.6.3 Suitability for Recreation Grades

'Dry weather' SFRGs, intended to represent conditions when swimming is most likely to occur, ranged from 'very good' at sites on the Waingawa and Waiohine rivers and at Otaki River at Pots to 'poor' at Ruamahanga River at Cliffs, Ruamahanga River at Bentleys Beach, Hutt River at Boulcott and Wainuiomata River at Richard Prouse Park (Figure 3.18). No site was graded 'very poor'.

Dry weather SFRGs across the region's rivers generally reflect a similar picture to that of compliance with the MfE/MoH (2003) surveillance guideline. However, SFRGs identified for Ruamahanga River sites from 'The Cliffs' downstream have been modified to reflect the uncertainty associated with the risk to human health from the four municipal wastewater treatment plants that discharge to the Ruamahanga River or its tributaries. As outlined in Section 3.5.4, although *E. coli* counts at these sites are generally low during dry weather, it is unknown whether the wastewater treatment plants remove pathogens to the same degree as the indicator bacteria used to monitor their presence.

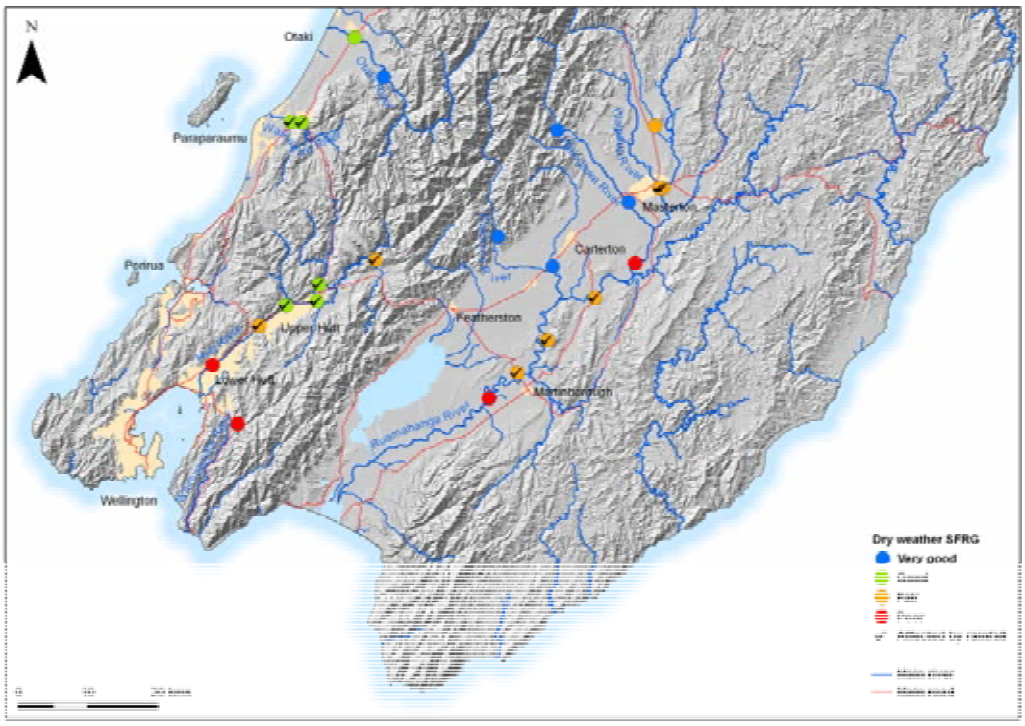


Figure 3.18: 'Dry weather' SRFGs for selected river sites in the Wellington region derived from MAC values based on routine summer sampling results collected at less than median flow between 2006/07 and 2010/11. Sites identified as being affected by rainfall are those where a significant increase in risk to public health occurs (eg, a change in SFRG from 'good' to 'fair' or worse, and from 'fair' to 'poor' or worse).

3.6.4 Nuisance algae and benthic cyanobacteria

At most river recreational water quality monitoring sites there were few, if any, exceedances of the MfE (2000) aesthetic guidelines for filamentous and mat algae during summer bathing seasons between 2005/06 and 2009/10. The exceptions were Wainuiomata River at Richard Prouse Park, Waipoua River at Colombo Road and Ruamahanga River at both Waihenga and Bentleys Beach where numerous exceedances of the guideline for filamentous or mat algae cover were recorded.

Frequency of flushing flows[11] and dissolved nutrient concentrations are key factors that control periphyton growth (MfE 2000) and these are likely to be driving the observed differences in periphyton growth across the region's rivers. The Waipoua River often has a low frequency of flushing flows during the summer period (on average each year the maximum number of days between flushing flows is 96) (Thompson & Gordon 2010) and has very high dissolved inorganic nitrogen (DIN) concentrations in its lower reaches (median of 0.915 mg/L at Colombo Road[12], Perrie et al. 2012) making it particularly susceptible to algal proliferations. The lower reaches of the Ruamahanga River also regularly experience elevated nutrient concentrations (Perrie et al. 2012), with long periods between freshes (on average a maximum of 69 days) often

[11] A 'flushing' flow is a high river flow (usually defined as 3x the median river flow) that generally follows a heavy rainfall event and can 'scour' periphyton from the riverbed.

[12] Based on monthly sampling from July 2008 to June 2011 inclusive.

occurring during the summer period (Thompson & Gordon 2010). Nutrient concentrations in the Wainuiomata River at Richard Prouse Park are not known but may be relatively low given the largely forested upstream catchment area; however, potential inputs from the Wainuiomata Stream and long periods between flushing flows in summer (eg, average maximum accrual upstream at RSoE site Wainuiomata at Manuka Track is 96 days) make the site at Richard Prouse Park susceptible to periphyton growth.

Exceedances of the alert and action levels of the (MfE/MoH 2009) interim cyanobacteria guidelines were recorded regularly at many of the region's most popular river swimming spots, resulting in health warning signs being posted at many of these. The Hutt and Waipoua rivers were the most affected where, as well as 'closure' of sites to swimming[13], 10 dogs died after coming into contact with toxins released from the cyanobacteria mats; nine of these dog deaths were from the Hutt River while one was from the Waipoua River (Milne & Watts 2007; Wood et al. 2007; Ryan & Warr 2008; Ryan & Warr 2010; Morar & Warr 2011).

Phormidium autumnale has been identified as the species that dominates cyanobacteria mat proliferations in rivers in the Wellington region and across New Zealand (Heath et al. 2010). As with other forms of periphyton, the length of time between 'flushing' flow events, river flow and water temperature have been identified as key factors controlling benthic cyanobacteria growth (Milne & Watts 2007; Heath et al. 2011). Recent studies suggest that DIN concentrations may also play a key part in regulating *Phormidium* growth (Wood & Young 2011; M. Heath[14] pers comm. 2011). As discussed above, the Waipoua River is particularly prone to algal proliferation due to infrequent freshes and high DIN concentrations. The Hutt River also experiences long periods of time between flushing flows in summer (on average 67 days is the maximum period between flushing flows each year) but has much lower concentrations of DIN (median of 0.215 mg/L at Manor Park[12], Perrie et al. 2012). This suggests that the Hutt River may be particularly sensitive to nutrient inputs and further investigation of nutrient sources to the river is necessary.

[13] Closure of sites is inferred from the use of 'high risk' warning signs (refer Figure 3.2, Section 3.1.2).
[14] Victoria University PhD candidate researching *Phormidium*.

4. Recreational water quality in coastal waters

4.1 Introduction

Recreational water quality was monitored at 77 coastal sites across the Wellington region between 2005/06 and 2009/10 (Figure 4.1, Appendix 1), as follows:

- Kapiti Coast – 20 sites
- Porirua city – 15 sites
- Hutt city – 15 sites
- Wellington city – 22 sites
- Wairarapa – 5 sites

One site, Pauatahanui Inlet at Paremata Bridge (Porirua), was added to the programme in 2007/08. In 2009/10 three sites – Plimmerton Beach at Queens Avenue (Porirua), Paremata Beach at Pascoe Avenue (Porirua) and Kio Bay (Wellington city) – were removed from the programme as they were either in close proximity to other sites or were no longer considered to be commonly used for recreation.

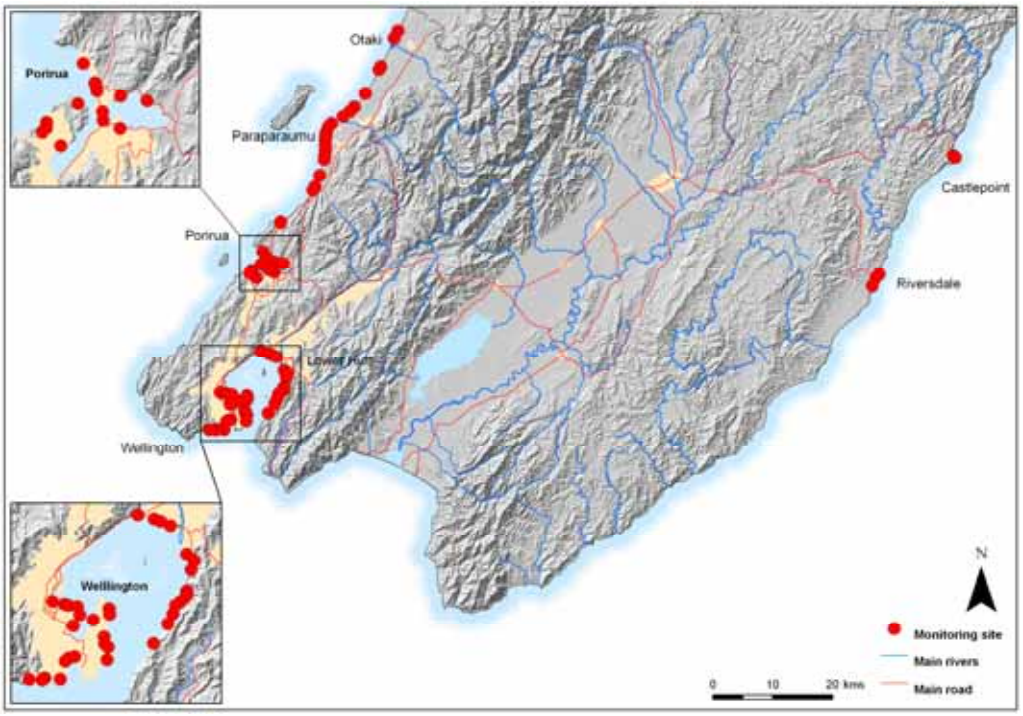


Figure 4.1: Coastal recreational water quality monitoring sites in the Wellington region sampled between 2005/06 and 2009/10

This section provides a brief overview of the sampling protocols and guidelines used to monitor coastal recreational sites in the Wellington region as well as the approach taken to assess and present monitoring results collected over the 2005/06 to 2009/10 summer bathing seasons. Microbiological water quality monitoring results, Suitability for Recreation Grades (SFRGs) and compliance with shellfish gathering guidelines are then presented for each of 13 coastal areas in the region. The section concludes with a synthesis of recreational water quality across the region's coastal waters.

4.1.1 Monitoring protocol

Most sites are sampled weekly during the bathing season (1 November to 31 March) for a minimum of 20 weeks. During the 2005/06 to 2009/10 reporting period the exceptions were Breaker Bay (Wellington city), Princess Bay (Wellington city) and Riversdale Beach South (Wairarapa) which were sampled fortnightly, and Camp Bay (Hutt city) which was sampled monthly[15].

On each sampling occasion a single water sample is collected 0.2 m below the surface in 0.5 m water depth and analysed for enterococci indicator bacteria and, at nine sites designated as shellfish monitoring sites, faecal coliform bacteria (see Appendix 3 for methods). Observations of weather (including rainfall and wind direction and intensity) and the state of the tide, and visual estimates of seaweed cover, are also made at each site to assist with interpretation of the monitoring results.

4.1.2 Guidelines

(a) Microbiological guidelines for marine (coastal) waters

As outlined in Section 2.3, the MfE/MoH (2003) recreational water quality guidelines use bacteriological 'trigger' values to help water managers determine when management intervention is required. The 'trigger' values underpin a three-tier management framework analogous to traffic lights (Table 4.1).

Table 4.1: MfE/MoH (2003) surveillance, alert and action levels for marine (coastal) waters

Mode	Guideline Enterococci (cfu/100mL)	Management response
Green/Surveillance	Single sample ≤ 140	Routine monitoring
Amber/Alert	Single sample >140	Increased monitoring, investigation of source and risk assessment
Red/Action	Two consecutive samples within 24 hours >280	Closure, public warnings, increased monitoring and investigation of source

When water quality falls into the 'surveillance mode', this indicates that the risk of illness from bathing is acceptable (for marine waters the accepted level of risk is 19 in every 1,000 bathers). If water quality falls into the 'alert' category, this indicates an increased risk of illness from bathing, but still within an acceptable range. However, if the water quality enters the 'action' category, then the water poses an unacceptable health risk from bathing. At this point, warning signs are erected at the bathing site, and the public is informed that it is unsafe to swim at that site. The only time a warning is unlikely to be issued is when an action level result is preceded by heavy rainfall. This is because it is widely known that rainfall is often correlated with elevated bacteria counts in

[15] Milne and Wyatt (2006) recommended the frequency of sampling reduce from weekly to fortnightly from 1 November 2006 because these sites have a 'very low' to 'low' risk of microbiological contamination and a high level of compliance with recreational water quality guidelines. The frequency of sampling at Camp Bay was reduced to monthly in November 2009 as indicator bacteria counts at this site were consistently below the surveillance guideline (140 enterococci/100mL), indicating a low risk of illness from bathing.

coastal waters. For this reason Greater Wellington and Regional Public Health advise avoiding swimming and other contact recreation activities in coastal waters during and for up to 48 hours after heavy rainfall.

The MfE/MoH (2003) guidelines do not cover toxic algal blooms, which in certain places and under certain conditions may pose a significant risk to contact recreation. Such blooms have occurred in coastal recreational waters in the Wellington region in the past.

(b) Suitability for Recreation Grades

The process to grade the suitability of recreational waters from a public health perspective was outlined in Section 2.3 and involves combining a qualitative assessment of the susceptibility of a recreational site to faecal contamination (the SIC component) with direct measurements of the appropriate bacteriological indicator at the site (the MAC component). The SIC and MAC categories used to identify SFRGs for coastal waters are shown in Table 4.2 and the five different SFRGs are explained in detail in Appendix 2.

Table 4.2: MfE/MoH (2003) Suitability for Recreation Grades (SFRGs) for marine (coastal) waters

Susceptibility to faecal influence		Microbiological Assessment Category (MAC)[1]			
		A ≤40 Enterococci/ 100mL	B 41–200 Enterococci/ 100mL	C 201–500 Enterococci/ 100mL	D >500 Enterococci/ 100mL
Sanitary Inspection Category (SIC)	Very Low	Very Good	Very Good	Follow Up[3]	Follow Up[3]
	Low	Very Good	Good	Fair	Follow Up[3]
	Moderate	Follow Up[2]	Good	Fair	Poor
	High	Follow Up[2]	Follow Up[2]	Poor	Very Poor
	Very High	Follow Up[2]	Follow Up[2]	Follow Up[2]	Very Poor

[1] 95th percentile value calculated using the Hazen percentile method from five years of data obtained from routine weekly monitoring during the bathing season.
[2] Indicates unexpected results requiring investigation (reassess SIC and MAC).
[3] Implies non-sewage sources of indicator bacteria that require verification.

(c) Microbiological guidelines for shellfish-gathering waters

As outlined in Section 2.3, the MfE/MoH (2003) guidelines use faecal coliform bacteria as indicators of microbiological contamination in shellfish-gathering waters. The guidelines state:

- The median faecal coliform content of samples taken over a shellfish-gathering season shall not exceed 14 MPN/100mL[16]; and
- Not more than 10% of samples collected over a shellfish gathering season should exceed 43 MPN/100mL.

[16] Note that although the MfE/MoH (2003) guidelines recommend the five-tube decimal dilution test (known as the Most Probable Number (MPN) method), Greater Wellington uses the membrane filtration method which produces an equivalent result in colony forming units (cfu) because it is a faster test, providing a result in 24 hours.

The MfE/MoH (2003) guidelines also state the guideline values above should be applied in conjunction with a sanitary survey (see Greenfield et al. 2012 for Sanitary Inspection Categories (SICs) for each coastal site which indicate the susceptibility of a site to faecal contamination).

The MfE/MoH (2003) guidelines only address microbiological contamination and do not address marine biotoxins, heavy metals, or harmful organic contaminants which in certain places and locations can pose a significant risk to people gathering shellfish. For this reason, the guidelines can not be used to determine whether shellfish are actually safe to eat. Monitoring of microbiological contaminants in *shellfish flesh* is needed to provide a direct measure of the risks associated with consuming shellfish. Greater Wellington periodically undertakes shellfish flesh monitoring; the most recent monitoring was undertaken in early 2006 (Milne 2006).

4.1.3 Data analysis and reporting

All indicator bacteria results have been assessed in accordance with the MfE/MoH (2003) microbiological water quality guidelines for marine waters (Table 4.1) and, where applicable, the microbiological guidelines for shellfish gathering waters. Although additional water samples are often collected following exceedances of the alert or action guidelines, only results from routine samples are presented here. These routine results are presented as an overall summary – see Appendix 4 for a breakdown of results by site and summer bathing season.

Prior to data analysis, enterococci and faecal coliform counts below the laboratory detection limit were halved apart from those where the detection limit was <1 cfu/100mL (in which case a result of 1 cfu/100mL was used).

Box-and-whisker plots (box plots) are used to graphically summarise and compare the median and range of enterococci concentrations measured across different sampling sites. All plots were generated in Sigmaplot (v11.0), with the whiskers (error bars) above and below the box (interquartile range) set at the 90th and 10th percentiles, respectively (Figure 3.3).

The MfE/MoH (2003) guidelines state that a marine/coastal bathing site only enters the action mode when *two consecutive samples* exceed 280 enterococci/100mL but, in practice, there can be delays in collecting a second sample (eg, bad weather). Therefore to ensure that recreational water quality is assessed on an equal basis across all 77 marine sites, the approach taken by Greater Wellington is to treat any single result greater than 280 enterococci/100mL obtained from routine weekly sampling as an exceedance of the action guideline. This is also the approach taken by the Ministry for the Environment in its national recreational water quality monitoring reporting and means that a second consecutive action guideline exceedance is simply used to confirm the appropriate management response (eg, erection of public warnings), (MfE 2005).

The guidelines for shellfish-gathering waters do not define a shellfish gathering season, nor do they provide any guidance on the minimum number of samples

that should be used to calculate compliance with the median guideline. In the absence of such guidance, the approach taken in Greater Wellington's reporting is to align the shellfish gathering season with the summer bathing season (ie, 1 November to 31 March inclusive), even though it is acknowledged that shellfish gathering is likely to occur year round at many sites to some degree. See Oliver and Milne (2012) for an assessment of year-round microbiological water quality in the Wellington region.

The bulk of the analysis is based on monitoring results from the 2005/06 to 2009/10 summer bathing seasons. However, in order to present the most up-to-date SFRGs for the region, routine water quality data collected over the 2006/07 to 2010/11 summers were utilised, along with revised SIC grades from a recent re-evaluation of the microbiological risk factors undertaken in consultation with the region's territorial and public health authorities (Greenfield et al. 2012). As noted in Section 1.2, the updated SFRGs effectively indicate the current *state* of recreational water quality.

(a) Land cover information

Land cover in the catchment upstream of each coastal monitoring site were obtained from the interpretation of aerial photographs taken in 2008 and published by the Ministry for the Environment (2010).

(b) Rainfall and trend analysis

Enterococci data were assessed against an estimate of the daily rainfall in the catchment adjoining each site by obtaining records from the nearest rain gauge (Appendix 3). It was not possible to analyse temporal trends in microbiological data collected from coastal monitoring sites due to the confounding effects of other environmental variables, such as tide and weather conditions, on indicator bacteria counts. However, as an indication of possible changes in water quality at beach monitoring sites over time, MAC grades calculated for each site in this report were compared to those calculated for the 2001/02 to 2005/06 bathing seasons reported in Milne and Wyatt (2006). This comparison is presented in Section 4.15.

4.2 Otaki, Te Horo and Peka Peka

Recreational water quality monitoring is undertaken at five coastal beach sites in the Otaki, Te Horo and Peka Peka area: two sites each at Otaki and Te Horo beaches and one at Peka Peka (Figure 4.2).

4.2.1 Land use and catchment impacts

The coastline in the vicinity of Otaki, Te Horo and Peka Peka consists of predominantly sandy beaches. Land use along the coastline is largely agricultural with small urban areas adjoining the beach at Otaki and Te Horo. Otaki Beach is bounded by the Waitohu Stream mouth to the north and the Otaki River mouth to the south. The Mangaone Stream discharges to the coast in the immediate vicinity of the northern-most Te Horo Beach site.

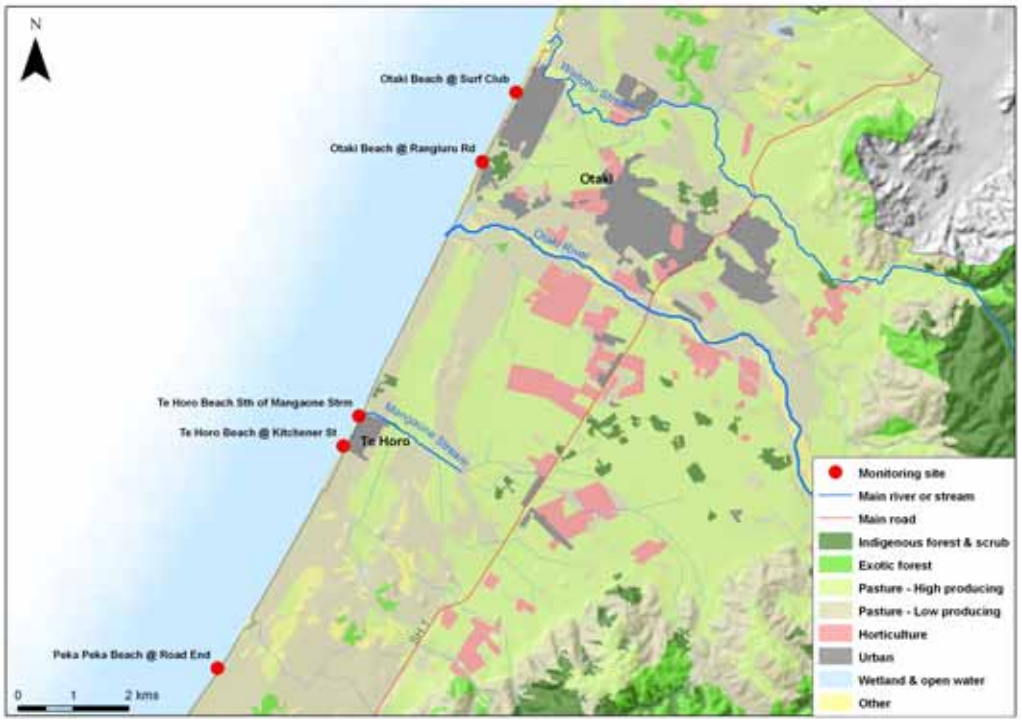


Figure 4.2: Location and surrounding land cover of recreational water quality monitoring sites at Otaki, Te Horo and Peka Peka beaches

The Otaki River catchment is dominated by indigenous forest with only a small amount of agricultural land use in the lower catchment. In contrast both the Waitohu and Mangaone stream catchments are dominated by high producing pasture and include significant amounts of dairying (Figure 4.2).

Stormwater is discharged directly to Otaki Beach via several discharge points. Although there are no known problems with the stormwater network in the Otaki area there is potential for sewage contaminated stormwater to be discharged on occasion (C Hardy[17], pers comm. 2011). Both Te Horo and Peka Peka townships are serviced by on-site wastewater systems.

4.2.2 Enterococci counts

Median enterococci counts were low at all five northern Kapiti beach monitoring sites during the 2005/06 to 2009/10 summer bathing seasons, ranging from just 4 cfu/100mL at Otaki Beach at Surf Club and Peka Peka Beach to 15 cfu/100mL at Te Horo Beach at Mangaone Stream (Figure 4.3). The maximum enterococci counts recorded at these sites ranged from 310 cfu/100mL at Peka Peka Beach (30 December 2009) to 1,480 cfu/100mL at Te Horo Beach at Mangaone Stream (10 January 2008).

[17] Corinne Hardy, Infrastructure Projects Officer, Kapiti Coast District Council.

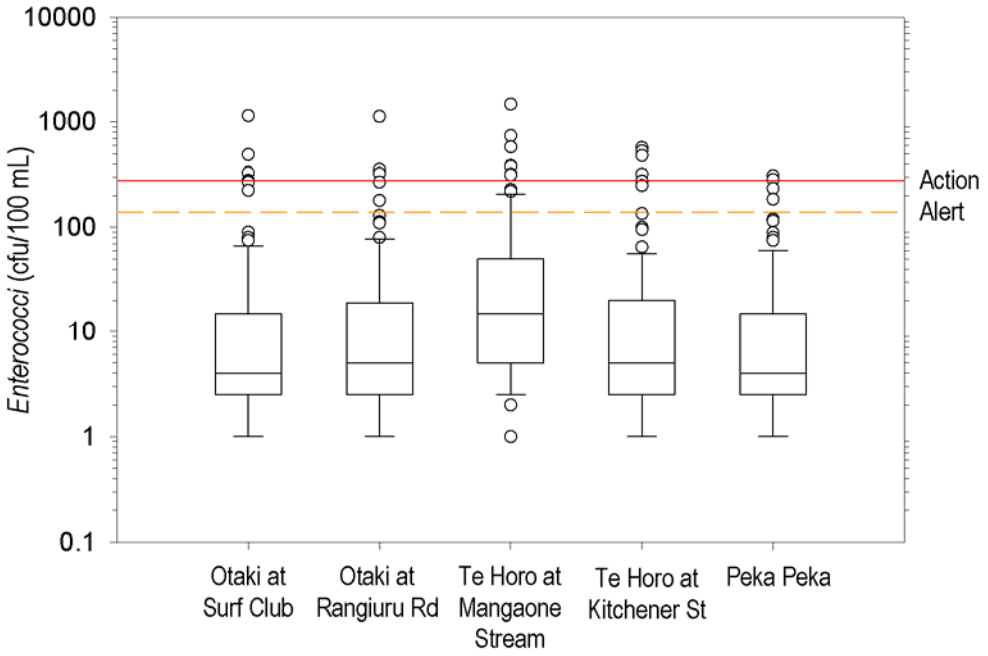


Figure 4.3: Box plot summarising the range of enterococci counts recorded at Otaki, Te Horo and Peka Peka beaches from routine weekly sampling over the 2005/06 to 2009/10 summer bathing seasons. Note the logarithmic scale on the *y*-axis.

4.2.3 Compliance with national microbiological water quality guidelines

Compliance with the MfE/MoH (2003) surveillance guideline during routine weekly monitoring over the 2005/06 and 2009/10 summer bathing seasons ranged from 88% at Te Horo Beach south of Mangaone Stream to 96% at Peka Peka Beach (Table 4.3). The number of action level guideline exceedances recorded over this period ranged from two at Peka Peka Beach at Road End to eight at Te Horo Beach south of Mangaone Stream. Most (approximately 60%) of these exceedances coincided with greater than 10 mm of rainfall in the 72 hours preceding sampling (Figure 4.4).

Table 4.3: Number and percentage of routine weekly sample results coinciding with the surveillance, alert and action modes of the MfE/MoH (2003) guidelines at Otaki, Te Horo and Peka Peka beach monitoring sites over the 2005/06 to 2009/10 summer bathing seasons

Site	*n*	Surveillance		Alert		Action	
		No.	%	No.	%	No.	%
Otaki Beach @ Surf Club	105	98	93.3	4	3.8	3	2.9
Otaki Beach @ Rangiuru Rd	105	99	94.3	2	1.9	4	3.8
Te Horo Beach S of Mangaone S	105	92	87.6	5	4.8	8	7.6
Te Horo Beach @ Kitchener St	105	99	94.3	2	1.9	4	3.8
Peka Peka Beach @ Road End	105	101	96.2	2	1.9	2	1.9

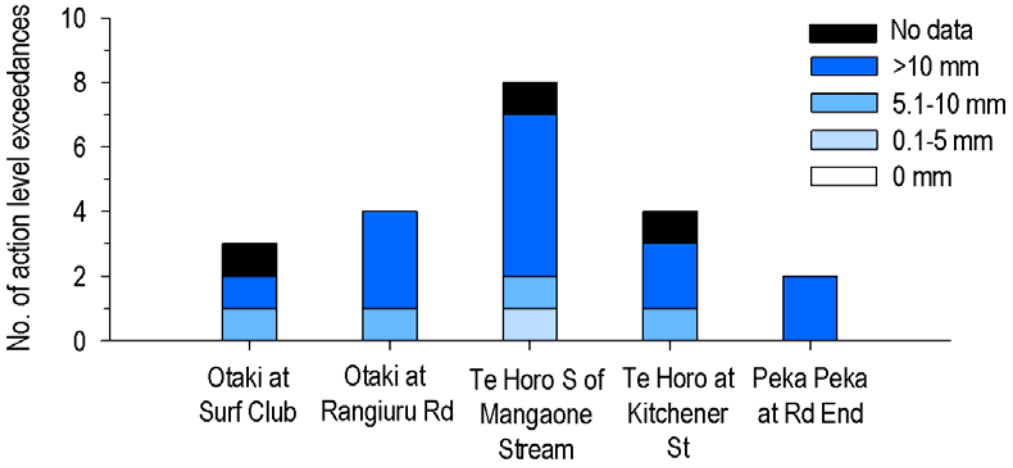


Figure 4.4: Summary of rainfall recorded in the 72 hours preceding sampling for each exceedance of the MfE/MoH (2003) action guideline recorded during routine weekly sampling at Otaki, Te Horo and Peka Peka beaches between the 2005/06 and 2009/10 summer bathing seasons

The high number of action guideline exceedances at Te Horo Beach south of Mangaone Stream is likely to be due to the proximity of this site to the mouth of the Mangaone Stream. The lower reaches of the Mangaone Stream have high concentrations of indicator bacteria, with a median *E. coli* count of 430 cfu/100mL and a maximum count of 4,800 cfu/100mL recorded from monthly sampling at Sims Road Bridge between July 2008 and June 2011 (Perrie et al. 2012). Microbial source tracking tests performed on weekly water samples taken from Te Horo Beach south of Mangaone Stream between 15 February 2011 and 8 March 2011 suggested contamination from ruminants in two out of the four samples (Cornelisen et al. 2011). However, enterococci counts were relatively low (maximum count of 192 cfu/100mL) in all samples and further analysis of both beach and stream samples with high indicator bacteria counts are required to confirm the source(s) of faecal contamination. Intensive agricultural land use in the catchment is certainly likely to be the main contributor of contamination to the stream; information provided by Fonterra in September 2011 indicates that there are currently around 2,820 dairy cows within the Mangaone Stream catchment and there have been anecdotal reports of dairy cows crossing through the stream in the past (J. Milne, pers. observation).

4.2.4 Suitability for Recreation Grades

Based on assigned SIC grades and routine water quality monitoring results collected over the 2006/07 to 2010/11 summers, SFRGs were 'fair' at Otaki Beach at Surf Club and the two Te Horo Beach sites and 'good' at Otaki Beach at Rangiuru Road and Peka Peka Beach at Road End (Table 4.4). The grade of 'fair' for Otaki Beach at Surf Club compared to 'good' at Otaki Beach at Rangiuru Road reflects the higher SIC and MAC grades identified at the Surf Club due to runoff from areas of intensive agriculture and discharges of urban stormwater to the Waitohu Stream (Greenfield et al. 2012).

Table 4.4: SFRGs for Otaki, Te Horo and Peka Peka beach monitoring sites, with MAC grades based on enterococci counts from routine sampling over the 2006/07 to 2010/11 summer bathing seasons

Site	SIC grade	MAC grade (95th%-ile value)	SFRG
Otaki Beach @ Surf Club	Moderate	C (273)	Fair
Otaki Beach @ Rangiuru Rd	Low	B (185)	Good
Te Horo Beach S of Mangaone Str	Moderate	C (450)	Fair
Te Horo Beach @ Kitchener St	Moderate	C (298)	Fair
Peka Peka Beach @ Rd End	Low	B (117)	Good

4.2.5 Compliance with guidelines for shellfish-gathering waters

Water quality for recreational shellfish gathering is monitored at two sites on the northern Kapiti Coast: Otaki Beach at Surf Club and Peka Peka Beach at Road End. Based on routine weekly sampling, Otaki Beach at Surf Club exceeded the median guideline of 14 cfu/100mL during four of the five bathing seasons between 2005/06 and 2009/10 (Table 4.5). Peka Peka Beach at Road End exceeded the guideline during three of the five bathing seasons. Neither site complied with the guideline of no more than 10% exceedances of 43 cfu/100mL in any bathing season.

Table 4.5: Comparison of faecal coliform counts at Otaki and Peka Peka beaches with the MfE/MoH (2003) guidelines for recreational shellfish gathering waters, based on routine weekly monitoring over the 2005/06 to 2009/10 bathing seasons. Results in bold font complied with the guideline.

Bathing season	*n*	Otaki Beach at Surf Club		Peka Peka Beach at Road End	
		Median (cfu/100mL)	No. and % of results >43 cfu/100mL	Median (cfu/100mL)	No. and % of results >43 cfu/100mL
2005/06	22	15	6 (27%)	15	4 (18%)
2006/07	21	16	9 (43%)	34	9 (43%)
2007/08	21	6	4 (19%)	6	4 (19%)
2008/09	21	16	6 (29%)	10	8 (38%)
2009/10	20	35	9 (45%)	19	6 (30%)
All summer data	105	15	34 (32%)	15	31(30%)

When all routine sampling results collected during bathing seasons between 2005/06 and 2009/10 were considered, both sites had a median faecal coliform count of 15 cfu/100mL while the percentage of results greater than 43 cfu/100mL was 32% and 30% at Otaki and Peka Peka beaches, respectively.

4.3 Waikanae and Paraparaumu

Recreational water quality monitoring is undertaken at three sites on Waikanae Beach and five sites on Paraparaumu Beach (Figure 4.5).

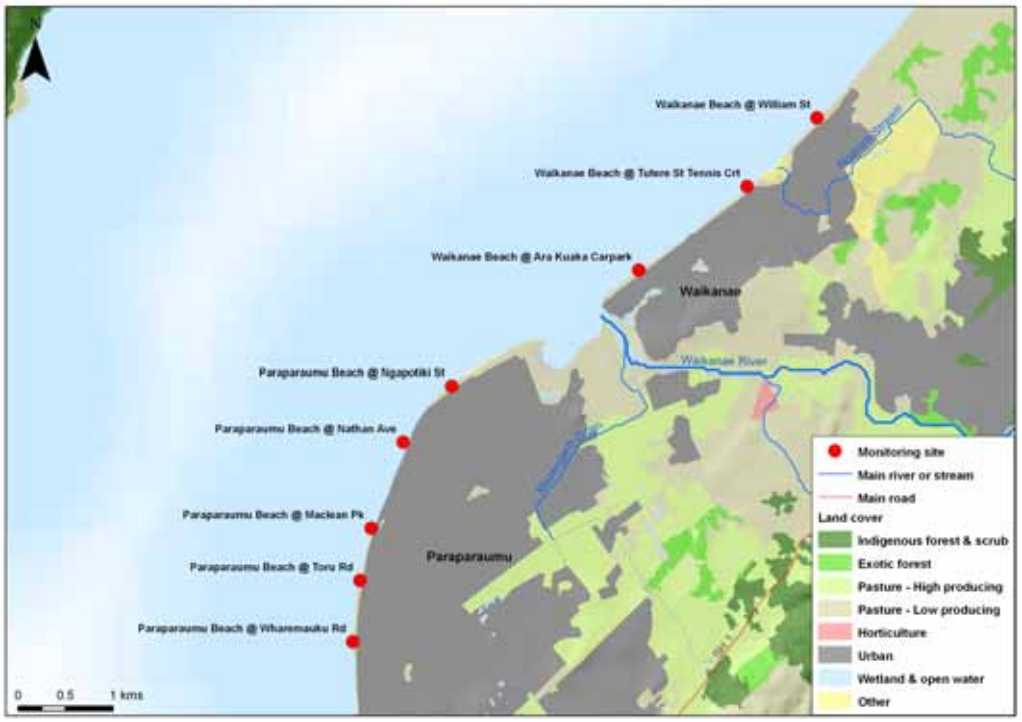


Figure 4.5: Location and surrounding land cover of recreational water quality monitoring sites along Waikanae and Paraparaumu beaches

4.3.1 Land cover and catchment impacts

Waikanae and Paraparaumu beaches are sandy beaches separated by the Waikanae River estuary and bordered by Waikanae and Paraparaumu townships, respectively. The Waikanae River is the predominant freshwater discharge to the coast in the area. As discussed in Section 3.2.1, the Waikanae River catchment is dominated by indigenous forest and scrub land cover but includes areas of pasture in the lower catchment, as well as urban areas. The Ngarara Stream discharges to the coast at Waikanae Beach between the Williams Street and Tutere Street Tennis Courts sites and has a catchment dominated by a mixture of agricultural and urban land use.

Stormwater is discharged to both Waikanae and Paraparaumu beaches as well as the Waikanae River via several outfalls. In addition, Kapiti Coast District Council (KCDC) has resource consent to discharge treated wastewater from the Paraparaumu Wastewater Treatment Plant (WWTP) to the Waikanae River via the Mazengarb Drain (refer Section 3.2.1 for more details).

4.3.2 Enterococci counts

Based on routine weekly monitoring between the 2005/06 and 2009/10 summer bathing seasons, median enterococci counts at Waikanae and Paraparaumu beach monitoring sites ranged from 8 cfu/100mL at Waikanae Beach at Ara Kuaka Carpark to 25 cfu/100mL at Paraparaumu Beach at Maclean Park (Figure 4.6). Maximum enterococci counts recorded ranged from 485 cfu/100mL at Waikanae Beach at William Street (22 March 2006) to 3,130 cfu/100mL at Paraparaumu Beach at Maclean Park (6 December 2005).

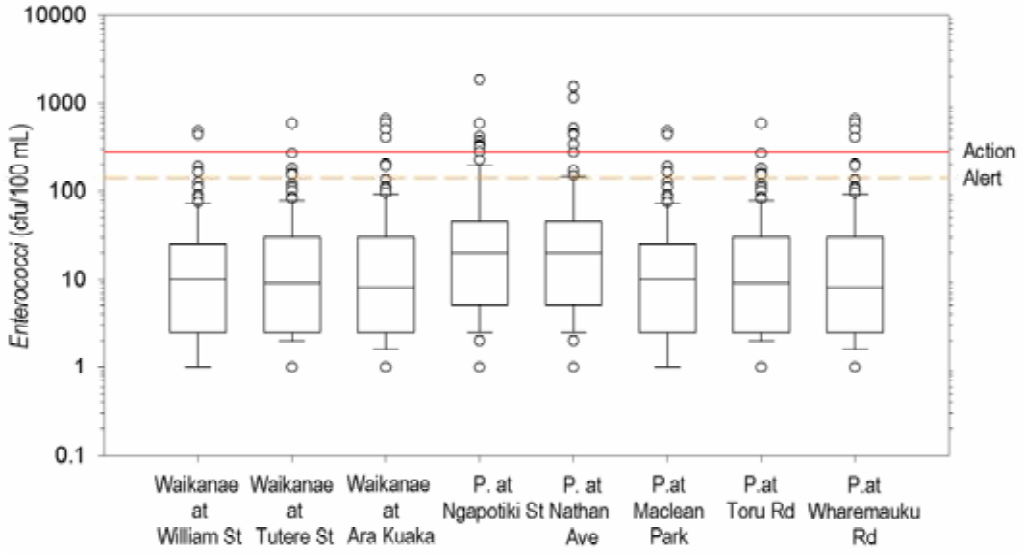


Figure 4.6: Box plot summarising the range of enterococci counts recorded at Waikanae and Paraparaumu beaches from routine weekly sampling over the 2005/06 to 2009/10 summer bathing seasons. Note the logarithmic scale on the *y*-axis.

4.3.3 Compliance with national microbiological water quality guidelines

Compliance with the MfE/MoH (2003) surveillance guideline at Waikanae and Paraparaumu beaches during routine weekly monitoring over the 2005/06 to 2009/10 summer bathing seasons ranged from 88% at Paraparaumu Beach at Ngapotiki Street to 96% for Waikanae Beach at William Street (Table 4.6). All sites except the Waikanae Beach at Tutere Street Tennis Courts exceeded the action guideline on more than one occasion, with Paraparaumu Beach at Ngapotiki Street exceeding the action guideline on eight occasions. Overall, Paraparaumu Beach sites fared worse than Waikanae Beach sites; in addition to recording more action level exceedences, four of the five sites exceeded the alert guideline on five or more occasions.

Table 4.6: Number and percentage of routine weekly sample results coinciding with the surveillance, alert and action modes of the MfE/MoH (2003) guidelines at Waikanae and Paraparaumu beach monitoring sites over the 2005/06 to 2009/10 summer bathing seasons

Site	*n*	Surveillance		Alert		Action	
		No.	%	No.	%	No.	%
Waikanae Beach @ William St	105	101	96.2	2	1.9	2	1.9
Waikanae Beach @ Tutere St T.C.	105	100	95.2	4	3.8	1	1.0
Waikanae Beach @ Ara Kuaka C.P.	105	99	94.3	2	1.9	4	3.8
Paraparaumu Beach @ Ngapotiki St	105	92	87.6	5	4.8	8	7.6
Paraparaumu Beach @ Nathan Ave	105	94	89.5	5	4.8	6	5.7
Paraparaumu Beach @ Maclean Pk	105	94	89.5	7	6.7	4	3.8
Paraparaumu Beach @ Toru Rd	105	98	93.3	1	1.0	6	5.7
Paraparaumu Beach @ Wharemauku Rd	105	97	92.4	6	5.7	2	1.9

While all but one of the seven action exceedances recorded at Waikanae Beach sites coincided with 10 mm or more of rainfall in the 72 hours prior to sampling, half of the action guideline exceedances at Paraparaumu Beach sites occurred following little or no rainfall (Figure 4.7). Many of the alert guideline exceedances at these sites also occurred in the absence of any significant rainfall.

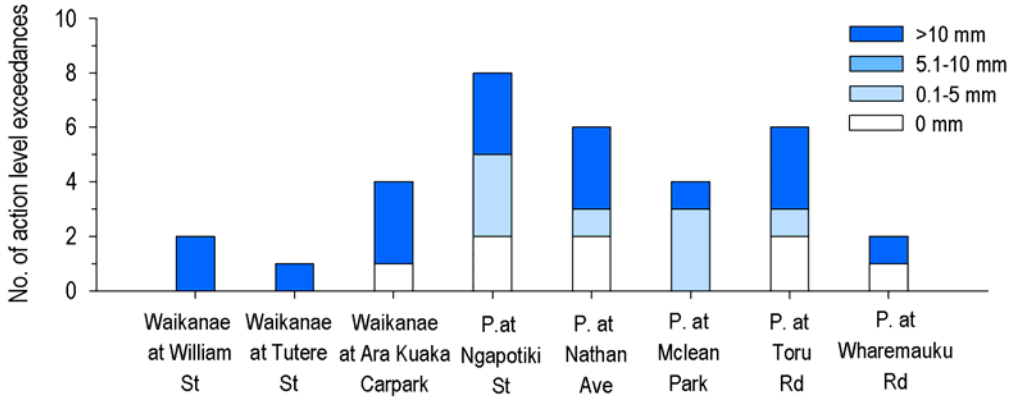


Figure 4.7: Summary of rainfall recorded in the 72 hours preceding sampling for each exceedance of the MfE/MoH (2003) action guideline recorded during routine weekly sampling at Waikanae and Paraparaumu beaches between the 2005/06 and 2009/10 summer bathing seasons

The Waikanae River mouth lies immediately adjacent to Paraparaumu Beach and is likely to be the key source of faecal contamination during low flows. Although no action guideline exceedances were recorded at the Waikanae River at Jim Cooke Park during low flows (refer Section 3.2.3), there are a number of streams and stormwater outfalls that discharge to the river downstream of this point. Greater Wellington has previously recorded faecal coliform counts of up to 32,400 cfu/100mL in the Mazengarb Drain (Milne & Perrie 2005), which enters the river approximately 700 m upstream of the river mouth; this drain receives treated wastewater from the Paraparaumu WWTP, runoff from the Otaihanga landfill and runoff from areas of industrial and residential land use. Faecal inputs from bird populations which inhabit the Waikanae River estuary as well as the Waimanu and Marina lagoons that discharge directly to the Waikanae River mouth may also contribute to dry weather faecal contamination of Paraparaumu Beach. There are no known faults in sewer/stormwater infrastructure in the vicinity of Paraparaumu Beach and therefore discharges from these sources are unlikely to be contributing to contamination during dry weather (C. Hardy, pers. comm. 2011).

4.3.4 Suitability for Recreation Grades

Based on assigned SIC grades and routine water quality monitoring results collected over the 2006/07 to 2010/11 summers, the SFRGs at all Waikanae and Paraparaumu beach sites are ‘good’ (Table 4.7). Greenfield et al. (2012) noted that although discharge from the Paraparaumu WWTP is unlikely to be a principal source of contamination to Waikanae or Paraparaumu beaches further information on the pathogen removal capacity of this WWTP should be sought.

Table 4.7: SFRGs for Waikanae and Paraparaumu beach monitoring sites, with MAC grades based on enterococci counts from routine sampling over the 2006/07 to 2010/11 summer bathing seasons

Site	SIC grade	MAC grade (95th%-ile value)	SFRG
Waikanae Beach @ William St	Moderate	B (114)	Good
Waikanae Beach @ Tutere St T.C.	Moderate	B (113)	Good
Waikanae Beach @ Ara Kuaka C.P.	Moderate	B (115)	Good
Paraparaumu Beach @ Ngapotiki St	Moderate	B (196)	Good
Paraparaumu Beach @ Nathan Ave	Moderate	B (185)	Good
Paraparaumu Beach @ Maclean Pk	Moderate	B (187)	Good
Paraparaumu Beach @ Toru Rd	Moderate	B (168)	Good
Paraparaumu Beach @ Wharemauku Rd	Moderate	B (162)	Good

4.4 Raumati and Paekakariki

Recreational water quality monitoring is undertaken at four sites along Raumati Beach and three sites along Paekakariki Beach (Figure 4.8).

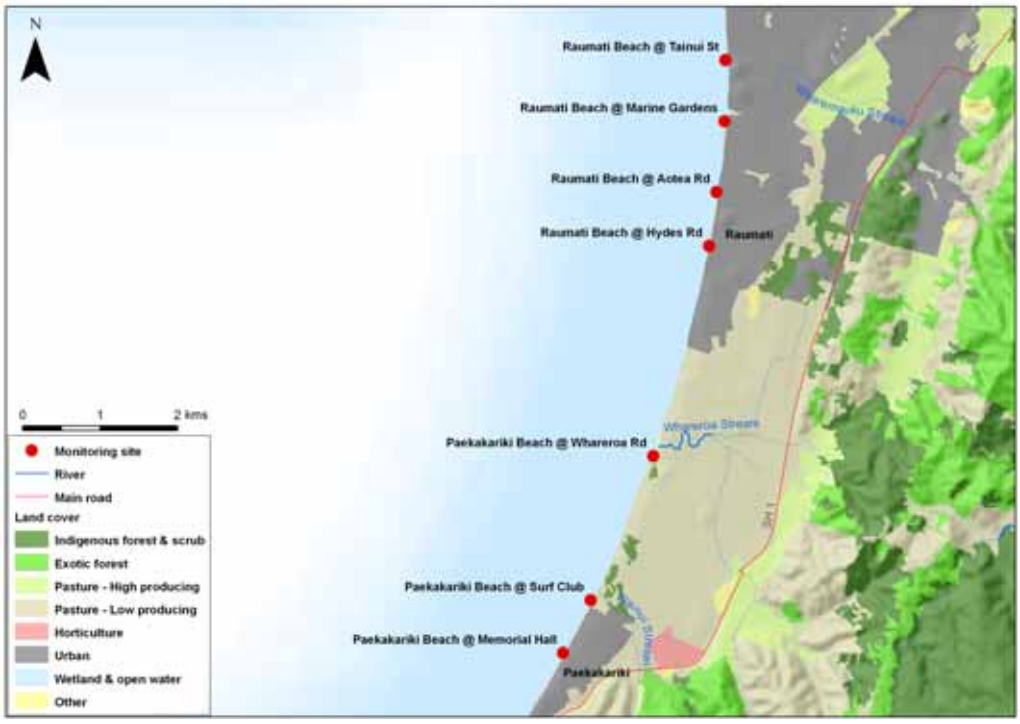


Figure 4.8: Location and surrounding land cover of recreational water quality monitoring sites along Raumati and Paekakariki beaches

4.4.1 Catchment land cover and impacts

All three Raumati Beach sites are bordered by Raumati township while two of the three Paekakariki Beach sites are bounded by Paekakariki township. Paekakariki Beach at Whareroa Road lies on the edge of Queen Elizabeth II Regional Park. Streams draining to these beaches include the Wharemauku Stream which discharges to the sea approximately 100 m to the north of Raumati Beach at Marine Gardens, Whareroa Stream which discharges to the sea approximately 150 m north of the Paekakariki Beach at Whareroa Road,

and Wainui Stream which flows onto Paekakariki Beach at the Surf Club. The Wharemauku Stream has a largely urbanised catchment while the Whareroa and Wainui Stream catchments are dominated by low producing pasture.

Stormwater is discharged onto both Raumati and Paekakariki beaches, both directly and indirectly via the Wharemauku and Wainui streams.

4.4.2 Enterococci counts

Based on routine weekly water quality monitoring between the 2005/06 and 2009/10 summer bathing seasons, median enterococci counts ranged from 3 cfu/100mL at Paekakariki Beach at Memorial Hall to 15 cfu/100mL at Raumati Beach sites at Tainui Street and Marine Gardens (Figure 4.9). Maximum enterococci counts recorded ranged from 140 cfu/100mL (Paekakariki Beach at Memorial Hall on 27 February 2006) to 2,001 cfu/100mL (Raumati Beach at Marine Gardens on 29 December 2009).

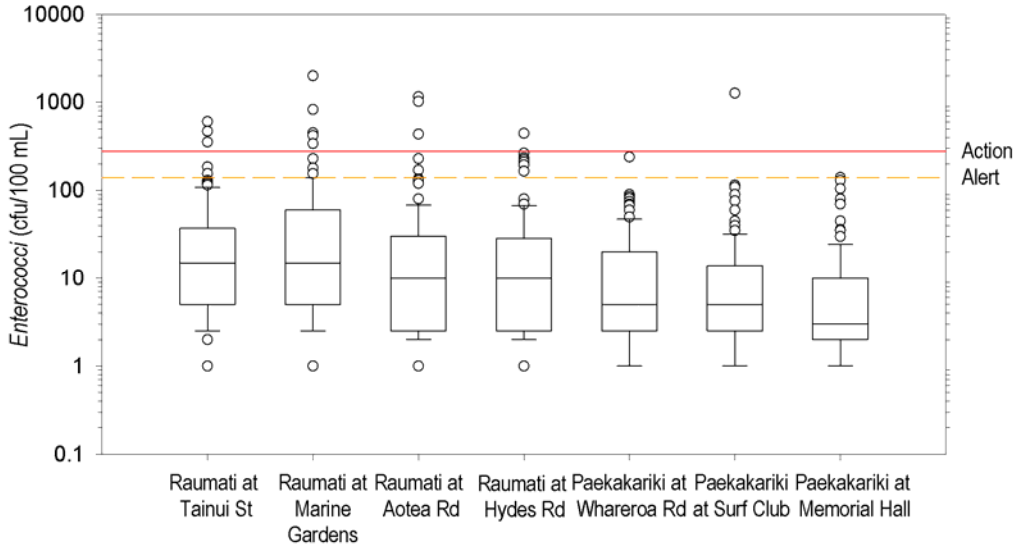


Figure 4.9: Box plot summarising the range of enterococci counts recorded at Raumati and Paekakariki beaches from routine weekly sampling over the 2005/06 to 2009/10 summer bathing seasons. Note the logarithmic scale on the *y*-axis.

4.4.3 Compliance with national microbiological water quality guidelines

Compliance with the MfE/MoH (2003) surveillance guideline during routine weekly monitoring each summer between 2005/06 and 2009/10 ranged from 91% at Raumati Beach at Marine Gardens to over 99% at all Paekakariki Beach monitoring sites (Table 4.8). Two Paekakariki sites – Whareroa Road and Memoral Hall – were among a group of 11 (14%) coastal sites across the Wellington region that did not exceed the action level guideline (280 enterococci/100mL) on any routine sampling occasion. In contrast, Raumati Beach at Marine Gardens exceeded the action guideline five times (Table 4.8).

Table 4.8: Number and percentage of routine weekly sample results coinciding with the surveillance, alert and action modes of the MfE/MoH (2003) guidelines at Raumati and Paekakariki beach monitoring sites over the 2005/06 to 2009/10 summer bathing seasons

Site	*n*	Surveillance		Alert		Action	
		No.	%	No.	%	No.	%
Raumati Beach @ Tainui St	105	100	95.2	2	1.9	3	2.9
Raumati Beach @ Marine Gardens	105	96	91.4	4	3.8	5	4.8
Raumati Beach @ Aotea Rd	105	100	95.2	2	1.9	3	2.9
Raumati Beach @ Hydes Rd	105	98	93.3	6	5.7	1	1.0
Paekakariki Beach @ Whareroa Rd	105	104	99.0	1	1.0	0	0
Paekakariki Beach @ Surf Club	105	104	99.0	0	0	1	1.0
Paekakariki Beach @ Memorial Hall	105	105	100	0	0	0	0

The higher number of action guideline exceedances at Raumati Beach at Marine Gardens is likely to be related to the proximity of this site to the mouth of the Wharemauku Stream. High counts of indicator bacteria have been regularly recorded in the Wharemauku Stream and the source of these is currently being investigated by KCDC (C. Hardy, pers. comm. 2011). Microbial source tracking analysis undertaken in early 2011 suggested that the source of contamination in the Wharemauku Stream is not of human origin (SKM 2011) and other potential sources in the upper catchment are being investigated.

Although there were relatively few action guideline exceedances at Raumati Beach, five of the 12 exceedances at Raumati Beach sites occurred in the absence of any significant rainfall (Figure 4.10). The reasons for these exceedances are unclear.

The only exceedance of the action guideline recorded at Paekakariki Beach occurred at the Surf Club site after 37 mm of rain fell in the 72 hours preceding sampling.

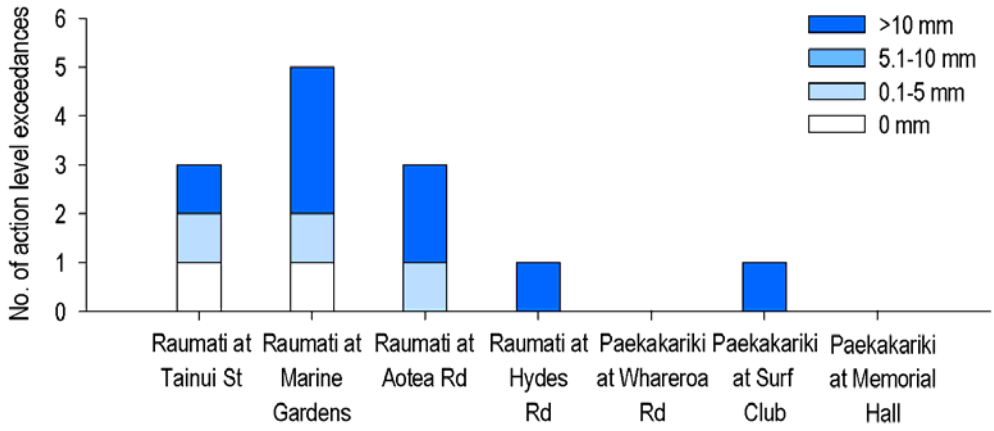


Figure 4.10: Summary of rainfall recorded in the 72 hours preceding sampling for each exceedance of the MfE/MoH (2003) action guideline recorded during routine weekly sampling at Raumati and Paekakariki beaches between the 2005/06 and 2009/10 summer bathing seasons

4.4.4 Suitability for Recreation Grades

Based on assigned SIC grades and routine water quality monitoring results collected over the 2006/07 to 2010/11 summers, SFRGs for Raumati and Paekakariki beach monitoring sites ranged from 'fair' at Raumati Beach at Marine Gardens to 'very good' at Paekakariki Beach at Memorial Hall (Table 4.9).

Table 4.9: SFRGs for Raumati and Paekakariki beach monitoring sites based on enterococci counts from routine sampling over the 2006/07 and 2010/11 summer bathing seasons

Site	SIC grade	MAC grade (95th%-ile value)	SFRG
Raumati Beach @ Tainui St	Moderate	B (118)	Good
Raumati Beach @ Marine Gardens	Moderate	C (268)	Fair
Raumati Beach @ Aotea Rd	Moderate	B (144)	Good
Raumati Beach @ Hydes Rd	Moderate	B (110)	Good
Paekakariki Beach @ Whareroa	Low	B (72)	Good
Paekakariki Beach @ Surf Club	Low	B (64)	Good
Paekakariki Beach @ Memorial	Low	A (40)	Very good

4.4.5 Compliance with guidelines for shellfish-gathering waters

Based on routine weekly sampling, Raumati Beach at Hydes Road exceeded the median guideline of 14 cfu/100mL during three of the five bathing seasons between 2005/06 and 2009/10 (Table 4.10). In addition, this site did not comply with the guideline of no more than 10% exceedances of 43 cfu/100mL in any bathing season.

Table 4.10: Comparison of faecal coliform counts at Raumati Beach at Hydes Road with the MfE/MoH (2003) guidelines for recreational shellfish gathering waters, based on routine weekly monitoring over the 2005/06 to 2009/10 bathing seasons. Results in bold font complied with the guideline.

Bathing season	*n*	Median (cfu/100 mL)	No. and % of results >43 cfu/100mL
2005/06	22	33	9 (41%)
2006/07	21	5	7 (33%)
2007/08	21	6	4 (19%)
2008/09	21	15	5 (24%)
2009/10	20	25	8 (40%)
All summer data	105	19	34 (32%)

When the results of all routine summer sampling over the 2005/06–2009/10 period are considered, Raumati Beach had a median faecal coliform count of 19 cfu/100mL and 32% of samples exceeded the upper guideline value of 43 cfu/100mL.

4.5 Pukerua Bay and outer Porirua Harbour

During bathing seasons between 2005/06 and 2009/10 recreational water quality monitoring was undertaken at two sites along Plimmerton Beach and at one site each at South Beach and Pukerua, Karehana, and Onehunga bays (Figure 411).

Figure 4.11: Location and surrounding land cover of recreational water quality monitoring sites at Pukerua Bay and outer Porirua Harbour

4.5.1 Catchment land cover and impacts

All sites in Pukerua Bay and the outer Porirua Harbour apart from Onehunga Bay are bordered by urban areas. Onehunga Bay is surrounded by low producing pasture. Small, predominantly urban streams discharge to Pukerua and Karehana bays while Taupo Stream, which discharges to the sea approximately 100 m to the north of South Beach at Plimmerton, drains a catchment dominated by high and low producing pasture. The bottom of the Taupo Stream catchment receives some urban stormwater and also, due to the presence of Taupo Swamp in this area, supports a significant bird population.

Stormwater is discharged to Pukerua and Karehana bays, Plimmerton Beach and South Beach, both directly via roadside drains and indirectly via tributary streams.

4.5.2 Enterococci counts

Median enterococci counts at Pukerua Bay and outer Porirua Harbour monitoring sites sampled weekly over the 2005/06 to 2009/10 summer bathing seasons ranged from 4 cfu/100mL at Pukerua Bay and Onehunga Bay to 18 cfu/100mL at South Beach at Plimmerton (Figure 4.12). The highest enterococci count was 2,800 cfu/100mL at Plimmerton Beach at Bath Street on 7 November 2006.

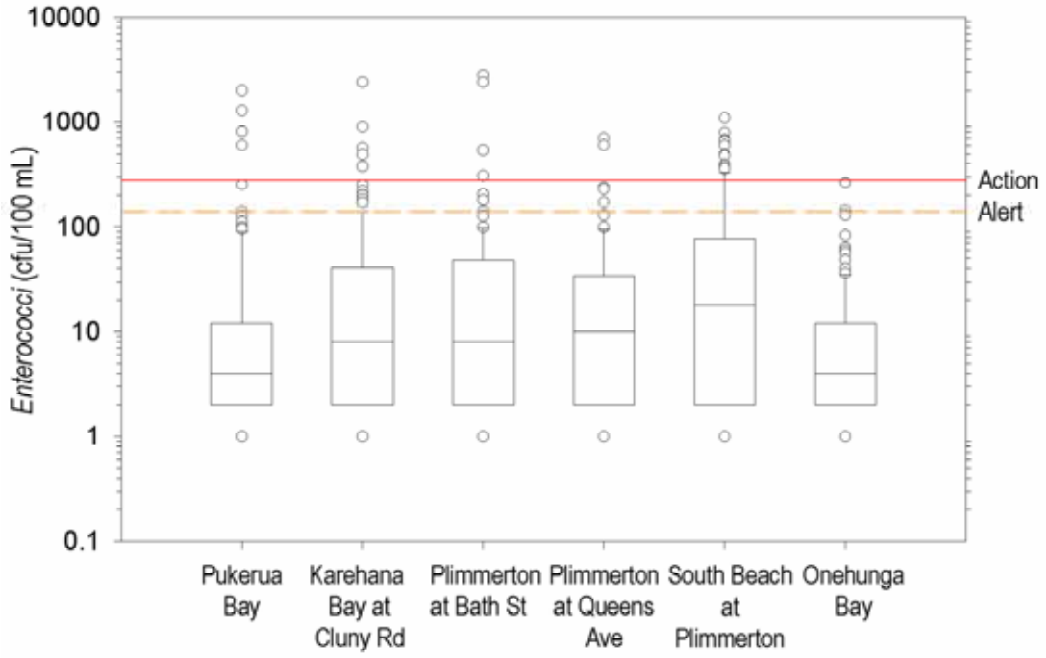


Figure 4.12: Box plot summarising the range of enterococci counts recorded at Pukerua Bay and outer Porirua Harbour monitoring sites from routine weekly sampling over the 2005/06 to 2009/10 summer bathing seasons. Note the logarithmic scale on the *y*-axis.

4.5.3 Compliance with national microbiological water quality guidelines

Compliance with the MfE/MoH (2003) surveillance guideline during routine weekly sampling over the 2005/06 and 2009/10 summer bathing seasons ranged from 83% for South Beach at Plimmerton to 98% for Onehunga Bay. The latter site was one of just 11 coastal sites across the Wellington region not to exceed the action guideline during the five-year reporting period. In contrast, South Beach at Plimmerton exceeded the action guideline on 11 occasions; this site also exceeded the alert guideline on a further seven occasions (Table 4.11).

Table 4.11: Number and percentage of routine weekly sample results coinciding with the surveillance, alert and action modes of the MfE/MoH (2003) guidelines at Pukerua Bay and outer Porirua Harbour monitoring sites over the 2005/06 to 2009/10 summer bathing seasons

Site	*n*	Surveillance		Alert		Action	
		No.	%	No.	%	No.	%
Pukerua Bay	105	100	95.2	1	1.0	4	3.8
Karehana Bay @ Cluny Rd	105	95	90.5	5	4.8	5	4.8
Plimmerton Beach @ Bath St	105	99	94.3	2	1.9	4	3.8
Plimmerton Beach @ Queens Ave	85[1]	79	92.9	3	3.5	3	3.5
South Beach @ Plimmerton	105	87	82.9	7	6.7	11	10.5
Onehunga Bay	105	103	98.1	2	1.9	0	0.0

[1] Sampling at this site ceased at the end of the 2008/09 bathing season.

Many of the action and alert guideline exceedances at South Beach at Plimmerton occurred in the absence of any rainfall (Figure 4.13), suggesting that faecal contamination from Taupo Stream is the most likely cause. As noted in Section 4.5.1, Taupo Stream drains Taupo Swamp, a large wetland that often supports a large waterfowl population. However, a low level of contamination from a human source was detected in one of four beach water samples collected at the stream mouth in February and March 2011 for microbial source analysis (Cornelison et al. 2011). Although no major problems have been identified with sewer and stormwater infrastructure in the area (J Sutton[18], pers. comm. 2011), there are several stormwater discharges to Taupo Stream and directly to South Beach and it is possible that discharges of contaminated stormwater at times contribute to faecal contamination at this site.

At Pukerua Bay, Karehana Bay and Plimmerton Beach sites most action guideline exceedances coincided with significant rainfall in the 72 hours prior to sampling. However, on 13 February 2007 all four sites exceeded the action guideline in the absence of any rainfall at all. Action guideline exceedances were also recorded at South Beach at Plimmerton and Titahi Bay at Toms Road on this date. The occurrence of so many guideline exceedances across these geographically isolated locations, on the same date and in the absence of any rainfall, is unusual; it is possible that at least some of the elevated bacteria counts occurred as a result of contamination during sample collection.

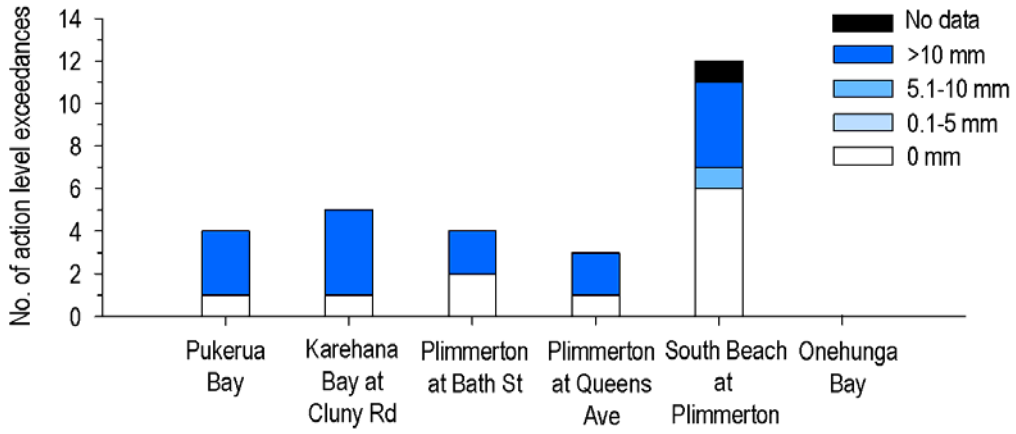


Figure 4.13: Summary of rainfall recorded in the 72 hours preceding sampling for each exceedance of the MfE/MoH (2003) action guideline recorded during routine weekly sampling at Pukerua Bay and outer Porirua Harbour monitoring sites between the 2005/06 and 2009/10 summer bathing seasons

4.5.4 Suitability for Recreation Grades

Based on assigned SIC grades and routine water quality monitoring results collected over the 2006/07 to 2010/11 summers, the SFRGs for Pukerua Bay and outer Porirua Harbour monitoring sites ranged from 'good' at Onehunga Bay to 'poor' at South Beach at Plimmerton (Table 4.12).

[18] Jim Sutton, Manager Environmental Standards, Porirua City Council.

Table 4.12: SFRGs for Pukerua Bay and outer Porirua Harbour monitoring sites, with MAC grades based on enterococci counts from routine sampling over the 2006/07 to 2010/11 summer bathing seasons

Site	SIC grade	MAC grade (95th%-ile value)	SFRG
Pukerua Bay	Moderate	C (321)	Fair
Karehana Bay @ Cluny Rd	Moderate	C (297)	Fair
Plimmerton Beach @ Bath St	Moderate	C (317)	Fair
Plimmerton Beach @ Queens Ave	Moderate	C (206)[1]	Fair[1]
South Beach @ Plimmerton	Moderate	D (692)	Poor
Onehunga Bay	Low	B (70)	Good

[1] As monitoring at this site stopped at the end of the 2008/09 bathing season the MAC grade was calculated from routine data collected over the five summer bathing seasons between 2004/05 and 2008/09.

4.6 Porirua Harbour

Between 2005/06 and 2009/10, recreational water quality was monitored at six sites in Porirua Harbour; one site in the Onepoto arm of the harbour and five sites in Pauatahanui Inlet (Figure 4.14).

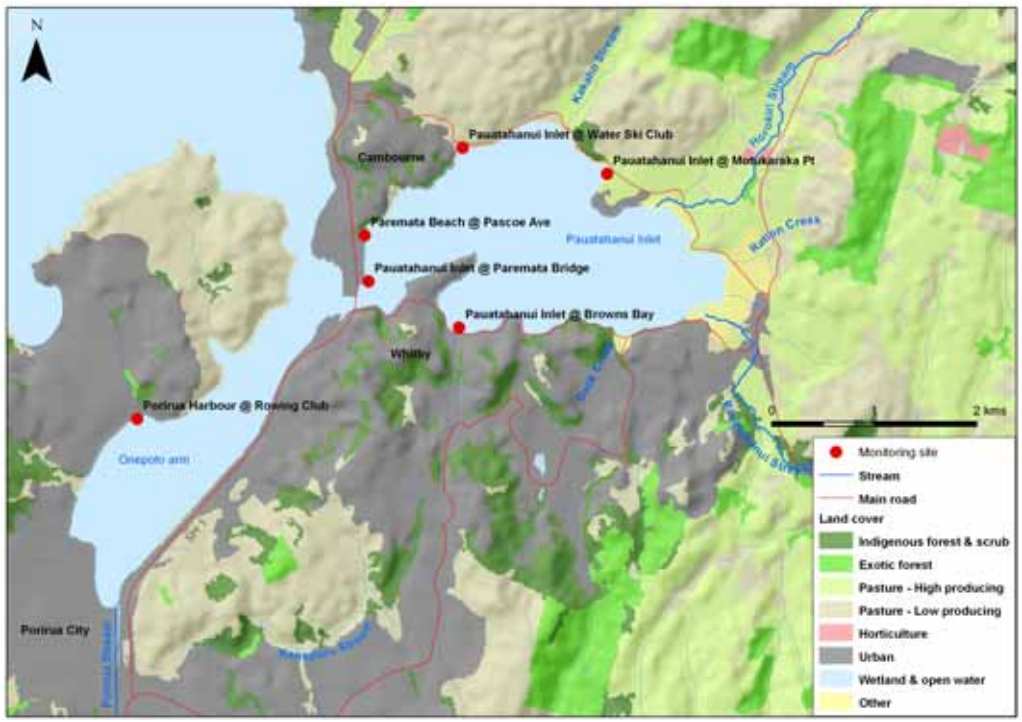


Figure 4.14: Location and surrounding land cover of recreational water quality monitoring sites in Porirua Harbour

4.6.1 Catchment land cover and impacts

Much of the Onepoto arm of Porirua Harbour is bordered by Porirua city while the southern and western sides of Pauatahanui Inlet are bordered by the urban areas of Whitby and Cambourne, respectively. Land cover to the north and east of Pauatahanui Inlet is dominated by high and low producing pasture as well as exotic forest (Figure 4.14). Agricultural activity in the catchment is of relatively low intensity, consisting mainly of sheep and beef farming.

The main watercourse flowing into the Onepoto arm of Porirua Harbour is the Porirua Stream, which drains urban areas of parts of Wellington and Porirua cities. There are also several small streams or drains with predominantly urban catchments. Streams flowing into the southern side of Pauatahanui Inlet include Browns Stream which has a largely urban catchment and Duck Creek which has a mixture of urban and pastoral land cover. Streams draining the pastoral and forestry dominated land to the north and east of Pauatahanui Inlet include Kakaho Stream, Horikiri Stream, Ration Creek and Pauatahanui Stream.

Stormwater is discharged into Porirua Harbour, both directly via roadside drains and indirectly via tributary streams. The largest stormwater outfalls are located at the southern end of the Onepoto arm of the harbour adjacent to Porirua city's CBD. Together with Porirua Stream, these outfalls contribute significant amounts of contaminants to the harbour (eg, Sorensen & Milne 2009; Oliver & Milne 2012; Perrie et al. 2012).

4.6.2 Enterococci counts

Median enterococci counts over the 2005/06 to 2009/10 summer bathing seasons ranged from 4 cfu/100mL at Paremata Beach (Pascoe Avenue) and Pauatahanui Inlet sites (Motukaraka Point and Paremata Bridge) to 24 cfu/100mL at Porirua Harbour at Rowing Club (Figure 4.15). Maximum enterococci counts at these sites ranged from 410 cfu/100mL at Pauatahanui Inlet at Paremata Bridge (8 January 2008) to 9,600 cfu/100mL at Porirua Harbour at Rowing Club (12 February 2008).

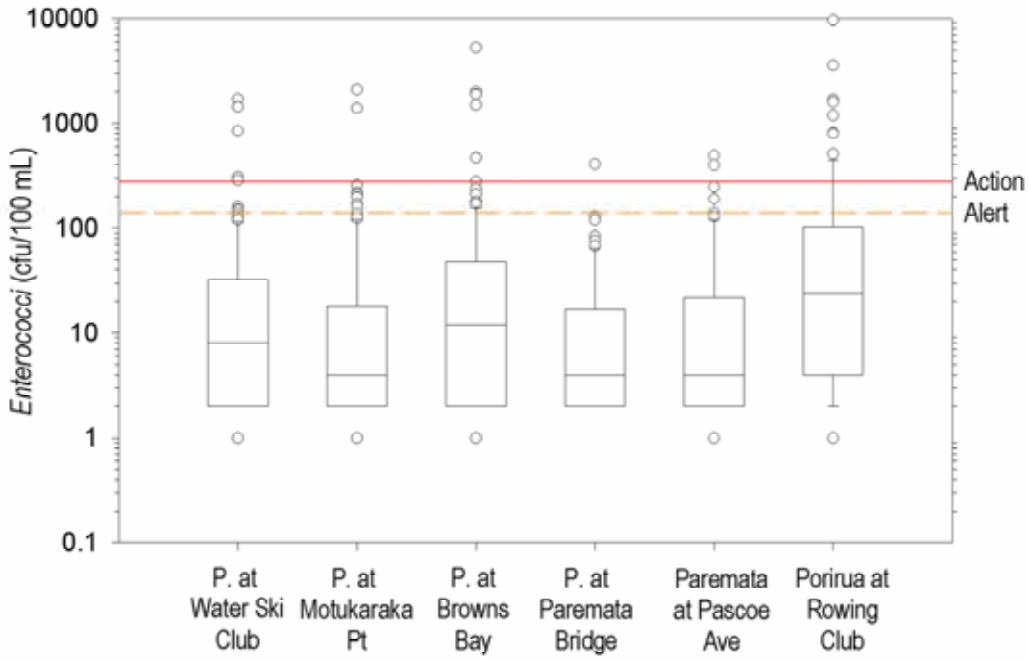


Figure 4.15: Box plot summarising the range of enterococci counts recorded at Porirua Harbour monitoring sites from routine weekly sampling over the 2005/06 to 2009/10 summer bathing seasons. Note the logarithmic scale on the *y*-axis.

4.6.3 Compliance with national microbiological water quality guidelines

Compliance with the MfE/MoH (2003) surveillance guideline during routine weekly sampling between 2005/06 and 2009/10 ranged from 83% at Porirua Harbour at Rowing Club to 98% at Pauatahanui Inlet at Paremata Bridge (Table 4.13). In terms of action guideline exceedances, the Porirua Harbour at Rowing Club recorded the most (11); seven exceedances of the alert guideline were also recorded at this site over the same period. Pauatahanui Inlet at Browns Bay similarly recorded a large number of alert guideline exceedances (9), in addition to five action guideline exceedances (Table 4.13).

Table 4.13: Number and percentage of routine weekly sample results coinciding with the surveillance, alert and action modes of the MfE/MoH (2003) guidelines at Porirua Harbour monitoring sites over the 2005/06 to 2009/10 summer bathing seasons

Site	*n*	Surveillance		Alert		Action	
		No.	%	No.	%	No.	%
Pauatahanui Inlet @ Water Ski Club	105	98	93.3	2	1.9	5	4.8
Pauatahanui Inlet @ Motukaraka Pt	105	97	92.4	6	5.7	2	1.9
Pauatahanui Inlet @ Browns Bay	105	91	86.7	9	8.6	5	4.8
Pauatahanui Inlet @ Paremata Br	62[1]	61	98.4	0	0.0	1	1.6
Paremata Beach @ Pascoe Ave	85[2]	80	94.1	2	2.4	3	3.5
Porirua Harbour @ Rowing Club	105	87	82.9	7	6.7	11	10.5

[1] Monitoring at this site commenced in November 2008.
[2] Monitoring at this site ceased in March 2009.

All exceedances of the action guideline at Porirua Harbour at Rowing Club were recorded from January 2008 onwards, with five exceedances recorded in the 2008/09 bathing season alone (Figure 4.16). Of these exceedances, all but two occurred following more than 5 mm of rainfall in the 72 hours preceding sampling (Figure 4.17). In addition to the exceedances of the action guideline during routine monitoring, on many occasions, enterococci counts also exceeded the alert or action guidelines in one or two consecutive follow up samples (eg, Warr 2009).

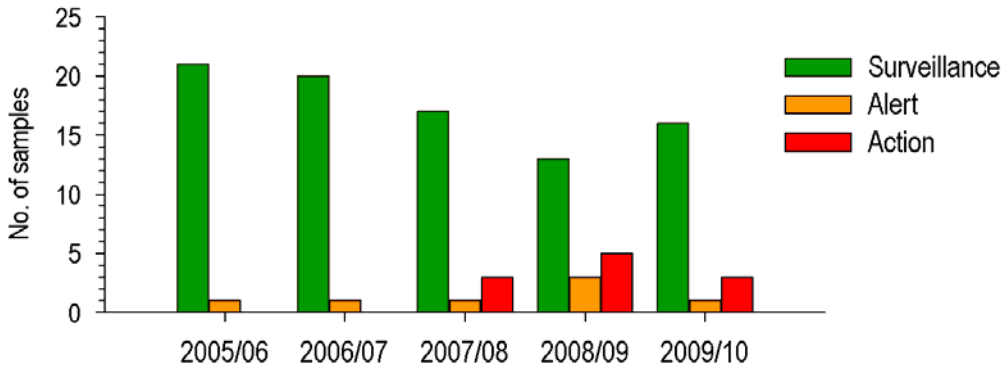


Figure 4.16: Summary of compliance with the MfE/MoH (2003) surveillance, alert and action guidelines at Porirua Harbour at Rowing Club, based on routine weekly sampling during bathing seasons between 2005/06 and 2009/10

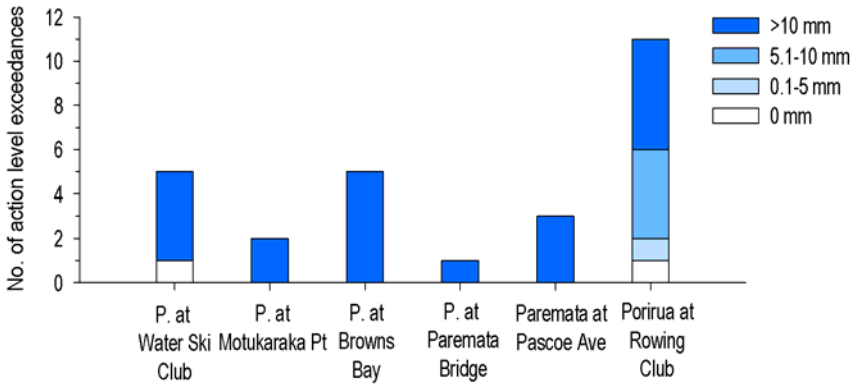


Figure 4.17: Summary of rainfall recorded in the 72 hours preceding sampling for each exceedance of the MfE/MoH (2003) action guideline recorded during routine weekly sampling at Porirua Harbour monitoring sites between the 2005/06 and 2009/10 summer bathing seasons. Note P=Pauatahanui Inlet

A likely source of contamination at Porirua Harbour at Rowing Club is the un-named stream (known locally as 'Onepoto Drain') which enters the harbour immediately northeast of the Rowing Club. *E. coli* counts of up to 2,200 cfu/100mL were measured in this stream during an investigation undertaken by Porirua City Council (PCC) in March 2009. Subsequent to this investigation a number of illegal sewer connections to the stormwater network at newly constructed properties in the stream catchment were found and fixed. PCC is currently investigating potential sewer pump overflow sites and the performance of a septic tank still operating in the area (N. MacDonald[19], pers. comm. 2012).

Eight out of the eleven action guideline exceedances at Porirua Harbour at Rowing Club coincided with winds from a southerly, southwest or southeast direction suggesting that re-suspension of harbour sediment caused by winds blowing across the harbour may also contribute to elevated enterococci counts at this site. Similarly, the coincidence of action guideline exceedances at Browns Bay on the southern side of Pauatahanui Inlet with northerly or northwest winds suggests that sediment re-suspension may also contribute to elevated faecal indicator bacteria counts at this site.

Of the action guideline exceedances recorded at Pauatahanui Inlet and Paremata Beach sites, all but one coincided with heavy rainfall in the 72 hours prior to sampling (Figure 4.17).

4.6.4 Suitability for Recreation Grades

Based on assigned SIC grades and routine monitoring results collected over the 2006/07 to 2010/11 summers, SFRGs at Porirua Harbour monitoring sites ranged from 'good' at Pauatahanui Inlet at Paremata Bridge to 'poor' at Porirua Harbour at Rowing Club (Table 4.14). In the case of the Porirua Harbour Rowing Club, the 95th percentile enterococci count (ie, the MAC value) is very high (1,340 cfu/100mL); PCC are undertaking ongoing investigations into possible sources of contamination at this site.

[19] Nick MacDonald, Senior Environmental Health Officer, Porirua City Council.

Table 4.14: SFRGs for Porirua Harbour monitoring sites, with MAC grades based on enterococci counts from routine sampling over the 2006/07 and 2010/11 summer bathing seasons

Site	SIC grade	MAC grade (95th%-ile value)	SFRG
Pauatahanui Inlet @ Water Ski Club	Moderate	C (283)	Fair
Pauatahanui Inlet @ Motukaraka Pt	Moderate	C (215)	Fair
Pauatahanui Inlet @ Browns Bay	Moderate	D (555)	Poor
Pauatahanui Inlet @ Paremata Bridge	Moderate	B (124)[1]	Good[1]
Paremata Beach @ Pascoe Ave	Moderate	B (199)[2]	Good[2]
Porirua Harbour @ Rowing Club	Moderate	D (1,340)	Poor

[1] Interim grade as MAC based on 3 years of data, *n*=62.

[2] As monitoring at this site stopped at the end of the 2008/09 bathing season the MAC grade was calculated from routine data collected over the five bathing seasons between 2004/05 and 2008/09.

4.6.5 Compliance with guidelines for shellfish-gathering waters

Water quality for recreational shellfish gathering is monitored at three sites in Porirua Harbour: Pauatahanui Inlet at Motukaraka Point, Pauatahanui Inlet at Browns Bay and Porirua Harbour at Rowing Club. Although these sites are not recommended as shellfish gathering sites and are rarely used for this purpose, sampling was initiated here in July 2007 in response to community interest.

Based on routine weekly sampling, faecal coliform counts at Pauatahanui Inlet at Motukaraka Point complied with both guidelines for shellfish gathering in two of the three bathing seasons sampled (Table 4.15). Pauatahanui Inlet at Browns Bay met the seasonal median guideline (<14 cfu/100mL) in two of three bathing seasons but never met the upper guideline (no more than 10% of samples >43 cfu/100mL). Faecal coliform counts at Porirua Harbour at Rowing Club rarely complied with either guideline.

When all routine monitoring results collected over the three bathing seasons were compared with the guidelines, Pauatahanui Inlet at Motukaraka Point complied with both guidelines. In contrast, Pauatahanui Inlet at Browns Bay complied with only the seasonal median guideline and Porirua Harbour at Rowing Club did not comply with either guideline.

Table 4.15: Comparison of faecal coliform counts at Porirua Harbour monitoring sites with the MfE/MoH (2003) guidelines for recreational shellfish gathering waters, based on routine weekly monitoring over the 2005/06 to 2009/10 bathing seasons. Results in bold font complied with the guideline.

Bathing season	*n*	Pauatahanui Inlet at Motukaraka Point		Pauatahanui Inlet at Browns Bay		Porirua Harbour at Rowing Club	
		Median (cfu/100mL)	No. and % >43 cfu/100mL	Median (cfu/100mL)	No. and % >43 cfu/100mL	Median (cfu/100mL)	No. and % >43 cfu/100mL
2007/08	21	2	1 (5%)	4	3 (14%)	28	8 (38%)
2008/09	21	4	3 (14%)	8	9 (43%)	12	9 (43%)
2009/10	20	3	1 (5%)	26	8 (40%)	36	9 (45%)
All summer data	62	4	5 (8%)	8	20 (32%)	30	26 (42%)

4.7 Titahi Bay

Recreational water quality monitoring is undertaken at three sites in Titahi Bay: Titahi Bay at Bay Drive, Titahi Bay and Toms Road and Titahi Bay at South Beach Access Road (Figure 4.18).

Figure 4.18: Location and surrounding land cover of recreational water quality monitoring sites in Titahi Bay

4.7.1 Catchment land cover and impacts

Titahi Bay is bordered by urban areas of the suburb of Titahi Bay. Three small un-named streams drain into the bay, each of which has been highly modified and in places, piped. These un-named streams drain small urban catchments and discharge to the bay at South Beach Access Road, Toms Road and Bay Drive.

From a recreational water quality perspective, the most significant point source discharges into the Titahi Bay catchment are urban stormwater which enter the bay at approximately seven locations, including the three unnamed tributary streams. PCC also has consent to discharged treated wastewater from the Porirua WWTP into the surf zone at Rukutane Point, approximately 700 m southwest of Titahi Bay. This plant services an estimated population of 80,000 people across a catchment that takes in the northern suburbs of Wellington city and most of Porirua city.

4.7.2 Enterococci counts

Median enterococci counts at Titahi Bay monitoring sites over the 2005/06 to 2009/10 summer bathing seasons ranged from 8 cfu/100mL at Toms Road to 16 cfu/100mL at South Beach Access Road (Figure 4.19). Maximum enterococci counts recorded ranged from 488 cfu/100mL at Bay Drive on 1 December 2009 to 1,559 cfu/100mL at South Beach Access Road on 29 December 2009.

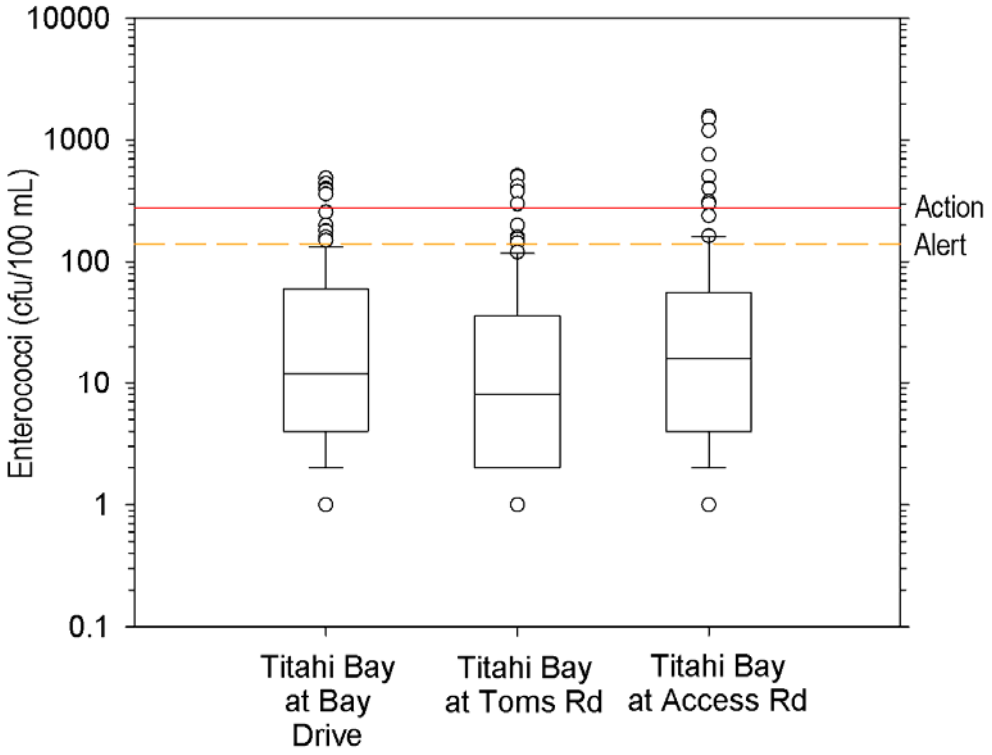


Figure 4.19: Box plot summarising the range of enterococci counts recorded at Titahi Bay beach sites from routine weekly sampling over the 2005/06 to 2009/10 summer bathing seasons. Note the logarithmic scale on the *y*-axis.

4.7.3 Compliance with national microbiological water quality guidelines

Compliance with the MfE/MoH (2003) surveillance guideline over the five-summer reporting period ranged from 88% at Titahi Bay at South Beach Access Road to 91% at Toms Road (Table 4.16). Eight exceedances of the MfE/MoH (2003) action guideline were recorded at South Beach Access Road over this period.

Table 4.16: Number and percentage of routine weekly sample results coinciding with the surveillance, alert and action modes of the MfE/MoH (2003) guidelines at Titahi Bay monitoring sites over the 2005/06 to 2009/10 summer bathing seasons

Site	*n*	Surveillance		Alert		Action	
		No.	%	No.	%	No.	%
Titahi Bay @ Bay Drive	105	95	90.5	5	4.8	5	4.8
Titahi Bay @ Toms Rd	105	96	91.4	4	3.8	5	4.8
Titahi Bay @ South Beach Access Rd	105	92	87.6	5	4.8	8	7.6

The majority (72%) of action guideline exceedances at Titahi Bay sites coincided with significant rainfall in the 72 hours preceding sampling (Figure 4.20). However, two and three action guideline exceedances were recorded following little or no rain at Toms Road and South Beach Access Road, respectively. None of the dry weather exceedances at these two sites coincided on the same dates, suggesting a locally confined contaminant source was responsible.

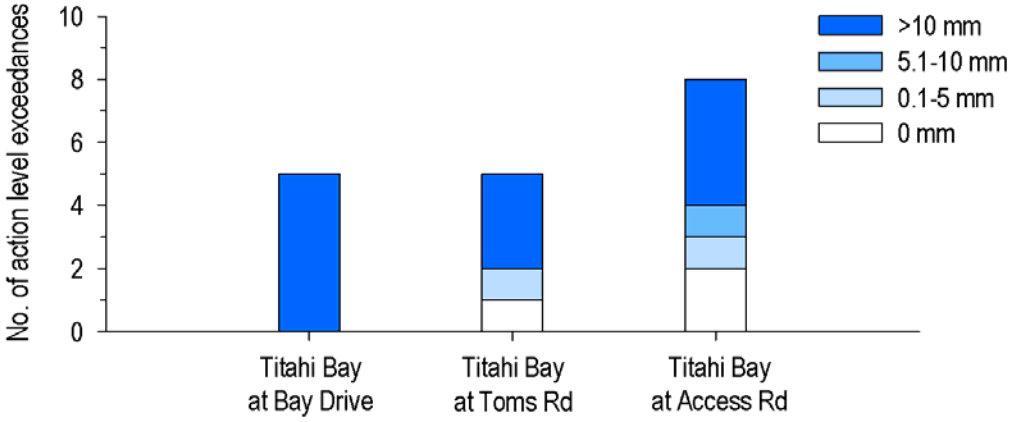


Figure 4.20: Summary of rainfall recorded in the 72 hours preceding sampling for each exceedance of the MfE/MoH (2003) action guideline recorded during routine weekly sampling at Titahi Bay Beach between the 2005/06 and 2009/10 summer bathing seasons

The source of dry weather contamination at Titahi Bay at South Beach Access Road was investigated by PCC staff in December 2010. A water sample taken from the piped stream at this site was found to have an *E. coli* count of 62,000 cfu/100mL; microbial source tests performed on water samples taken at this time were found to have a 'strong positive' signal for human faecal contamination (Devane 2010). These results suggest that sewer/stormwater infrastructure cross connections are present in the catchment of the South Beach Access Road stormwater outfall; despite ongoing investigations, PCC staff have not yet been able to identify the location of these cross connection; s (N. McDonald, pers. comm. 2011).

In addition to possible sewer/stormwater cross connections, water quality in Titahi Bay may on occasion be affected by the Porirua WWTP. Given the location of the WWTP discharge in relation to Titahi Bay (700 m southwest), it is likely that south-westerly wind conditions combined with an incoming tide would bring the greatest risk of the WWTP discharge impacting on water quality in Titahi Bay. However, all of the action guideline exceedances recorded in Titahi Bay between 2005/06 and 2009/10 coincided with northerly or northwest winds and most occurred on an outgoing tide; this suggests that the WWTP discharge was not contributing to contamination of Titahi Beach monitoring sites on these occasions. While it is possible that the WWTP discharge does influence microbiological water quality in Titahi Bay at times, wet weather monitoring undertaken by PCC at seven sites around the WWTP (including two in Titahi Bay) has not highlighted any obvious contamination attributable to the Porirua WWTP.

4.7.4 Suitability for Recreation Grades

Based on assigned SIC grades and routine water quality monitoring results collected over the 2006/07 to 2010/11 summers, SFRGs for Titahi Bay monitoring sites ranged from 'fair' at Bay Drive and Toms Road to 'poor' at South Beach Access Road (Table 4.17).

Table 4.17: SFRGs for Titahi Bay monitoring sites, with MAC grades based on enterococci counts from routine sampling over the 2006/07 and 2010/11 summer bathing seasons

Site	SIC grade	MAC grade (95th%-ile value)	SFRG
Titahi Bay @ Bay Drive	Moderate	C (370)	Fair
Titahi Bay @ Toms Rd	Moderate	C (328)	Fair
Titahi Bay @ South Beach Access Rd	Moderate	D (598)	Poor

4.8 Inner Wellington Harbour

The coastline along the inner Wellington Harbour is predominantly rocky with a number of small, embayed, gravely or sandy beaches. Between Oriental Bay and Korokoro, the shoreline consists of almost entirely artificial structures associated with the port and arterial transport systems. While most of the bays and beaches between Oriental Bay and Evans Bay have short, steep catchments, north of Oriental Bay, several large catchments drain into the harbour.

Recreational water quality was monitored at seven sites in the western part of Wellington Harbour over the 2005/06 to 2009/10 bathing seasons: three in Oriental Bay, one each in Balaena and Kio bays, one on Hataitai Beach and one in Aotea Lagoon (Figure 4.21).

Figure 4.21: Location and surrounding land cover of recreational water quality monitoring sites in the inner Wellington Harbour

4.8.1 Catchment land cover and impacts

Urban areas of Wellington city dominate the area surrounding the inner Wellington Harbour. The Kaiwharawhara and Ngauranga streams, which drain

large urban catchments, discharge to Wellington Harbour to the north of Wellington city's CBD. Several smaller streams, many of which have been integrated into the city's stormwater infrastructure, discharge to the harbour between the port area and Evans Bay.

A large number of stormwater outfalls discharge into inner Wellington Harbour, including several very large outfalls (eg, Davis Street and the Overseas Passenger Terminal) that at times of heavy or sustained rainfall can discharge stormwater contaminated with untreated sewage. Wellington City Council (WCC) has resource consent for these discharges which incorporates monitoring of both stormwater and receiving water quality.

4.8.2 Enterococci counts

Median enterococci counts, based on routine bathing season sampling between 2005/06 and 2009/10, were very low (<5 cfu/100mL) at all monitoring sites in the inner Wellington Harbour. Maximum enterococci counts ranged from 150 cfu/100mL at Hataitai Beach on 27 March 2006 to 1,700 cfu/100mL at Oriental Bay at Freyberg Beach on 11 February 2008.

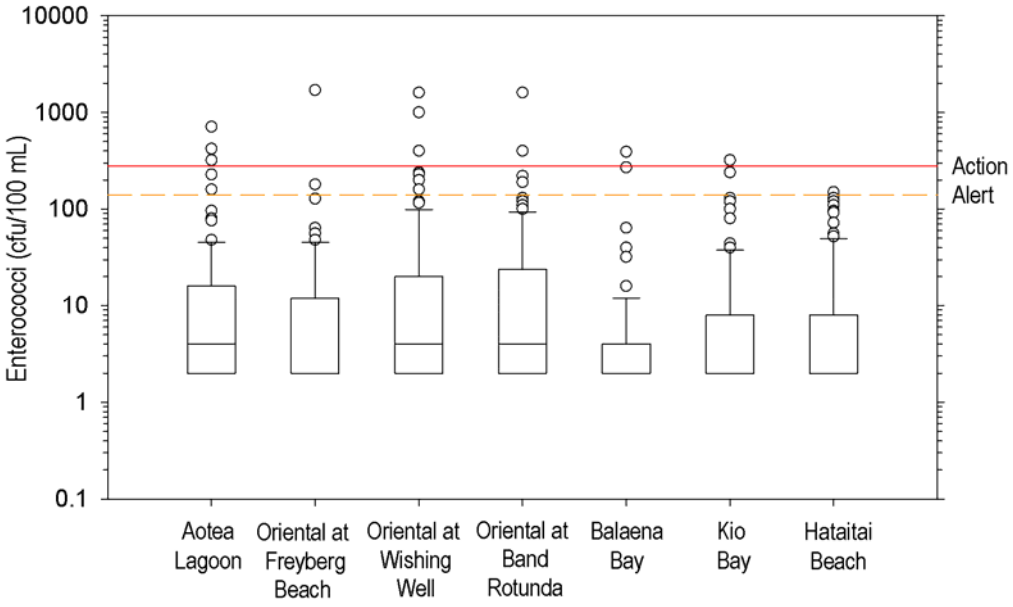


Figure 4.22: Box plot summarising the range of enterococci counts recorded at inner Wellington Harbour monitoring sites from routine weekly sampling over the 2005/06 to 2009/10 summer bathing seasons. Note the logarithmic scale on the *y*-axis.

4.8.3 Compliance with national microbiological water quality guidelines

Compliance with the MfE/MoH (2003) surveillance guideline at inner Wellington Harbour monitoring sites over the 2005/06 to 2009/10 summer bathing seasons ranged from 92% at Oriental Bay at Wishing Well to 99% at Hataitai Beach (Table 4.18). Hataitai Beach was the only site not to exceed the action guideline over the five summer period. In contrast, Aotea Lagoon and Oriental Bay exceeded the action guideline on three occasions each.

Table 4.18: Number and percentage of routine weekly sample results coinciding with the surveillance, alert and action modes of the MfE/MoH (2003) guidelines at inner Wellington Harbour monitoring sites over the 2005/06 to 2009/10 summer bathing seasons

Site	*n*	Surveillance		Alert		Action	
		No.	%	No.	%	No.	%
Aotea Lagoon	105	100	95	2	2	3	3
Oriental Bay @ Freyberg Beach	105	103	98	1	1	1	1
Oriental Bay @ Wishing Well	105	97	92	5	5	3	3
Oriental Bay @ Band Rotunda	105	101	96	2	2	2	2
Balaena Bay	105	103	98	1	1	1	1
Kio Bay	85[1]	83	98	1	1	1	1
Hataitai Beach	105	104	99	1	1	0	0

[1] Sampling at this site ceased at the end of the 2008/09 bathing season.

Although only eleven action guideline exceedances were recorded across all monitoring sites in inner Wellington Harbour, approximately 70% of these occurred in the absence of any significant rainfall (Figure 4.23). This was particularly apparent at Aotea Lagoon, where all three action guideline exceedances occurred following less than 4 mm of rainfall in the 72 hours preceding sampling. As no stormwater outfalls discharge directly into Aotea Lagoon (one outfall discharges just outside) the cause of these dry weather exceedances is unclear; there were no patterns in wind or tide conditions that coincided with these exceedances.

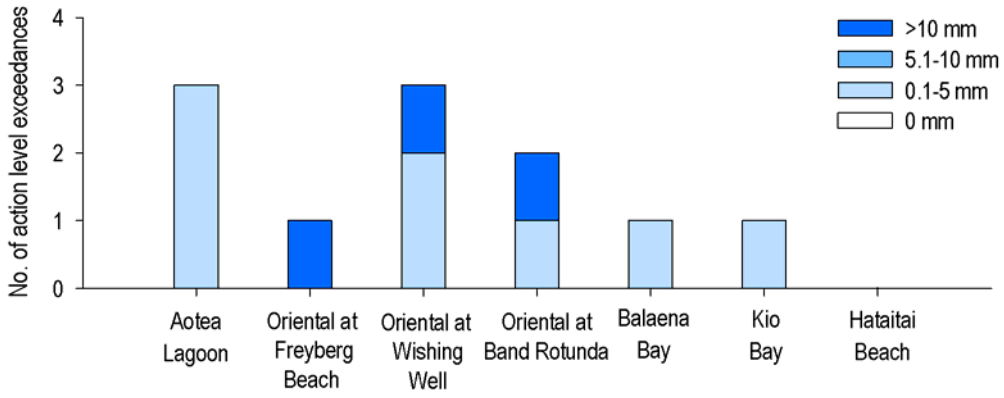


Figure 4.23: Summary of rainfall recorded in the 72 hours preceding sampling for each exceedance of the MfE/MoH (2003) action guideline recorded during routine weekly sampling at inner Wellington Harbour monitoring sites between the 2005/06 and 2009/10 summer bathing seasons

4.8.4 Suitability for Recreation Grades

Based on assigned SIC grades and routine water quality monitoring results collected over the 2006/07 to 2010/11 summers, all sites in inner Wellington Harbour have SFRGs of 'good'. The exception is Balaena Bay which is graded 'very good' (Table 4.19).

Table 4.19: SFRGs for inner Wellington's Harbour monitoring sites, with MAC grades based on enterococci counts from routine sampling over the 2006/07 to 2010/11 summer bathing seasons

Site	SIC grade	MAC grade (95th%-ile value)	SFRG
Aotea Lagoon	Moderate	B (184)	Good
Oriental Bay @ Freyberg Beach	Moderate	B (59)	Good
Oriental Bay @ Wishing Well	Moderate	B (200)	Good
Oriental Bay @ Band Rotunda	Moderate	B (123)	Good
Balaena Bay	Low	A (32)	Very good
Kio Bay	Moderate	B (120)[1]	Good[1]
Hataitai Beach	Moderate	B (49)	Good

[1] As monitoring at this site stopped at the end of the 2008/09 bathing season the MAC grade was calculated from routine data collected over the five summer bathing seasons between 2004/05 and 2008/09.

4.9 Wellington eastern bays

Recreational water quality is monitored at seven sites around Wellington's Eastern Bays including one site each at Shark, Mahanga, Scorching, Worser and Breaker bays, and two sites along Seatoun Beach. At Shark and Mahanga bay sites, suitability for shellfish gathering is also monitored (Figure 4.24).

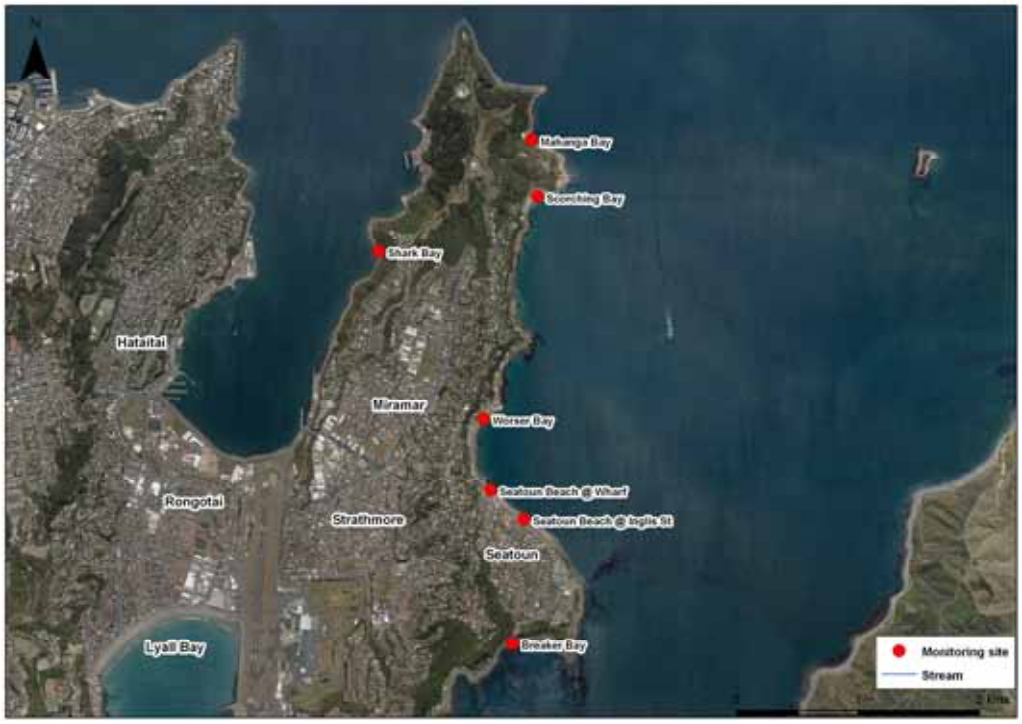


Figure 4.24: Location and surrounding land cover of recreational water quality monitoring sites around Wellington city's eastern bays

4.9.1 Catchment land cover and impacts

Shark, Mahanga, Scorching and Breaker bays have small, steep catchments which are dominated by scrub while Worser Bay and Seatoun Beach are bordered by the urban areas of Miramar and Seatoun, respectively. Stormwater is discharged to the coast at numerous locations, with the largest outfalls being those that discharge to Seatoun Beach near the Wharf and Inglis Street sites.

4.9.2 Enterococci counts

Median enterococci counts were very low at all monitoring sites over the 2005/06 to 2009/10 summer bathing seasons, with most sites recording a median enterococci count of just 2 cfu/100mL (Figure 4.25). Maximum enterococci counts recorded over this period ranged from just 32 cfu/100mL at Breaker Bay (11 February 2008) to 1,800cfu/100mL at Seatoun Beach at Wharf (18 February 2008).

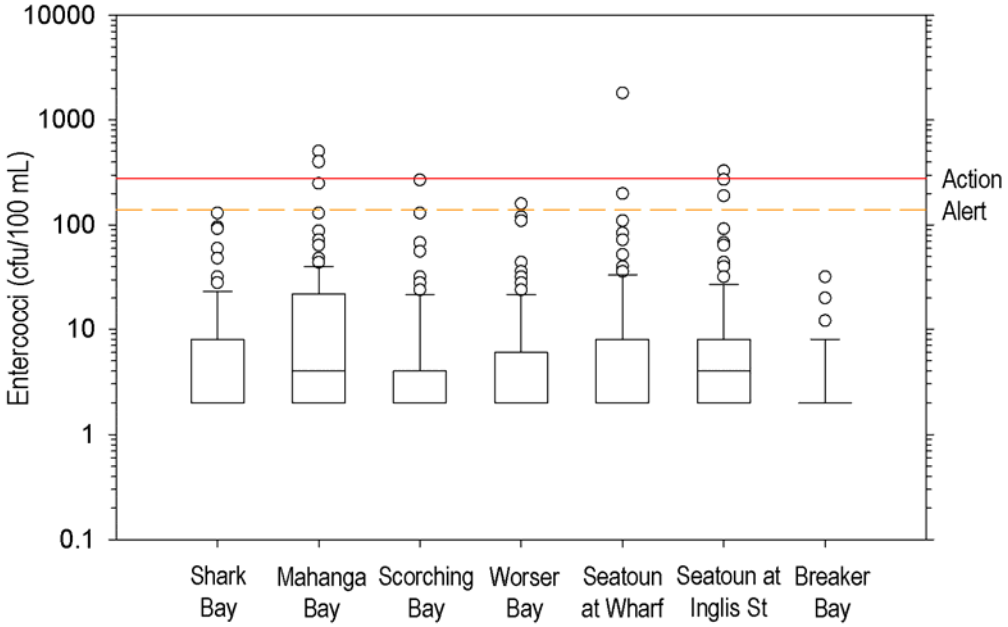


Figure 4.25: Box plot summarising the range of enterococci counts recorded at Wellington's eastern bay monitoring sites from routine weekly sampling over the 2005/06 to 2009/10 summer bathing seasons. Note the logarithmic scale on the *y*-axis.

4.9.3 Compliance with national microbiological water quality guidelines

There was 100% compliance with the MfE/MoH (2003) surveillance guideline at Shark Bay and Breaker Bay over the 2005/06 to 2009/10 summer bathing seasons. Compliance with the surveillance guideline was 97% or greater at the remaining five sites, with only three of these sites (Mahanga Bay and Seatoun Beach at both Wharf and Inglis Street) exceeding the action guideline during the reporting period (Table 4.20). Two of the four action guideline exceedances coincided with more than 10 mm of rainfall in the 72 hours preceding sampling; the other two exceedances occurred following only small rainfall events (Figure 4.26).

Table 4.20: Number and percentage of routine weekly sample results coinciding with the surveillance, alert and action modes of the MfE/MoH (2003) guidelines at eastern bay monitoring sites over the 2005/06 to 2009/10 summer bathing seasons

Site	*n*	Surveillance		Alert		Action	
		No.	%	No.	%	No.	%
Shark Bay	105	105	100	0	0	0	0
Mahanga Bay	105	102	97	1	1	2	2
Scorching Bay	105	104	99	1	1	0	0
Worser Bay	105	104	99	1	1	0	0
Seatoun Beach @ Wharf	105	103	98	1	1	1	1
Seatoun Beach @ Inglis St	105	102	97	2	2	1	1
Breaker Bay	65[1]	65	100	0	0	0	0

[1] Since November 2006 this site has been sampled fortnightly during the bathing season.

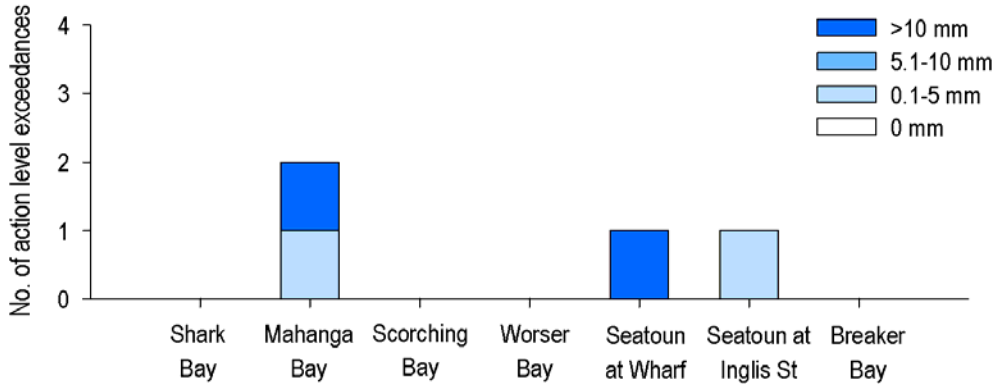


Figure 4.26: Summary of rainfall recorded in the 72 hours preceding sampling for each exceedance of the MfE/MoH (2003) action guideline recorded during routine weekly sampling at Wellington's eastern bay monitoring sites between the 2005/06 and 2009/10 summer bathing seasons

4.9.4 Suitability for Recreation Grades

The SFRGs for Wellington city's eastern bay monitoring sites, based on assigned SIC grades and the results of routine water quality monitoring over the 2006/07 to 2010/11 summers, ranged from 'very good' at Scorching Bay and Breaker Bay to 'good' at all other sites (Table 4.21).

Table 4.21: SFRGs for Wellington's eastern bay monitoring sites, with MAC grades based on enterococci counts from routine sampling over the 2006/07 to 2010/11 summer bathing seasons

Site	SIC grade	MAC grade (95th%-ile value)	SFRG
Shark Bay	Moderate	B (71)	Good
Mahanga Bay	Low	B (54)	Good
Scorching Bay	Low	A (32)	Very good
Worser Bay	Moderate	B (41)	Good
Seatoun Beach @ Wharf	Moderate	B (63)	Good
Seatoun Beach @ Inglis St	Moderate	B (78)	Good
Breaker Bay[1]	Low	A (8)	Very good

[1] Since November 2006 this site has been sampled fortnightly during the bathing season

4.9.5 Compliance with guidelines for shellfish-gathering waters

Based on routine weekly summer sampling results collected between 2005/06 and 2009/10, both Shark Bay and Mahanga Bay consistently complied with the seasonal median guideline for median faecal coliform bacteria (14 cfu/100mL) (Table 4.22). Shark Bay also fully complied with the upper guideline (no more than 10% of sample results to exceed 43 cfu/100mL) while results collected from Mahanga Bay complied with this guideline in three out of five bathing seasons. When all routine data collected across the five summer seasons were considered, Mahanga Bay complied with both shellfish gathering guidelines.

Table 4.22: Comparison of faecal coliform counts at Shark Bay and Mahanga Bay with the MfE/MoH (2003) guidelines for recreational shellfish gathering waters, based on routine weekly monitoring over the 2005/06 to 2009/10 bathing seasons. Results in bold font exceeded guideline values.

Bathing season	*n*	Shark Bay		Mahanga Bay	
		Median (cfu/100mL)	No and % of results >43 cfu/100mL	Median (cfu/100mL)	No and % of results >43 cfu/100mL
2005/06	22	2	1 (5%)	4	4 (18%)
2006/07	21	2	0	2	0
2007/08	21	2	1 (5%)	4	1 (5%)
2008/09	21	2	1 (5%)	2	3 (14%)
2009/10	20	2	1 (5%)	2	1 (5%)
All summer data	105	2	4 (4%)	2	9 (9%)

4.10 Wellington south coast

Wellington city's south coast, which forms part of the northern seaboard of Cook Strait, consists of a rocky shoreline interspersed with sandy or gravelly beaches. Part of this coastline is protected by Taputeranga Marine Reserve which extends from Owhiro Bay in the west to Te Raekaihau in the east.

Recreational water quality is monitored at eight sites along the south coast: three each within Lyall Bay and Island Bay, and one each in Princess Bay and Owhiro Bay (Figure 4.27).

4.10.1 Catchment land cover and impacts

Land cover along Wellington city's south coast includes urban areas of the suburbs of Lyall Bay, Houghton Bay, Island Bay and Owhiro Bay as well as scrub land bordering Princess Bay and parts of Houghton Bay (Figure 4.27).

The Owhiro Stream, whose catchment includes the suburbs of Brooklyn and Mornington, drains to Owhiro Bay. Streams which would have originally drained to Lyall Bay, Houghton Bay and Island Bay have since been piped and incorporated into the stormwater infrastructure.

Figure 4.27: Location and surrounding land cover of recreational water quality monitoring sites on Wellington city's south coast

Wellington City Council holds consent for multiple stormwater discharges along the south coast. These discharges occur both directly and indirectly via tributary streams (eg, Owhiro Stream). There are particularly large stormwater outfalls in Lyall and Island bays that, at times of very high rainfall, can be affected by sewage. Similarly, during heavy rainfall the stormwater outfall at Houghton Bay can be affected by leachate from a closed landfill. Within the Owhiro Bay catchment, runoff from three operative landfills provides an additional potential source of contamination.

The other principal discharge to Wellington city's south coast with potential to impact on microbiological water quality is effluent from the Moa Point WWTP. This plant services the majority of Wellington city and discharges treated effluent into Cook Strait via a 1.8 km long outfall east of Lyall Bay. At times of very heavy or sustained rainfall, high volumes of wastewater arriving at the WWTP (as a result of stormwater infiltrating into the sewer network) can exceed the available storage, resulting in the discharge of only partially treated effluent.

4.10.2 Enterococci counts

Based on routine sampling between the 2005/06 and 2009/10 summer bathing seasons, median enterococci counts were low at all Wellington south coast monitoring sites (Figure 4.28). However, there was a wide range of maximum enterococci counts, from just 44 cfu/100mL at Princess Bay to 2,300 cfu/100mL at Owhiro Bay. Island Bay at Surf Club and Island Bay at Reef Street also recorded maximum enterococci counts above 1,000 cfu/100mL.

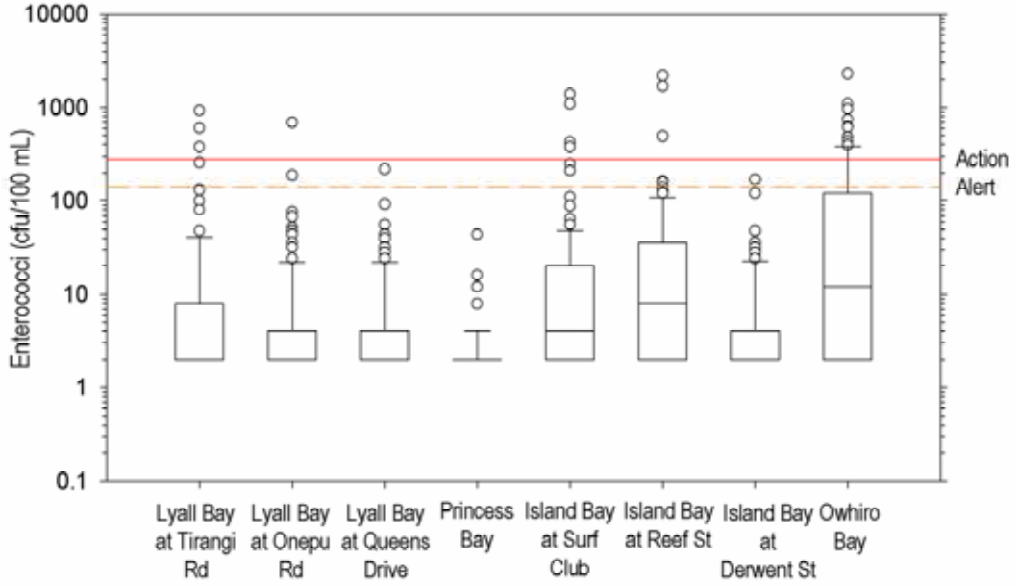


Figure 4.28: Box plot summarising the range of enterococci counts recorded along Wellington city's south coast from routine weekly sampling over the 2005/06 to 2009/10 summer bathing seasons. Note the logarithmic scale on the *y*-axis.

4.10.3 Compliance with national microbiological water quality guidelines

Compliance with the MfE/MoH (2003) surveillance guideline during routine summer bathing sampling between 2005/06 and 2009/10 ranged from 80% at Owhiro Bay to 100% at Princess Bay (Table 4.23). Lyall Bay at Tirangi Road, Island Bay at Surf Club, Island Bay at Reef Street and Owhiro Bay exceeded the MfE/MoH (2003) action guideline on the most occasions, with Owhiro Bay recording the highest number of exceedances (14) across all 77 coastal monitoring sites in the Wellington region.

All of the action guideline exceedances recorded at Owhiro Bay occurred from the 2007/08 bathing season onwards, with nine recorded in 2009/10 alone (Figure 4.29). During the 2009/10 bathing season, action guideline exceedances were often followed by up to three consecutive follow-up samples exceeding the alert or action guideline. As a result, health warning signs were in place along the beach for much of the 2009/10 season (Ryan & Warr 2010).

Approximately 60% of the action guideline exceedances recorded during routine sampling at Owhiro Bay occurred in the absence of any significant rainfall (Figure 4.30). Investigation by Capacity, on behalf of WCC, found high indicator bacteria counts at various locations in Owhiro Stream – suggesting that contamination of Owhiro Bay was occurring via discharge from the Owhiro Stream. Microbial source tests performed on water samples taken from the Owhiro Stream and Owhiro Bay near the stream mouth could not conclusively identify the source of this contamination although a weak signal for human faecal contamination was identified in one sample taken from Owhiro Bay (Kirs 2010). Faecal sterol analysis of water samples taken over three consecutive days in May 2010 also gave inconclusive results but suggested possible contamination from both bird and human sources (Gilpin 2010). At times large populations of seagulls congregate at Owhiro Bay.

Table 4.23: Number and percentage of routine weekly sample results coinciding with the surveillance, alert and action modes of the MfE/MoH (2003) guidelines at Wellington city south coast monitoring sites over the 2005/06 to 2009/10 summer bathing seasons

Site	*n*	Surveillance		Alert		Action	
		No.	%	No.	%	No.	%
Lyall Bay @ Tirangi Rd	105	101	96	1	1	3	3
Lyall Bay @ Onepu Rd	105	103	98	1	1	1	1
Lyall Bay @ Queens Drive	105	104	99	1	1	0	0
Princess Bay	65[1]	65	100	0	0	0	0
Island Bay @ Surf Club	105	99	94	2	2	4	4
Island Bay @ Reef St Recreation Grd	105	100	95	2	2	3	3
Island Bay @ Derwent St	105	103	98	2	2	0	0
Owhiro Bay	105	84	80	7	7	14	13

[1] Since November 2006 this site has been sampled fortnightly during the bathing season.

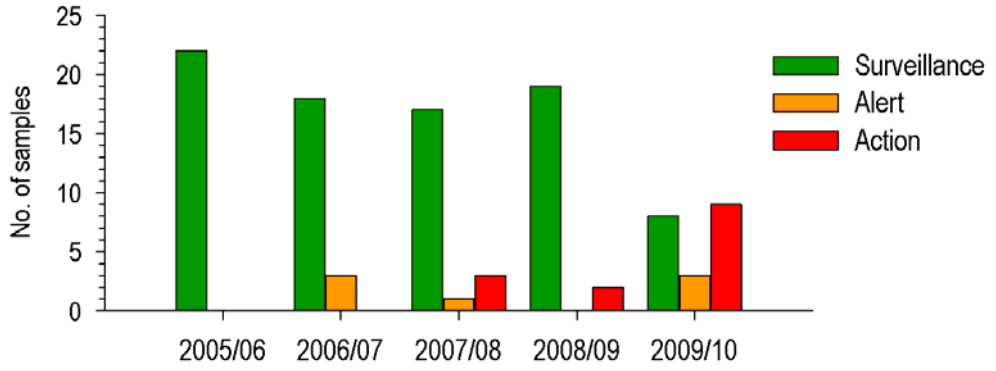


Figure 4.29: Summary of compliance with the MfE/MoH (2003) surveillance, alert and action guidelines at Owhiro Bay, based on routine weekly sampling during bathing seasons between 2005/06 and 2009/10

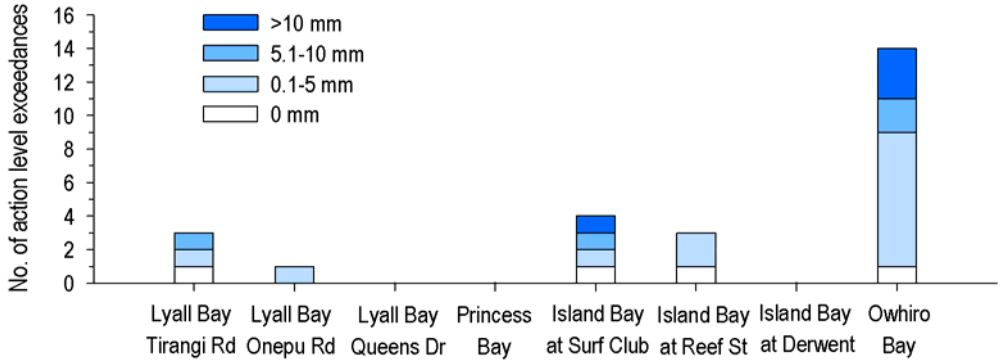


Figure 4.30: Summary of rainfall recorded in the 72 hours preceding sampling for each exceedance of the MfE/MoH (2003) action guideline recorded during routine weekly sampling at Wellington city's south coast monitoring sites between the 2005/06 and 2009/10 summer bathing seasons

In response to the action guideline exceedances in 2009/10, Capacity investigated the sewer/stormwater infrastructure in the Owhiro Bay catchment. A number of significant faults were found and subsequently fixed including a total of 170 m of sewer repairs. After the results of several consecutive follow-up water samples complied with the surveillance guideline, health warning signs were removed from Owhiro Bay in April 2010 (Ryan & Warr 2010).

4.10.4 Suitability for Recreation Grades

Based on assigned SIC grades and routine water quality monitoring results collected over the 2006/07 to 2010/11 summers, SFRGs of 'good' were achieved for most monitoring sites along Wellington's south coast (Table 4.24). The exceptions were Princess Bay (graded 'very good'), Island Bay at Surf Club ('fair') and Owhiro Bay ('poor').

Table 4.24: SFRGs for monitoring sites on Wellington's south coast, with MAC grades based on enterococci counts from routine sampling over the 2006/07 to 2010/11 summer bathing seasons

Site	SIC grade	MAC grade (95th%-ile value)	SFRG
Lyall Bay @ Tirangi Rd	Moderate	B (131)	Good
Lyall Bay @ Onepu Rd	Moderate[1]	A (39)	Good[1]
Lyall Bay @ Queens Drive	Moderate[1]	A (32)	Good[1]
Princess Bay	Low	A (4)	Very good
Island Bay @ Surf Club	Moderate	C (271)	Fair
Island Bay @ Reef St Recreation Grd	Moderate	B (148)	Good
Island Bay @ Derwent St	Moderate[1]	A (29)	Good[1]
Owhiro Bay	Moderate	D (618)	Poor

[1] This combination of SIC and MAC grades is unexpected and gives a 'not determined' SFRG grade. Although the MAC grade indicates a low risk of microbiological contamination, given the stormwater inputs into Lyall Bay and Island Bay and, in the case of Lyall Bay, the proximity of the Moa Point WWTP discharge, Greenfield et al. (2012) considered that a SIC grade of 'moderate' was appropriate. Accordingly, these sites have been assigned a conservative SFRG of 'good'.

4.11 Petone

Petone Beach is a long, sandy beach flanked to the west by Korokoro Stream and to the east by the mouth of the Hutt River. During 2005/06 and 2009/10, recreational water quality was monitored at four sites along Petone Beach (Figure 4.31).

4.11.1 Catchment land cover and impacts

Urban areas of the suburb of Petone dominate the area adjoining Petone Beach. The catchment of the Korokoro Stream is dominated by scrub and regenerating indigenous forest while the Hutt River drains a large catchment that includes a mixture of indigenous forest and scrub, farmland and urban areas (refer Section 3.3.1). The Waiwhetu Stream drains urban areas of Lower Hutt, including the Gracefield and Seaview industrial areas.

As well at the Hutt River, urban stormwater is the main discharge likely to impact on microbiological water quality along Petone Beach.

Figure 4.31: Location and surrounding land cover of recreational water quality monitoring sites along Petone Beach

4.11.2 Enterococci counts

Median enterococci counts were low (<10 cfu/100mL) at all four Petone Beach sites monitored over the 2005/06 to 2009/10 bathing seasons (Figure 4.32). However, maximum counts of 1,000 cfu/100mL or higher were recorded at all sites, with a count of 2,100 cfu/100mL recorded on one occasion at Sydney Street.

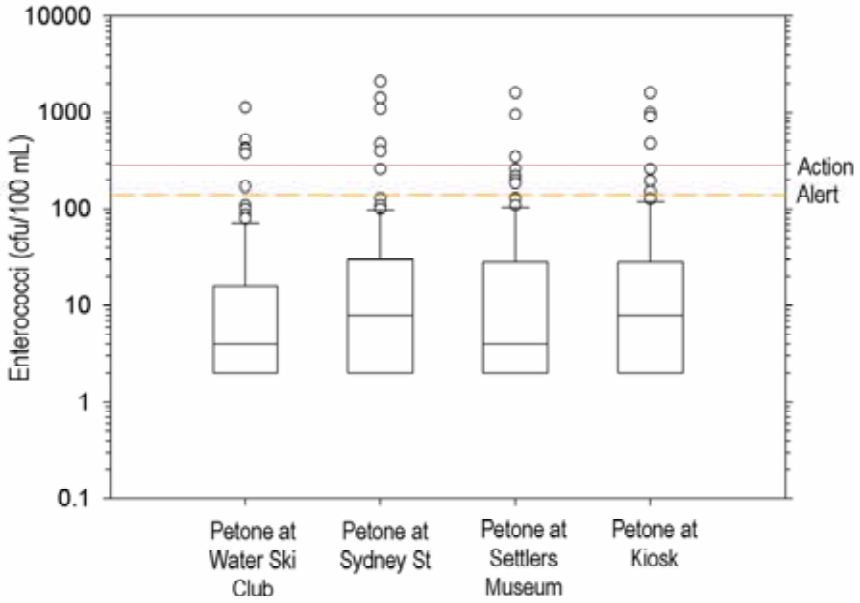


Figure 4.32: Box plot summarising the range of enterococci counts recorded along Petone Beach from routine weekly sampling over the 2005/06 to 2009/10 summer bathing seasons. Note the logarithmic scale on the *y*-axis.

4.11.3 Compliance with national microbiological water quality guidelines

Compliance with the MfE/MoH (2003) surveillance guideline was virtually the same across all four Petone Beach monitoring site over the five-summer reporting period, ranging from 93% to 94% (Table 4.25). The number of exceedances of the MfE/MoH (2003) action guideline ranged from three at Settlers Museum to five at both Water Ski Club and Sydney Street.

Table 4.25: Number and percentage of routine weekly sample results coinciding with the surveillance, alert and action modes of the MfE/MoH (2003) guidelines at Petone Beach monitoring sites over the 2005/06 to 2009/10 summer bathing seasons

Site	*n*	Surveillance		Alert		Action	
		No.	%	No.	%	No.	%
Petone Beach @ Water Ski Club	105	99	94	1	1	5	5
Petone Beach @ Sydney St	105	99	94	1	1	5	5
Petone Beach @ Settlers Museum	105	98	93	4	4	3	3
Petone Beach @ Kiosk	105	98	93	3	3	4	4

The majority of action guideline exceedances coincided with at least 5 mm of rainfall in the 72 hours preceding sampling (Figure 4.33). There was one notable exception on 18 December 2007 when the action guideline was exceeded at all four Petone Beach sites. The reason for this is unknown but it was noted that it was raining at the time of sampling.

In addition to coinciding with rainfall prior to sampling, all but one of the action guideline exceedances recorded at Petone Beach occurred during southerly wind conditions and at high tide. This suggests that the highest risk of microbiological contamination at Petone Beach is from the Hutt River during or shortly after southerly storms when the strong southerly winds push the river's outflow along the Petone foreshore.

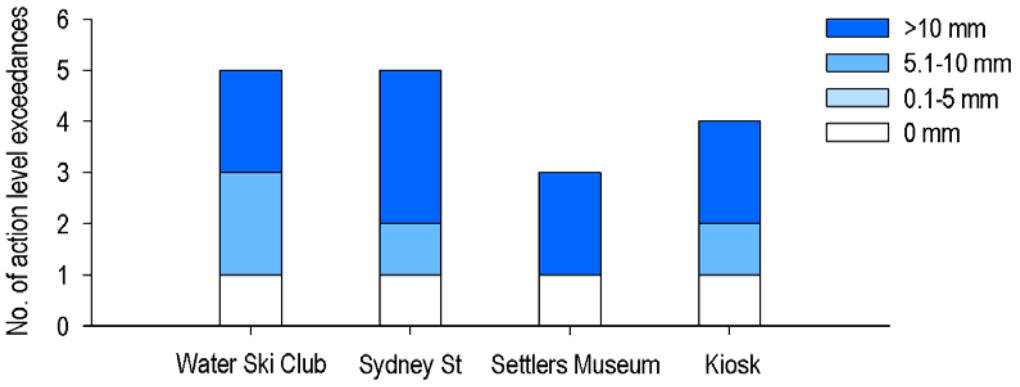


Figure 3.33: Summary of rainfall recorded in the 72 hours preceding sampling for each exceedance of the MfE/MoH (2003) action guideline recorded during routine weekly sampling at Petone Beach monitoring sites between the 2005/06 and 2009/10 summer bathing seasons

4.11.4 Suitability for Recreation Grades

Based on their assigned SIC grades and routine monitoring results collected over the 2006/07 to 2010/11 summers, all four Petone Beach monitoring sites have SFRGs of 'fair' (Table 4.26).

Table 4.26: SFRGs for Petone Beach monitoring sites, with MAC grades based on enterococci counts from routine sampling over the 2006/07 and 2010/11 summer bathing seasons

Site	SIC grade	MAC grade (95th%-ile value)	SFRG
Petone Beach @ Water Ski Club	Moderate	C (219)	Fair
Petone Beach @ Sydney St	Moderate	C (466)	Fair
Petone Beach @ Settlers	Moderate	C (265)	Fair
Petone Beach @ Kiosk	Moderate	C(204)	Fair

4.12 Sorrento, Lowry and York bays

Sorrento, Lowry and York bays comprise short, sandy or gravelly beaches separated by rocky outcrops. Each of these bays is fed by small but steep catchments. Recreational water quality is monitored at one site in each bay (Figure 4.34), with water quality at Sorrento Bay also monitored for shellfish gathering purposes.

Figure 4.34: Location and surrounding land cover of recreational water quality monitoring sites at Sorrento, Lowry and York bays

4.12.1 Catchment land cover and impacts

Sorrento, Lowry and York bay have similar catchment characteristics, with low density residential areas occurring in the immediate vicinity of each bay and indigenous forest and scrub dominating the surrounding hills.

Urban stormwater, principally road runoff, is discharged into each of Sorrento, Lowry and York bays. Only Lowry Bay is subject to any significant stormwater inputs, with a stormwater outfall located on either side of the monitoring site in this bay.

4.12.2 Enterococci counts

Median enterococci counts were very low (<4 cfu/100mL) at all three sites over the 2005/06 to 2009/10 summer bathing seasons (Figure 4.35). However, maximum enterococci counts across the three sites ranged from 1,000 cfu/100ml at York Bay to 2,000 cfu/100mL at Lowry Bay at Cheviot Road.

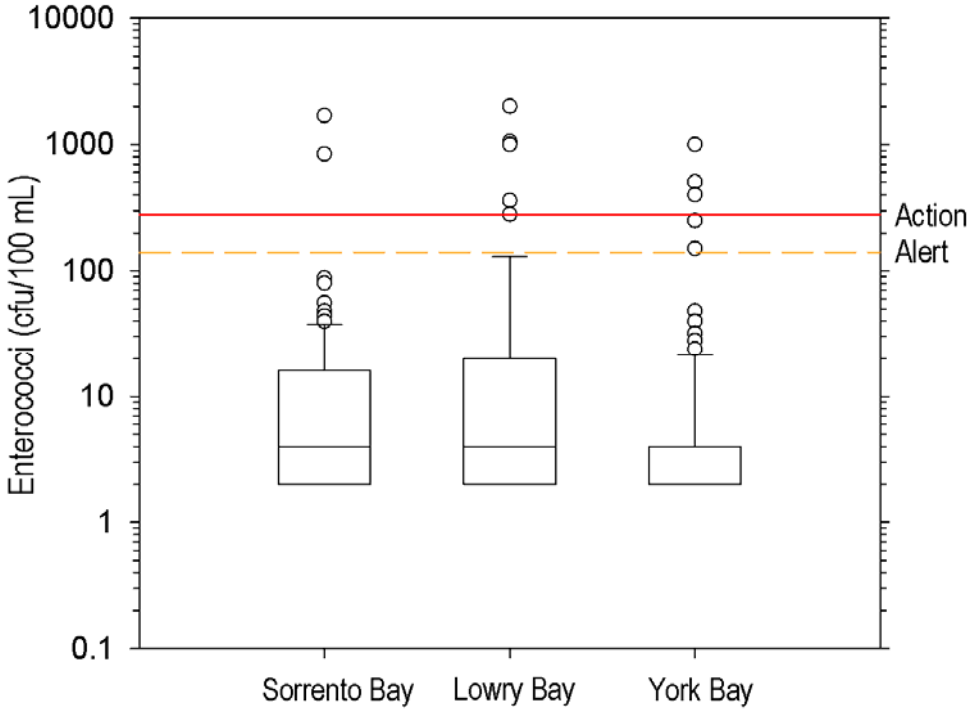


Figure 4.35: Box plot summarising the range of enterococci counts recorded at Sorrento, Lowry and York bays from routine weekly sampling over the 2005/06 to 2009/10 summer bathing seasons. Note the logarithmic scale on the *y*-axis.

4.12.3 Compliance with national microbiological water quality guidelines

Compliance with the MfE/MoH (2003) surveillance guideline was high at all three sites over the 2005/06 to 2009/10 summers, ranging from 94% at Lowry Bay to 98% at Sorrento Bay (Table 4.27). Despite this, each site exceeded the MfE/MoH (2003) action guideline on at least two occasions.

All action guideline exceedances recorded at Sorrento Bay and York Bay coincided with at least 5 mm of rainfall in the 72 hours prior to sampling (Figure 4.36). At Lowry Bay at Cheviot Road, two action guideline exceedances occurred in the absence of any rainfall prior to sampling, although for the exceedance recorded on 18 December 2007, rainfall at the time of sampling may have contributed to the elevated result.

Table 4.27: Number and percentage of routine weekly sample results coinciding with the surveillance, alert and action modes of the MfE/MoH (2003) guidelines at Sorrento, Lowry and York bays over the 2005/06 to 2009/10 bathing seasons

Site	*n*	Surveillance		Alert		Action	
		No.	%	No.	%	No.	%
Sorrento Bay	105	103	98.1	0	0.0	2	1.9
Lowry Bay @ Cheviot Rd	105	99	94.3	1	1.0	5	4.8
York Bay	105	100	95.2	2	1.9	3	2.9

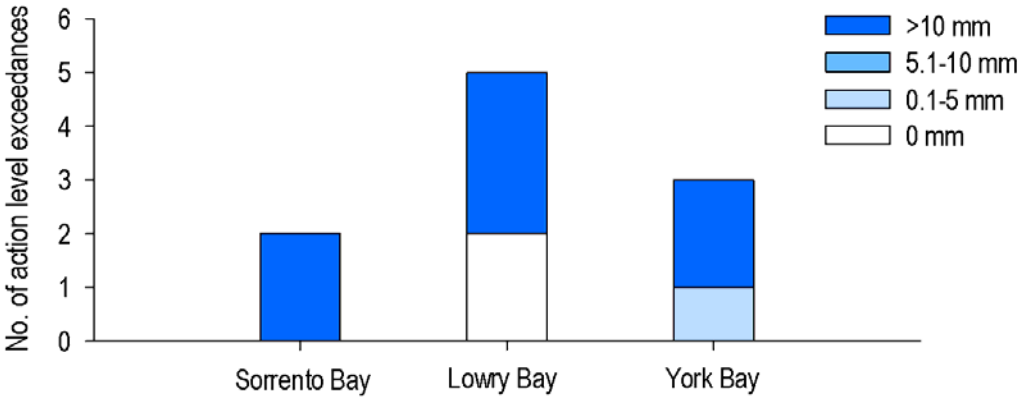


Figure 4.36: Summary of rainfall recorded in the 72 hours preceding sampling for each exceedance of the MfE/MoH (2003) action guideline recorded during routine weekly sampling at Sorrento, Lowry and York bays between the 2005/06 and 2009/10 summer bathing seasons

4.12.4 Suitability for Recreation Grades

Based on assigned SIC grades and routine water quality monitoring results collected over the 2006/07 to 2010/11 summers, SFRGs of 'good' were assigned to the Sorrento and York bay sites while Lowry Bay at Cheviot Road was graded 'fair' (Table 4.28).

Table 4.28: SFRGs for Sorrento, Lowry and York bay monitoring sites, with MAC grades based on enterococci counts from routine sampling over the 2006/07 to 2010/11 summer bathing seasons

Site	SIC grade	MAC grade (95th%-ile value)	SFRG
Sorrento Bay	Low	B (110)	Good
Lowry Bay @ Cheviot Rd	Moderate	C (210)	Fair
York Bay	Low	B (137)	Good

4.12.5 Compliance with guidelines for shellfish-gathering waters

Faecal coliform counts at Sorrento Bay complied with both the MfE/MoH (2003) seasonal median (14 cfu/100mL) and 90th percentile guidelines over each bathing season between 2005/06 and 2009/10 (Table 4.29).

Table 4.29: Comparison of faecal coliform counts at Sorrento Bay with the MfE/MoH (2003) guidelines for recreational shellfish gathering waters, based on routine weekly monitoring over the 2005/06 to 2009/10 bathing seasons

Bathing season	*n*	Median (cfu/100 mL)	No (and %) of results >43 cfu/100 mL
2005/06	22	6	2 (9%)
2006/07	21	2	2 (10%)
2007/08	21	2	2 (10%)
2008/09	21	2	2 (10%)
2009/10	20	2	2 (10%)
All summer data	105	2	10 (10%)

4.13 Days Bay, Rona Bay, Robinson Bay and Camp Bay

Days Bay and Camp Bay are characterised by a sandy beach separated by rocky outcrops. Rona Bay and Robinson Bay form a long stretch of sandy beach which runs from the northern end of Rona Bay to Point Arthur. Each of these bays is fed by small but steep catchments. Recreational water quality is monitored at three sites in Days Bay, at two sites each in Rona and Robinson bays, and at one site in Camp Bay (Figure 4.37).

Figure 4.37: Location and surrounding land cover of recreational water quality monitoring sites along the Eastbourne coast between Days Bay and Camp Bay

4.13.1 Catchment land cover and impacts

Days, Rona and Robinson Bays are bordered by suburban areas of Days Bay and Eastbourne and hills covered in scrub and regenerating indigenous forest.

The catchment of Camp Bay is dominated by scrub. Several first order streams drain into these bays, although many have been integrated into the stormwater infrastructure as they flow through urban areas.

Similar to the more northern situated Eastbourne monitoring sites, urban stormwater, principally road runoff, is discharged into each of Days, Rona and Robinson bays at multiple locations. Due to the extent of surrounding urban areas, Rona and Robinson bays are subject to larger quantities of urban stormwater runoff than Days Bay; several large outfalls discharge close to some monitoring sites in both of these bays.

4.13.2 Enterococci counts

Based on routine sample results collected over the 2005/06 to 2009/10 summer bathing seasons, median enterococci counts ranged from 3 cfu/100mL at Camp Bay to 12 cfu/100mL at Rona Bay at Clifford Bishop Park (Figure 4.38). Despite these low median enterococci counts, high maximum enterococci counts of 1,000 cfu/100mL or greater were recorded at all sites apart from Camp Bay. The highest count recorded was 2,000 cfu/100mL recorded at Rona Bay at Clifford Bishop Park on 28 March 2006.

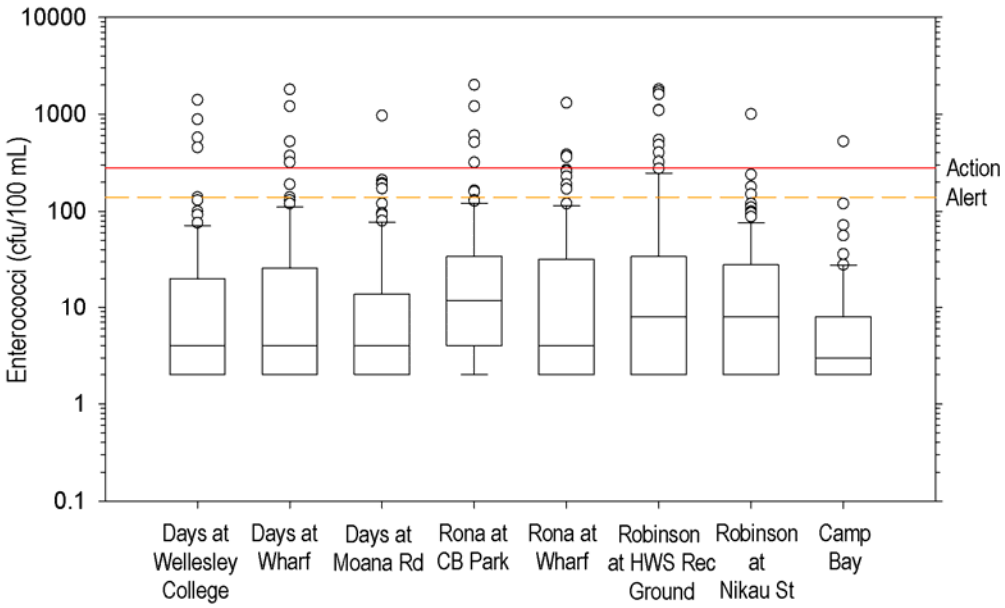


Figure 4.38: Box plot summarising the range of enterococci counts recorded at Days, Rona, Robinson and Camp bays from routine weekly sampling over the 2005/06 to 2009/10 summer bathing seasons. Note the logarithmic scale on the *y*-axis.

4.13.3 Compliance with national microbiological water quality guidelines

Compliance with the MfE/MoH (2003) surveillance guideline over the five summer bathing seasons ranged from 88% at Robinson Bay at HW Shortt Recreation Ground to 98% at Camp Bay (Table 4.30). All eight sites exceeded the action guideline at least once, with Robinson Bay at HW Shortt Recreation Ground exceeding this guideline on nine routine sampling occasions.

Table 4.30: Number and percentage of routine weekly sample results coinciding with the surveillance, alert and action modes of the MfE/MoH (2003) guidelines at Days, Rona, Robinson and Camp bays over the 2005/06 to 2009/10 bathing seasons

Site	*n*	Surveillance		Alert		Action	
		No.	%	No.	%	No.	%
Days Bay @ Wellesley College	105	101	96	0	0	4	4
Days Bay @ Wharf	105	99	94	1	1	5	5
Days Bay @ Moana Rd	105	99	94	5	5	1	1
Rona Bay @ N end of Cliff Bishop Pk	105	98	93	2	2	5	5
Rona Bay @ Wharf	105	97	92	5	5	3	3
Robinson Bay @ HW Shortt Rec Grd	105	92	88	4	4	9	9
Robinson Bay @ Nikau St	105	101	96	3	3	1	1
Camp Bay	60[1]	59	98	0	0	1	2

[1] Since November 2006 this site has been sampled fortnightly during the bathing season.

The majority (>60%) of action guideline exceedances coincided with at least 5 mm of rainfall in the 72 hours prior to sampling (Figure 4.39). However, at Robinson Bay at HW Shortt Recreation Ground, almost half of the recorded action guideline exceedances coincided with little or no rainfall prior to sampling, three of which occurred during the 2006/07 bathing season. There were no obvious patterns in tides or winds that accompanied these exceedances. The cause of this 'dry weather' contamination requires further investigation but is most likely to be related to faults in stormwater and sewer infrastructure (Greenfield et al. 2012).

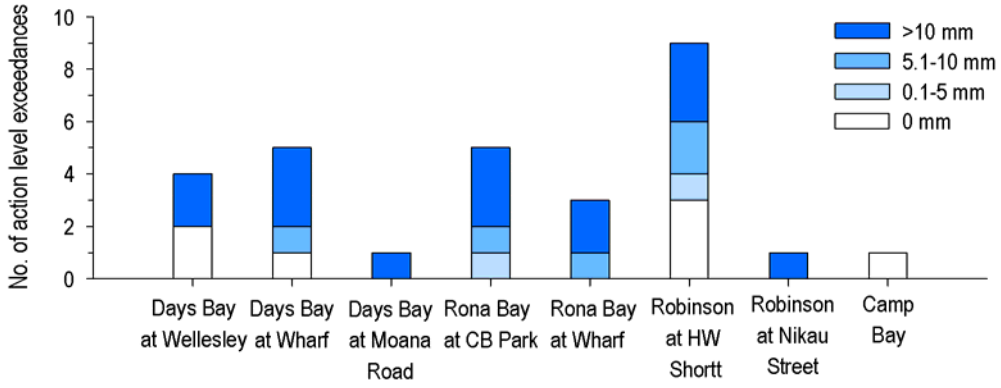


Figure 4.39: Summary of rainfall recorded in the 72 hours preceding sampling for each exceedance of the MfE/MoH (2003) action guideline recorded during routine weekly sampling at Days, Rona, Robinson and Camp bays between the 2005/06 and 2009/10 summer bathing seasons

4.13.4 Suitability for Recreation Grades

Based on the assigned SIC grades and the results of routine water quality monitoring over the 2006/07 to 2010/11 summers, SFRGs at Days, Rona, Robinson and Camp bays ranged from 'poor' at Robinson Bay at HW Shortt Recreation Ground to 'good' at Days Bay at Moana Road, Robinson Bay at Nikau Street and Camp Bay (Table 4.31).

Table 4.31: SFRGs for Days, Rona, Robinson and Camp bay monitoring sites, with MAC grades based on enterococci counts from routine sampling over the 2006/07 to 2010/11 summer bathing seasons

Site	SIC grade	MAC grade (95th%-ile value)	SFRG
Days Bay @ Wellesley College	Moderate	C (248)	Fair
Days Bay @ Wharf	Moderate	C (220)	Fair
Days Bay @ Moana Rd	Moderate	B (175)	Good
Rona Bay @ N end of Cliff Bishop Pk	Moderate	C (219)	Fair
Rona Bay @ Wharf	Moderate	C (272)	Fair
Robinson Bay @ HW Shortt Rec Grd	Moderate	D (693)	Poor
Robinson Bay @ Nikau St	Moderate	B (103)	Good
Camp Bay	Low	B (62)	Good

4.14 Castlepoint and Riversdale

The coastline at Castlepoint and Riversdale is dominated by long, sandy beaches and is popular for swimming, surfing and boating. Two sites are monitored at Castlepoint and three sites are monitored at Riversdale (Figure 4.40).

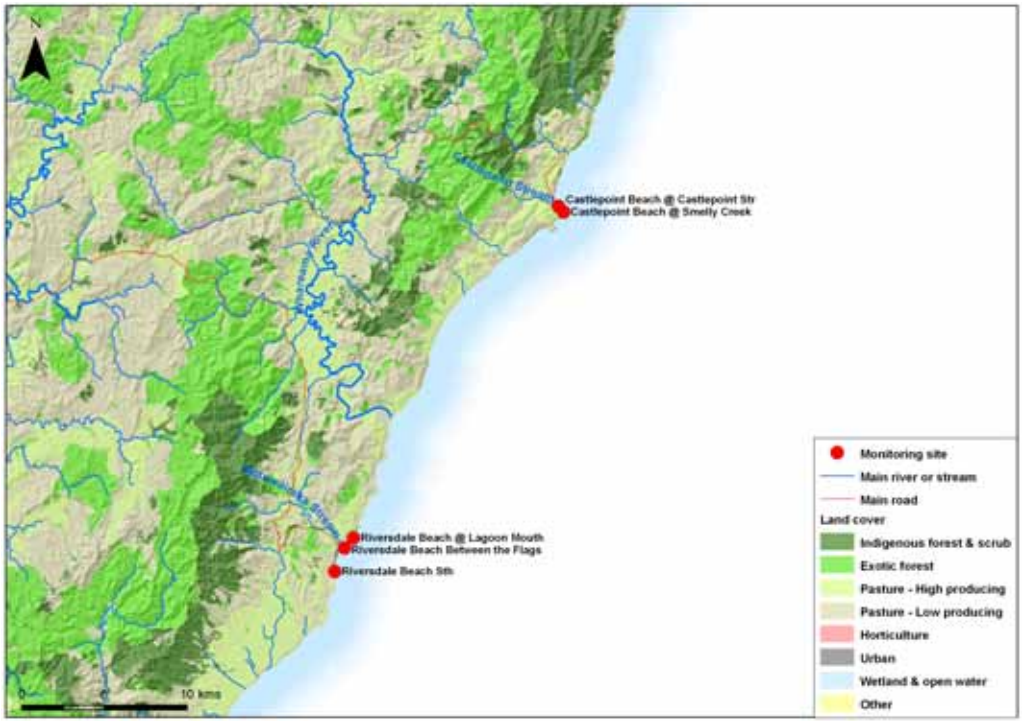


Figure 4.40: Location and surrounding land cover of recreational water quality monitoring sites at Castlepoint and Riversdale beaches

4.14.1 Catchment land cover and impacts

Castlepoint and Riversdale beaches are immediately bordered by their respective settlements, beyond which sheep and beef farmland and pine forest predominate. Castlepoint Stream, which discharges to the sea halfway along Castlepoint Beach, provides the only significant freshwater input to Castlepoint Beach, although during heavy rain fall an ephemeral stream known as 'Smelly Creek' drains stormwater from Castlepoint settlement to the south end of the beach. Masterton District Council (MDC) holds a resource consent to

discharge treated wastewater from the Castlepoint WWTP to Castlepoint Stream during the winter months. The WWTP, which comprises an oxidation pond and wetland system, does not discharge to the stream at any other time of the year, although surface runoff maybe possible in very wet weather (P. Pickford[20], pers. comm. 2011).

At Riversdale Beach, the primary freshwater input is the Motuwaireka Stream, which drains to the sea via the Motuwaireka Lagoon towards the north end of the beach. Faecal indicator bacteria counts are often high in the Motuwaireka Lagoon (Milne 2005) and permanent health warning signage is in place. Poor water quality in the Motuwaireka Lagoon has been historically attributed to possible contamination from septic tanks in the area, a decommissioned landfill in the mid reaches of the catchment, waterfowl and agricultural runoff (Stansfield 2000). In November 2011 MDC commissioned new municipal oxidation ponds to treat and discharge the settlement's wastewater to land. Connection of the majority of Riversdale residents to the WWTP is scheduled to be completed by September 2012.

4.14.2 Enterococci counts

Median enterococci counts were low (5 cfu/100mL or less) at all sites monitored along Castlepoint and Riversdale beaches over the 2005/06 to 2009/10 summer bathing seasons (Figure 4.41). However, high enterococci counts were recorded on occasion; the maximum counts recorded at both Castlepoint Beach monitoring sites and at Riversdale Beach at Lagoon Mouth exceeded 1,000 cfu/100mL.

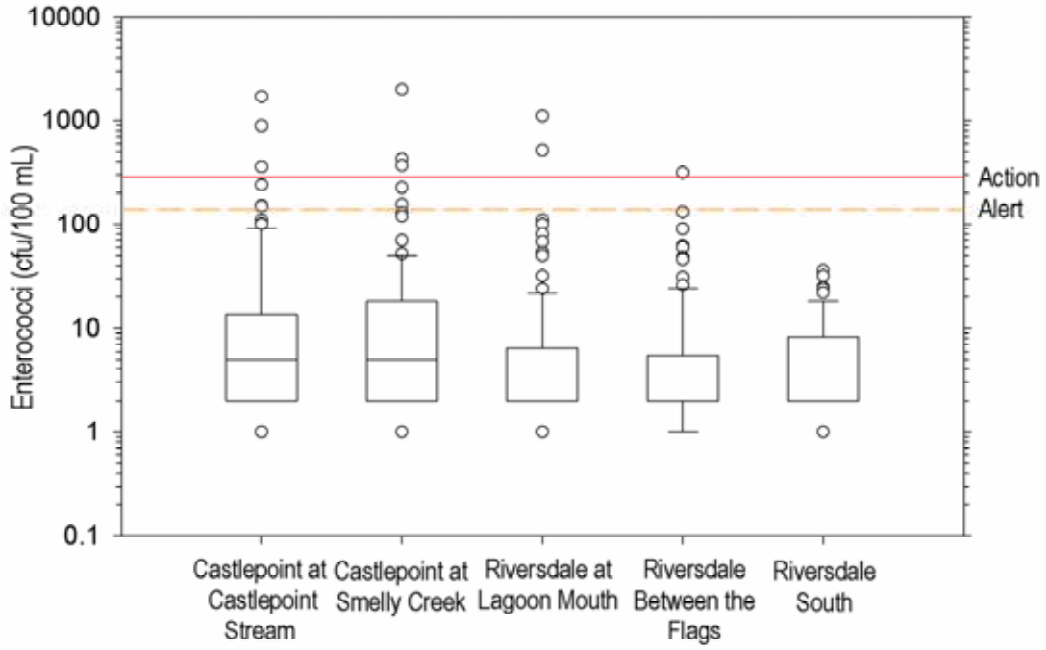


Figure 4.41: Box plot summarising the range of enterococci counts recorded at Castlepoint and Riversdale beaches from routine weekly sampling over the 2005/06 to 2009/10 summer bathing seasons. Note the logarithmic scale on the *y*-axis.

[20] Paula Pickford, Senior Resource Advisor, Greater Wellington.

4.14.3 Compliance with national microbiological water quality guidelines

Compliance with the MfE/MoH (2003) surveillance guideline was high at all Castlepoint and Riversdale beach monitoring sites over the five summer reporting period, ranging from 93% at Castlepoint Beach at Castlepoint Stream to 100% at Riversdale Beach South (Table 4.32). The highest number of exceedances of the MfE/MoH (2003) action guideline was three, recorded at both Castlepoint Beach sites.

Table 4.32: Number and percentage of routine weekly sample results coinciding with the surveillance, alert and action modes of the MfE/MoH (2003) guidelines at Castlepoint and Riversdale beaches over the 2005/06 to 2009/10 bathing seasons

Site	*n*	Surveillance		Alert		Action	
		No.	%	No.	%	No.	%
Castlepoint Beach @ Castlepoint Strm	105	98	93	4	4	3	3
Castlepoint Beach @ Smelly Crk	105	99	94	3	3	3	3
Riversdale Beach @ Lagoon Mouth	105	103	98	0	0	2	2
Riversdale Beach Between the Flags	105	104	99	0	0	1	1
Riversdale Beach South	66[1]	66	100	0	0	0	0

[1] Since November 2006 this site has been sampled fortnightly during the bathing season.

Six of the nine action guideline exceedances recorded at Castlepoint and Riversdale beaches coincided with more than 10 mm of rainfall in the 72 hours prior to sampling (Figure 4.42). At Castlepoint Beach at Castlepoint Stream, two action exceedances occurred in the absence of any significant rainfall.

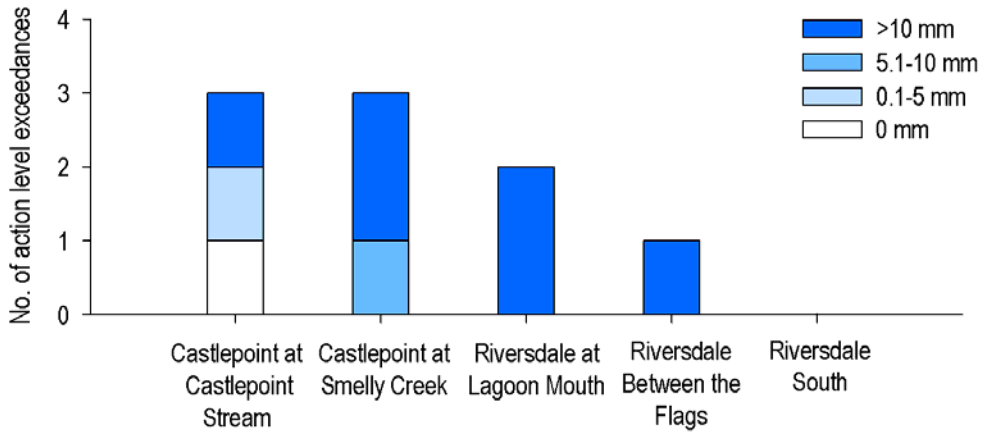


Figure 4.42: Summary of rainfall recorded in the 72 hours preceding sampling for each exceedance of the MfE/MoH (2003) action guideline recorded during routine weekly sampling at Castlepoint and Riversdale beaches between the 2005/06 and 2009/10 summer bathing seasons

4.14.4 Suitability for Recreation Grades

Based on assigned SIC grades and the results of routine water quality monitoring over the 2006/07 to 2010/11 summers, SFRGs are either 'good' or 'very good' at all Castlepoint and Riversdale beach monitoring sites (Table 4.33).

Table 4.33: SFRGs for Castlepoint and Riversdale beach monitoring sites, with MAC grades based on enterococci counts from routine sampling over the 2006/07 to 2010/11 summer bathing seasons

Site	SIC grade	MAC grade (95th%-ile value)	SFRG
Castlepoint Beach @ Castlepoint Strm	Moderate	B (150)	Good
Castlepoint Beach @ Smelly Creek	Low	A (39)	Very good
Riversdale Beach @ Lagoon Mouth	Moderate	B (72)	Good
Riversdale Beach Between the Flags	Low	A (24)	Very good
Riversdale Beach South	Low	A (12)	Very good

4.15 Synthesis

4.15.1 Compliance with microbiological national water quality guidelines

Microbiological water quality was generally very good across beaches in the Wellington region with 67 out of the 77 sites monitored meeting the MfE/MoH (2003) surveillance guideline on 90% or more of routine sampling occasions over the 2005/06 to 2009/10 summer bathing seasons (Figure 4.43). Wellington city beaches with short, scrub dominated catchments featured highly amongst the region's safest beaches; routine samples taken at Scorching, Worser, Breaker, Princess and Shark bays as well as Hataitai Beach and Lyall Bay at Queens Avenue complied with the surveillance guideline on 99% or sampling occasions over the five summer reporting period. Similarly, all three sites at Paekakariki Beach on the Kapiti Coast and two out of three sites at Riversdale Beach on the eastern Wairarapa coast complied with the surveillance guideline on 99% or more of routine sampling occasions (Figure 4.43).

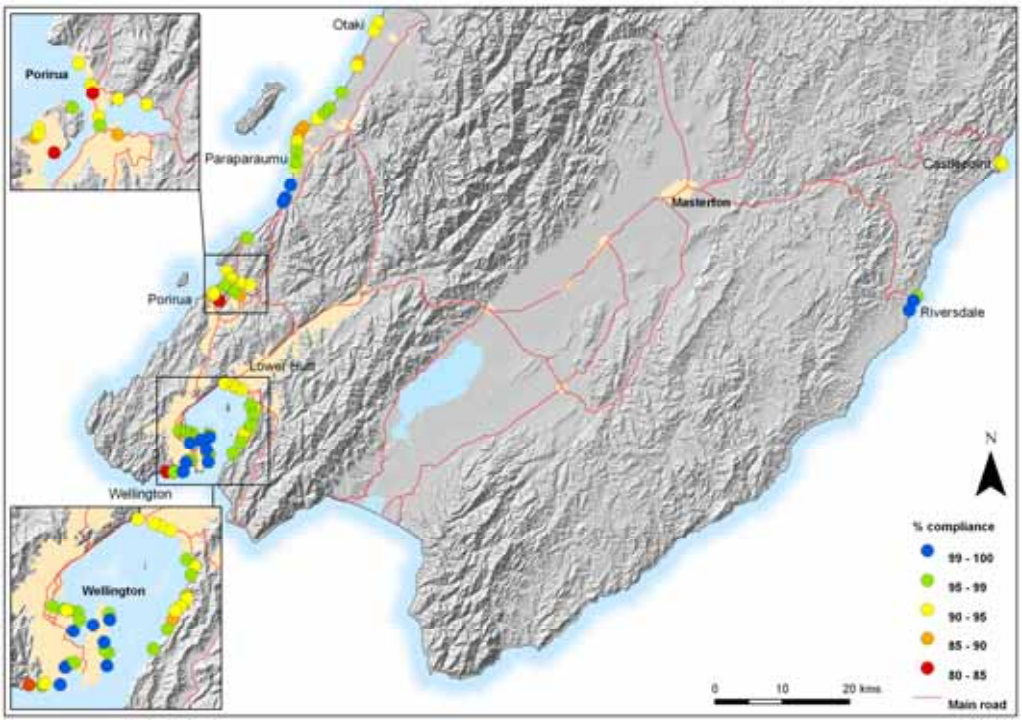


Figure 4.43: Summary of percent compliance of coastal recreational water quality monitoring sites in the Wellington region with the MfE/MoH (2003) surveillance guideline during routine summer sampling between 2005/06 and 2009/10

In contrast, recreational water quality was poorest at Owhiro Bay (Wellington south coast), Porirua Harbour at Rowing Club, and South Beach at Plimmerton. Water samples taken at these sites over the five summer reporting period only complied with the surveillance guideline between 80% and 83% of the time (Figure 4.43).

At the majority of the monitoring sites, exceedances of the MfE/MoH (2003) microbiological water quality guidelines occurred following significant rainfall. However, at sites with poorer water quality, exceedances during dry weather were also recorded.

Due to the proximity of many popular swimming beaches to urban areas, faults in stormwater and sewer infrastructure are the most common cause of contamination at beaches in the Wellington region. A combination of illegal connections of private sewer laterals to the stormwater system and vice versa and cracked or blocked sewer pipes are likely to be contributing to 'dry weather' contamination at several sites, including Porirua Harbour at Rowing Club and Owhiro Bay. In addition, during heavy or sustained rainfall events, sewage pump station failures and sewer pipe overflows can result in untreated sewage being discharged to coastal areas via the stormwater system. Because not all territorial authorities are required to monitor and report on sewer overflows or faults it is difficult to assess the extent of sewer/stormwater infrastructure problems across the region. However, as an example, in the Wellington city area there were 142 alleged sewer-related pollution incidents entered onto Greater Wellington's Incidents Database between July 2005 and June 2010.

Treated sewage is discharged to the Waiwhetu Stream (and therefore Wellington Harbour) on occasion in dry weather when maintenance works are undertaken on the main outfall pipeline that carries treated wastewater from the Seaview WWTP to the outfall at Pencarrow; this pipeline has experienced a number of leaks over its lifetime, including 47 leaks of the rubber ring joints (MWH 2011). The most significant leaks in recent years occurred in late March 2009 when an equipment failure at the main pump station caused a pressure surge through the pipeline (MWH 2011). Although most discharges associated with these leaks and their subsequent repair have occurred outside of the summer bathing season it is possible that on-going leaks in the Seaview main outfall pipeline may, on occasion, affect water quality at beaches along the Eastbourne coast.

Although contamination of the region's beaches from agricultural runoff is less apparent than that from urban infrastructure, there is evidence of occasional contamination at Otaki and Te Horo beaches where intensive agricultural land uses occur within the catchments of streams draining directly to the coast. Wildfowl such as ducks and seagulls may also contribute to faecal contamination at some sites. For example, a large bird population in Taupo Swamp – which drains to South Beach at Plimmerton – has long been suspected of contributing to poor compliance with microbiological guidelines at South Beach. Further work is needed to confirm this.

At some sites, bacteria re-suspended from bottom sediment may contribute to action guidelines exceedances. Assessment of weather conditions at Porirua and Wellington harbour sites suggests that exceedances at some sites tended to

coincide with the wind direction that resulted in the maximum length or 'fetch' of open water being disturbed. For example, action guideline exceedances at Porirua Harbour at Rowing Club and Petone Beach sites almost always occurred during southerly conditions while Pauatahanui Inlet at Browns Bay and Oriental Bay sites in inner Wellington Harbour usually coincided with northerly conditions.

4.15.2 Temporal trends

For the reasons outlined in Section 4.1.3(b), it was not possible to undertake temporal trend analysis on indicator bacteria counts collected from coastal beach sites. However, as an indication of possible changes in water quality at beach monitoring sites over time, MAC grades calculated for each site in this report were compared against those calculated for the 2001/02 to 2005/06 bathing seasons reported in Milne and Wyatt (2006). As described in Section 2.3.1, the MAC forms the quantitative component of the SFRG grade, and is based on the 95th percentile enterococci count.

There was no change in MAC grade at 51% of the 75 beach sites monitored over both reporting periods (Figure 4.44). However, at 33% of sites, including all but one of the five sites monitored at Riversdale and Castlepoint beaches and around 40% of Wellington city's sites, the MAC grade improved. Although some of these improvements may reflect differences in the number of rainfall events between the two reporting periods[21] it is likely that at least some, particularly those in Wellington city, are a result of work undertaken to improve stormwater/sewer infrastructure. For example, Hataitai Beach, which exceeded the MfE/MoH (2003) action and alert guidelines on four and nine occasions between the 2001/02 and 2005/06 summer bathing seasons, respectively (Milne

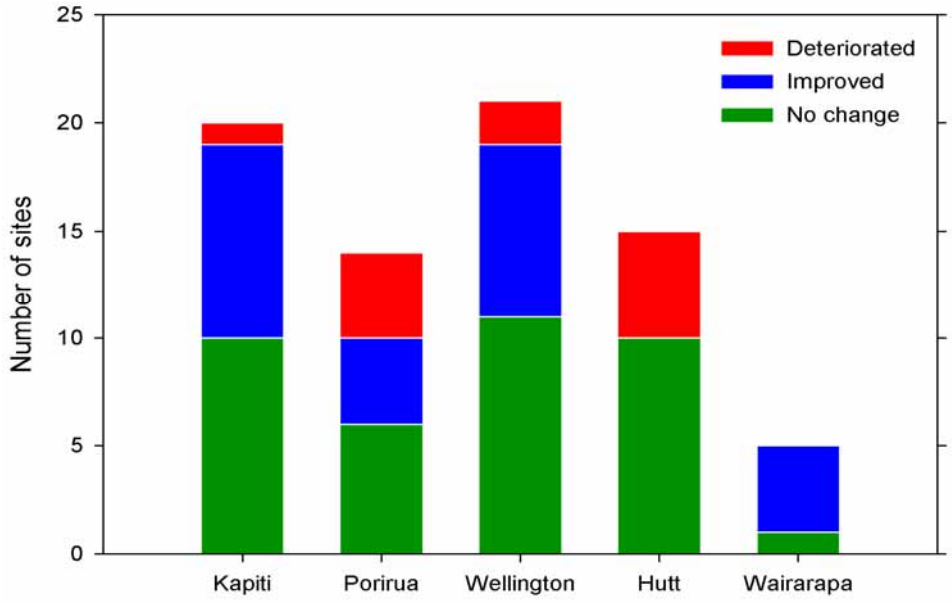


Figure 4.44: Coastal recreational water quality monitoring sites grouped into one of three categories, based on the change in MAC grade calculated from routine summer bathing season enterococci results compared between the 2001/02–2005/06 period (Milne & Wyatt 2006) and the 2005/06–2009/10 period

[21] The five years of data reported by Milne and Wyatt (2006) included the exceptionally wet summer of 2003/04.

& Wyatt 2006), did not exceed the action or alert guideline on any occasion between 2006/07 and 2010/11. This improved compliance with guidelines is attributed to works undertaken in the catchment to address illegal sewer connections to stormwater and faecal contamination arising from ducks and other birds in a tributary stream (I. Idris[22], pers. comm. 2011).

One site in Porirua – Onehunga Bay – improved by two MAC grades (from 'D' to 'B'). The reasons for such a marked improvement at this site are unclear. However, as this site has a scrub-dominated catchment and no obvious sources of faecal contamination it is suspected that the improvement may actually reflect changes in sampling personnel and practices.[23]

Deterioration in MAC grade between the two reporting periods was identified at 16% of sites, with the highest proportion of these sites being in Hutt city. Here, 33% of the 15 sites monitored deteriorated by one grade, including sites in Days Bay, Petone Beach and Robinson Bay. No sites in the Hutt city area had a MAC grade better than the previous reporting period.

4.15.3 Suitability for Recreation Grades

Drawing on recently revised SIC grades and routine water quality sampling results from the 2006/07 to 2010/11 summer bathing seasons (Greenfield et al. 2012), 64% of beach sites monitored have a SFRG grade of 'good' or 'very good' while 36% of sites have a grade of 'fair' or worse (Figure 4.45). This indicates that the majority of the region's beaches are suitable for recreation most of the time.

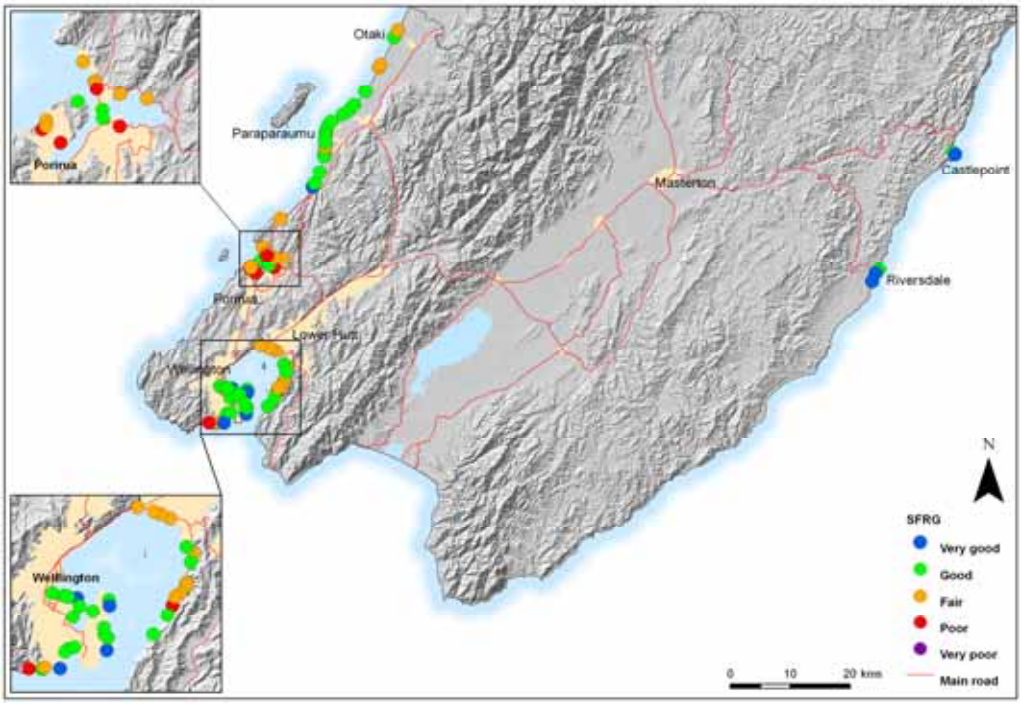


Figure 4.45: Current SFRGs for coastal recreational water quality monitoring sites in the Wellington region, derived from MAC values based on routine summer sampling results collected between 2006/07 and 2010/11

[22] Iqbal Idris, Senior Project Manager, Wellington Water Management (Capacity) Ltd.

[23] For all of the period reported by Milne and Wyatt (2006), PCC staff collected and analysed their own samples without any formal training or laboratory certification in place.

The distribution of SFRG grades across the region's beaches (Figure 4.45) mirrors that of compliance with the surveillance guideline, with 'good' and 'very good' grades clustered around Wellington city and the Kapiti and Wairarapa coasts and 'poor' grades mostly clustered around Porirua city (the two exceptions being Owhiro Bay and Robinson Bay on Wellington's south coast and the Eastbourne coast, respectively).

4.15.4 Compliance with national guidelines for shellfish-gathering waters

Only four of the nine sites where water quality for shellfish gathering is assessed regularly complied with both faecal coliform thresholds in the MfE/MoH (2003) water quality guidelines. Sites in Shark and Mahanga bays in Wellington city, Sorrento Bay near Eastbourne and Pauatahanui Inlet at Motukaraka Point regularly complied with both guidelines while two other sites in Porirua Harbour and all three sites on the Kapiti Coast did not (Figure 4.46).

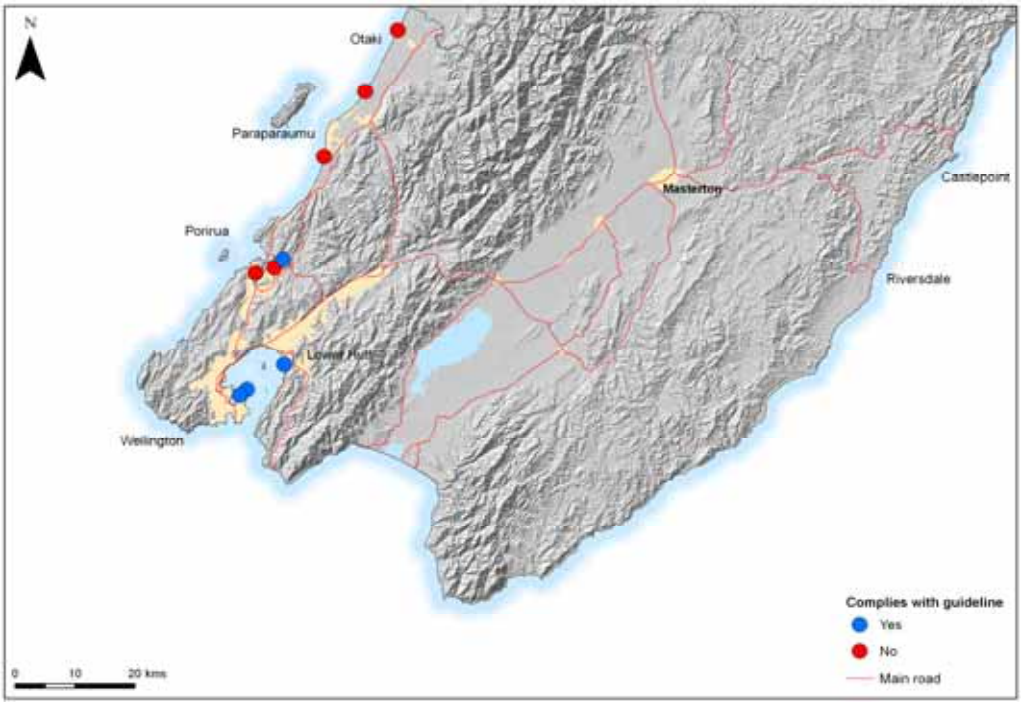


Figure 4.46: Summary of compliance with the MfE/MoH (2003) guidelines at shellfish gathering monitoring sites across the Wellington region, based on average compliance over the 2005/06 to 2009/10 summer bathing seasons

Non-compliance with microbiological water quality guidelines for shellfish gathering is likely to be related to factors similar to those causing non-compliance with the guidelines for swimming, including sewage contamination of stormwater and runoff from agricultural landuse. At Kapiti Coast sites, re-suspension of faecal bacteria attached to sediments may also contribute to non-compliance with water quality for shellfish gathering guidelines, particularly during strong northerly conditions when the beach waters are often turbid.

Maximum faecal coliform counts recorded at shellfish gathering monitoring sites typically coincided with significant rainfall prior to sampling (eg, Warr 2009; Ryan & Warr 2010) and, similar to warnings for other types of contact

recreation, Greater Wellington and Regional Public Health recommend avoiding shellfish collection for up to 48 hours after heavy rainfall.

For the three Kapiti Coast sites which were also monitored over the 2001/02 to 2004/05 summers, the results in Figure 4.46 are similar to those reported in Milne (2005). However, at Shark, Mahanga and Sorrento bays, compliance with the upper faecal coliform guideline that requires no more than 10% of samples to exceed 43 cfu/100mL has improved. This guideline was rarely met at these sites during summer bathing seasons between 2001/01 and 2004/05 (Milne 2006) but was met during all five summer seasons between 2005/06 and 2009/10 at Shark and Sorrento bays, and in three of five summer seasons at Mahanga Bay. There are no obvious reasons for this improvement.

As outlined in Section 4.1.2, monitoring of microbiological contaminants in *shellfish flesh* is needed to provide a direct measure of the risks associated with consuming shellfish. Greater Wellington last undertook such monitoring in early 2006 where microbiological and trace metal contamination was assessed in shellfish flesh at 20 sites in the western half of the Wellington region, including seven sites where water quality for shellfish gathering is monitored. The results, reported in Milne (2006) – and discussed in more detail in Oliver and Milne (2012) – showed that faecal coliform counts were well below the MoH (1995) guidelines for edible tissue at all sites. Concentrations of trace metals were also below national food standards for edible tissue in all samples (Milne 2006).

5. Discussion

This section revisits the main findings presented in Sections 3 and 4. These findings are first presented as a regional overview before being considered in a wider national context. The primary causes of microbiological contamination at the region's rivers and beaches are discussed, and monitoring limitations and knowledge gaps are outlined.

5.1 Regional overview

5.1.1 State

Analysis of microbiological water quality data collected between the 2005/06 and 2009/10 summer periods indicates that water quality at popular river swimming sites across the Wellington region is generally good. Just over half of the 23 river swimming spots monitored met the MfE/MoH (2003) surveillance guideline on 90% or more of sampling occasions over the five-year reporting period, with the majority (20) of sites meeting this threshold 85% of the time. Rivers with a high proportion of indigenous forest and scrub and little or no intensive agricultural or urban land use in the upstream catchment are the safest for swimming; these include the Otaki, Waiohine and Waingawa rivers (all monitoring sites on these rivers have SFRGs of 'very good').

Very few river sites exceeded the MfE (2000) guidelines for aesthetic and recreational use on a regular basis. However, widespread growth of potentially toxic cyanobacteria at sites in the Waikanae, Hutt and Waipoua rivers resulted in these rivers often being unsuitable for swimming and dog walking.

Microbiological water quality is generally very good across beaches in the Wellington region; 67 out of the 77 sites monitored met the MfE/MoH (2003) surveillance guideline on 90% or more of routine sampling occasions between the 2005/06 and 2009/10 summer bathing seasons. Overall, a high proportion (64%) of beach sites have current SFRGs of 'good' or 'very good', indicating that the majority of the region's beaches are suitable for recreation most of the time. The main exceptions are beaches around Porirua city (principally Porirua Harbour, South Beach at Plimmerton and Titahi Bay), Owhiro Bay on Wellington's south coast, and Robinson Bay on the Eastbourne coast.

Water quality for shellfish gathering is more mixed, with only four of the nine site assessed over the reporting period regularly complying with both faecal coliform thresholds in the MfE/MoH (2003) water quality guidelines. As discussed in Section 5.4, the faecal coliform thresholds appear conservative and appropriate application of them is unclear.

At both river and beach recreational spots, exceedances of microbiological water quality guidelines coincided with significant rainfall in the majority of instances. For this reason swimming and collecting shellfish up to 48 hours after heavy rainfall carries with it a potentially high risk to human health.

5.1.2 Temporal trends

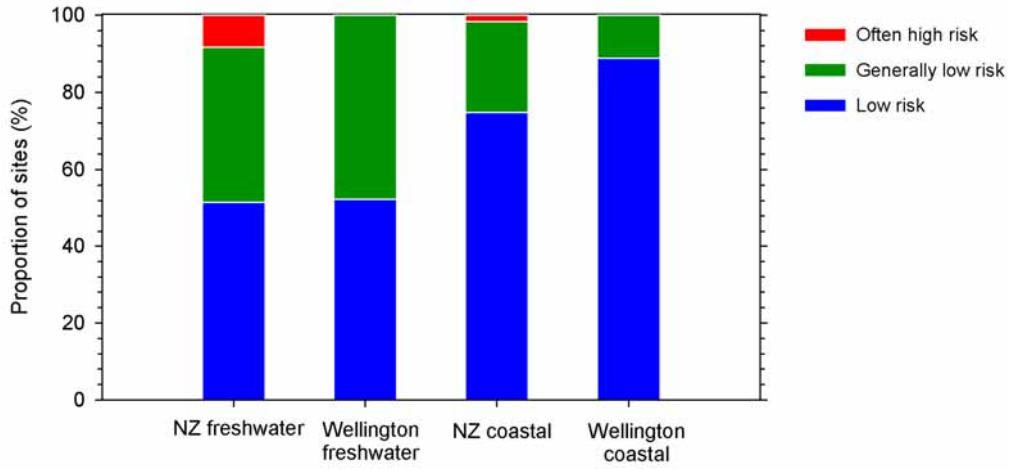
Very few statistically significant trends were identified in *E. coli* counts at river sites over the last 10 summer bathing seasons. Decreasing counts were observed at Waikanae River at SH 1 and Ruamahanga River at Double Bridges, although the magnitude of the decrease at the Waikanae River site was relatively small (<5% per year). The decrease at Double Bridges was larger (11% per year) and, although there is no obvious cause for the decrease, may possibly reflect a reduction in stock access in one or more upstream tributaries.

Assessing temporal trends in coastal water quality data is difficult, with tide and wind conditions confounding these assessments. Putting these confounding factors aside, comparison of the 95th percentile enterococci counts (ie, the MAC grades) presented in this report with those calculated for the 2001/02 to 2005/06 bathing seasons (Milne & Wyatt 2006), indicates that microbiological water quality at just over half of the 75 beach sites monitored over both reporting periods has not changed. However, at 33% of sites, including all but one of the sites monitored on the Wairarapa's east coast and 40% of Wellington city's monitoring sites, the MAC grade improved. Some of these improvements likely reflect differences in the number of rainfall events between the two reporting periods but at least some, such as that observed for Hataitai Beach in Wellington city, are likely to be a result of work undertaken to improve stormwater/sewer infrastructure. Conversely, at least some of the 12 coastal sites with a deterioration in MAC grade between the two reporting periods, including Titahi Bay at South Beach Access Road, Owhiro Bay and Robinson Bay at HW Shortt Recreation Ground, may reflect increasing contamination from stormwater/sewer infrastructure.

5.2 National context

Differences in the numbers of sites, site selection methods, sample numbers and sampling methods make it difficult to compare the quality of recreational waters in the Wellington region to those across New Zealand. However, regional data sets collated by the Ministry for the Environment (MfE) for national reporting purposes have been used here to give an indication of how rivers and beaches in the Wellington region compared with those monitored across the rest of the country, based on the 2005/06 to 2009/10 summer bathing seasons. At a national level, MfE assigns each recreation site one of three risk categories ('low risk', 'generally low risk' and 'often high risk') based on the degree of compliance with the MfE/MoH (2003) action guideline (Figure 5.1).

Figure 5.1 indicates that the proportion of freshwater sites in the 'low risk' category in the Wellington region was almost identical to the national picture. On the other hand, almost 15% more of the region's coastal sites were in the low risk category compared to all New Zealand sites combined. Another key difference was that no sites in the Wellington region fell into the 'often high risk' category of which 8% of freshwater sites and 2% of coastal sites across the rest of New Zealand fell into. Overall, Figure 5.1 indicates that Wellington's rivers and streams compare favourably to the national picture.



(Source: Regional data sets compiled by MfE)

Figure 5.1: The proportion of river and coastal monitoring sites across New Zealand and within the Wellington region in each of three risk categories based on compliance with the MfE/MoH (2003) action guideline during routine bathing season sampling between 2005/06 and 2009/10. Low risk=95% or more compliance, generally low risk=between 75 and 95% compliance, often high risk=less than 75% compliance.

5.3 Key sources of microbiological contamination in Wellington's recreational waters

Contaminated runoff from agricultural land use during heavy rain is considered to be a key source of microbiological contamination at many river swimming sites and some coastal sites. More action guideline exceedances were recorded at river sites with a high proportion of agricultural landuse in the catchment, such as those on the lower Ruamahanga River, than at sites with forest-dominated catchments such as the Otaki, Waiohine and Waingawa rivers. Agricultural contamination of coastal waters was evident at Te Horo and Otaki beaches, both of which are at times affected by streams draining catchments with a high proportion of intensive land use (including dairying). In addition, stock access to streams has been identified as the most likely cause of dry weather exceedances of the MfE/MoH (2003) action guideline during dry weather at Ruamahanga River at Double Bridges and possibly at Wainuiomata River at Richard Prouse Park.

Stormwater and sewer leaks/overflows are considered to be the main source of contamination at beaches in or near urban areas. Sewage contamination has been identified in the catchments of beach sites that frequently exceed the MfE/MoH (2003) action guidelines (eg, Porirua Harbour at Rowing Club, Titahi Bay at South Beach Access Road and Owhiro Bay) and may affect other urban beaches with SFRGs of 'fair' or worse (eg, Pauatahanui Inlet at Browns Bay and Robinson's Bay at HW Short Recreation Ground). Infrastructure-related contamination may also contribute to poor grades at sites in the lower reaches of the Hutt River.

Treated sewage is discharged in the vicinity of a number of popular swimming spots in the region. However, the risk to human health at these sites is uncertain due to a lack of information on pathogen removal efficiency of the

various municipal WWTPs. This is particularly relevant for swimming sites on the Ruamahanga River, a number of which have been conservatively assigned interim dry weather SFRGs of 'poor' or 'fair' to account for this uncertainty.

Birdlife such as ducks and seagulls probably contribute to faecal contamination at some recreation sites, including South Beach at Plimmerton and the Hutt River at Silverstream. It is possible that water quality at Owhiro Bay is also affected by birdlife, although further work is needed to confirm this. Similarly, further work is needed to better understand whether bacteria re-suspended from bottom sediment contributes to action guidelines exceedances at some coastal sites, particularly Porirua Harbour at Rowing Club.

5.4 Monitoring limitations and knowledge gaps

There are several important monitoring and reporting limitations, as well as general knowledge gaps that need to be considered when looking at recreational water quality in the Wellington region:

- Although Greater Wellington's recreational water quality monitoring programme is largely undertaken in accordance with the MfE/MoH (2003) guidelines, for some of the early part of the reporting period, water samples from sites in Porirua city and the Wairarapa were not analysed by an IANZ-accredited laboratory. It is unclear whether this has had any effect on the results reported although, in the case of Porirua where samples were analysed in-house in the absence of a laboratory technician, the potential for some errors in analysis and reporting clearly did exist.

- Assessments of recreational water quality and derivation of SFRGs are limited to routine monitoring data collected during the official bathing season specified in the MfE/MoH (2003) guidelines (November to March). While this reflects the time of greatest usage, it overlooks the fact that many recreational waters sites, particularly coastal sites in urban areas (eg, Oriential Bay and Scorching Bay in Wellington city), are utilised year-round and water quality is often poorer outside of the summer period (owing largely to higher rainfall). For example, Milne and Wyatt (2006) demonstrated that Island Bay monitoring sites on Wellington city's south coast exceed the MfE/MoH (2003) guidelines more frequently during the winter months and, if these results were included in SFRG derivation, then lower SFRGs would be assigned to these sites. It is therefore important to ensure that the appropriate application of SFRGs is clearly communicated to the public, along with the need to take more care outside of the bathing season.

- At several recreation sites, such as the Hutt River at both Silverstream and Boulcott, water quality at times exceeds the MfE/MoH (2003) action guideline in the absence of any significant rainfall and obvious source of contamination. There is a need to further investigate the sources of repeated dry weather exceedences at these sites, making use of catchment risk assessments and faecal source tracking tools.

- Discharges of treated municipal wastewater near to popular swimming spots such as 'The Cliffs' and 'Bentleys Beach' on the Ruamahanga River and, to a lesser extent, Paraparaumu Beach in Kapiti, Titahi Bay in Porirua and Lyall Bay on Wellington city's south coast, mean that the MfE/MoH (2003) microbiological guidelines cannot be applied to these areas with confidence. This is because wastewater treatment plants may treat effluent to a level where the indicator bacteria concentrations are very low, but pathogens such as viruses and protozoa may still be present at substantial concentrations, effectively changing the indicator/pathogen ratio. To assess the microbiological quality of water that is impacted by a discharge of treated effluent, the relationship between indicator bacteria and key pathogens must be established for each discharge (MfE/MoH 2003). Accordingly, monitoring sites on the Ruamahanga River potentially affected by wastewater treatment plant discharges have been assigned conservative interim SFRGs grades until further information on the indicator bacteria/pathogen ratio in these discharges is obtained (see Greenfield et al. 2012 for further discussion).

- There are some shortcomings in the beach grading process outlined in the MfE/MoH (2003) guidelines that can impact on recreational water quality reporting (see Greenfield et al. 2012 for further details).

- Interpreting the suitability of recreational waters for shellfish gathering is problematic. The MfE/MoH (2003) guidelines do not define a shellfish gathering season and the faecal coliform thresholds are based on quite dated reference material (DoH 1992) that appear to be very conservative. Overall, as outlined earlier in this report, monitoring of microbiological contaminants in *shellfish flesh* is needed to provide a direct measure of the risks associated with consuming shellfish.

- The MfE/MoH (2003) guidelines do not cover toxic chemicals such as heavy metals or toxic algal blooms, which in certain places and under certain conditions may pose a significant risk to contact recreation. While guidelines are now available for toxic cyanobacteria in fresh waters (MfE/MoH 2009), these are interim guidelines only and do not address potentially toxic algal blooms in marine waters; such blooms have occurred in marine recreational waters in the Wellington region in the past.

6. Conclusions

Routine microbiological water quality monitoring at popular recreational sites across the Wellington region over the five summers between November 2005 and March 2010 indicates that coastal waters are generally safer for swimming than fresh waters. Just over half of the 23 river swimming spots monitored over the 2005/06 to 2009/10 summers met the MfE/MoH (2003) surveillance guideline on 90% or more of sampling occasions compared with close to 90% of coastal swimming spots. This was mirrored in SFRGs assigned to each site; only half of river swimming spots have SFRGs of 'good' or better (based on 'dry weather' SFRGs) compared to close to 65% of coastal swimming spots. The reduced dilution and dispersal capacity of rivers and other freshwater bodies compared to coastal waters means that they are generally more sensitive to faecal contamination.

Very few rivers sites exceeded the MfE (2000) guidelines for aesthetic and recreational use on a regular basis. However, widespread growth of potentially toxic cyanobacteria in the Waikanae, Hutt and Waipoua rivers during periods of extended low or stable river flow resulted in parts of these rivers often being unsuitable for swimming and dog walking. A total of 10 dogs died over the reporting period after coming into contact with toxins released from the cyanobacteria mats (nine from the Hutt River).

Runoff from agricultural land use during heavy rain is considered to be a key source of contamination at many river swimming sites and some coastal sites. In dry weather, stock access is a source of faecal contamination in many of the region's rivers. Birdlife has also been identified as a potential source of contamination at a few sites.

Stormwater and sewer leaks/overflows are considered to be the main source of microbiological contamination at beaches in or near urban areas. Sewage contamination has been identified in the catchments of beach sites that frequently exceed the MfE/MoH (2003) guidelines such as Porirua Harbour at Rowing Club and Owhiro Bay, and may affect some other urban beaches with SFRGs of 'fair' or worse. Infrastructure-related contamination may also contribute to poor grades at sites on the lower reaches of the Hutt River.

The influence of treated municipal wastewater discharges on microbiological water quality in the region is unclear and requires further investigation. This is particularly the case for popular swimming spots on the Ruamahanga River but also for sites along Paraparaumu Beach, Titahi Bay, Lyall Bay and the Eastbourne coast.

Improvements in microbiological water quality were observed at some sites, including Waikanae River at SH 1, Ruamahanga River at Double Bridges and Oriental Bay and Hataitai Beach in Wellington city. While the reasons for improvements at freshwater sites are unclear, improvements at the two Wellington city sites may reflect work that has been undertaken in these catchments to fix sewer faults and upgrade stormwater and sewer infrastructure. Conversely increased contamination from stormwater and sewer infrastructure may have contributed to the deterioration in

microbiological water quality observed at some sites, notably Titahi Bay at South Beach Access Road, Owhiro Bay and Robinson Bay at HW Shortt Recreation Ground.

Only four of the nine sites where water quality for shellfish gathering is assessed regularly complied with both faecal coliform thresholds in the MfE/MoH (2003) water quality guidelines. However, interpreting the suitability of recreational waters for shellfish gathering is problematic due to the conservatism of the guidelines and uncertainties surrounding their application.

At both river and beach swimming and shellfish gathering spots, exceedances of microbiological guidelines coincide with significant rainfall in the majority of instances. For this reason swimming and collecting shellfish up to 48 hours after heavy rainfall carries with it a potentially high risk to human health. It is important that this risk continues to be communicated to the public, along with how to interpret the recently revised SFRGs for the region's rivers and beaches.

6.1 Recommendations

1. Continue to include updated SFRGs in annual recreational water quality reports but for freshwater sites use 'dry weather' grades and clearly identify those sites where microbiological water quality is affected by heavy rainfall.

2. Use faecal source tracking and other tools to investigate the key sources of microbiological contamination at Hutt River at Silverstream, Hutt River at Boulcott, Wainuiomata River at Richard Prouse Park, South Beach at Plimmerton, Porirua Harbour at Rowing Club, Titahi Bay at South Beach Access Road, Owhiro Bay and Robinson Bay at HW Shortt Recreation Ground.

3. Investigate the degree of stock access in tributary catchments upstream of monitoring sites on the Wainuiomata River at Richard Prouse Park and Ruamahanga River at Double Bridges.

4. In collaboration with Regional Public Health and the relevant territory authorities, collate existing information on the pathogen removal capacity of municipal WWTPs at Paraparaumu, Titahi Bay, Seaview, Moa Point and the Wairarapa to assess the risk of the WWTP discharges to public health at nearby swimming sites.

5. Continue to support investigations and research into the factors driving *Phormidium* growth in the region's rivers and undertake an assessment of the relative contribution of each major tributary to the total nutrient load of the Hutt River to support further understanding of the potential role of nutrients in stimulating *Phormidium* proliferations.

6. Review Greater Wellington's existing shellfish-related monitoring with the view to establishing a new programme that provides more confidence in recommendations regarding the safety of shellfish for human consumption.

7. Take into account the findings of this report in the review of Greater Wellington's existing regional plans, particularly the need to:

    - Improve existing stormwater and sewerage networks so that microbiological contamination from sewer/stormwater cross connections, leaks and overflows is minimised;
    - Promote the use of Low Impact Urban Design principles in areas of new development to reduce the impact of stormwater runoff on rivers and the coast;
    - Address the issue of municipal wastewater discharges to surface waters in the vicinity of areas regularly used for contact recreation, particularly freshwater bodies;
    - Minimise stock access to rivers and streams; and
    - Improve land use practises in agricultural areas to reduce effluent runoff during wet weather.

References

Ausseil O and Clark M. 2007. *Recommended water quality standards for the Manawatu-Wanganui region: Technical report to support policy development*. Horizons Regional Council, Report 2007/EXT/806.

Cornelisen CD, Kirs M, Gilpin B and Scholes P. 2012. *Microbial source tracking (MST) tools for water quality monitoring.* Report No. 2047 prepared for regional councils and the Coastal Special Interest Group. Cawthron Institute, Nelson.

Department of Health. 1992. *Provisional microbiological water quality guidelines for recreational and shellfish-gathering waters in New Zealand*. Public Health Services, Department of Health, Wellington.

Devane M. 2010. *Report on faecal source tracking*. Unpublished report prepared for Porirua City Council. Institute of Environmental Science and Research Ltd, Christchurch.

Gilpin B. 2010. *Report on faecal source tracking analysis*. Unpublished report prepared for Environmental Laboratory Services Ltd. Institute of Environmental Science and Research Ltd, Christchurch.

Greater Wellington Regional Council. 2005. *Measuring up – the state of the environment report for the Wellington region.* Greater Wellington Regional Council, Publication No. GW/ENV-G-05-278, Wellington.

Greater Wellington Regional Council. 2009. *Selection of rivers and lakes with significant amenity and recreational values.* Greater Wellington Regional Council, Publication No. GW/EP-G-09/28, Wellington.

Greater Wellington Regional Council. 2010. *Proposed regional policy statement for the Wellington region, May 2010.* Greater Wellington Regional Council, Publication No. GW/EP-G-08/200, Wellington.

Greenfield S, Milne JR and Ryan A. 2012. *Will I get sick if I swim? Updated suitability for recreation grades for fresh and coastal waters in the Wellington region*. Greater Wellington Regional Council, Publication No. GW/EMI-T-12/146, Wellington.

Heath MW, Wood SA and Ryan KG. 2010. Polyphasic assessment of fresh-water benthic mat-forming cyanobacteria isolated from New Zealand. *FEMS Microbiology Ecology*, 73: 95-109.

Heath MW, Wood SA and Ryan KG. 2011. Spatial and temporal variability in Phormidium mats and associated anatoxin-a and homoanatoxin-a in two New Zealand rivers. *Aquatic Microbial Ecology*, 64: 69-79.

Kirs M. 2010. *Microbial source tracking laboratory report*. Unpublished report prepared for Environmental Laboratory Services Ltd. Cawthron Institute, Nelson.

Milne JR. 2005. *Recreational water quality monitoring technical report.* Greater Wellington Regional Council, Publication No. GW/RINV-T-05/89, Wellington.

Milne JR. 2006. *Contaminants in shellfish flesh: An investigation into microbiological and trace metal contaminants in shellfish from selected locations in the Wellington region.* Greater Wellington Regional Council, Publication No. GW/EMI-G-06/285, Wellington.

Milne JR. 2007. *On the beaches 2006/07: Annual recreational water quality monitoring report for the Wellington region*. Greater Wellington Regional Council, Publication No. GW/EMI-T-07/126, Wellington.

Milne JR and Perrie A. 2005. *Freshwater quality monitoring technical report.* Greater Wellington Regional Council, Publication No. GW/RINV-T-05/87, Wellington.

Milne JR and Watts L. 2007. *Toxic benthic cyanobacteria proliferations in Wellington's rivers in 2005/06*. Greater Wellington Regional Council, Publication No.GW/EMI-T-07/72. Wellington.

Milne JR and Wyatt K. 2006. *Will I get sick if I swim? Suitability for recreation grades for selected marine and freshwater bathing sites in the Wellington region*. Greater Wellington Regional Council, Publication No. GW/EMI-G-06/160, Wellington.

Ministry for the Environment. 2000. *New Zealand periphyton guideline: Detecting, monitoring and managing enrichment of streams*. Report prepared for the Ministry for the Environment by NIWA, Christchurch.

Ministry for the Environment. 2005. *Follow-up (consecutive) sampling of marine waters – proposed amendments to guidelines*. Draft discussion paper. Ministry for the Environment, Wellington.

Ministry for the Environment. 2010. *Measuring carbon emissions from land-use change and forestry: the New Zealand land-use and carbon analysis system*. Ministry for the Environment, Wellington.

Ministry for the Environment, Ministry of Health. 2003. *Microbiological water quality guidelines for marine and freshwater recreational areas.* Ministry for the Environment, Wellington.

Ministry for the Environment, Ministry of Health. 2009. *New Zealand guidelines for cyanobacteria in recreational fresh waters – Interim guidelines*. Prepared for the Ministry for the Environment and the Ministry of Health by SA Wood, DP Hamilton, KA Safi and WM Williamson. Ministry for the Environment, Wellington.

Ministry of Health. 1995. *Microbiological reference criteria for food.* Ministry of Health, Wellington.

Morar S and Warr S. 2011. *On the beaches: Annual recreational water quality monitoring report for the Wellington region, 2010/11.* Greater Wellington Regional Council, Publication No. GW/EMI-G-11/88, Wellington.

MWH. 2011. *Temporary discharges of treated wastewater to Waiwhetu Stream and Wellington Harbour*. Report prepared for Hutt City Council. MWH Project No. ZO643829, Wellington.

Oliver M and Milne JR. 2012. *Coastal water quality and ecology in the Wellington region: State and trends*. Greater Wellington Regional Council, Publication No. GW/EMI-T-12/144, Wellington.

Perrie A, Morar S, Milne JR and Greenfield S. 2012. *River and stream water quality and ecology in the Wellington region: State and trends*. Greater Wellington Regional Council, Publication No. GW/EMI-T-12/143, Wellington.

Ryan A and Warr S. 2008. *On the beaches: Annual recreational water quality monitoring report for the Wellington region, 2007/08.* Greater Wellington Regional Council, Publication No. GW/EMI-T-08/79, Wellington.

Ryan A and Warr S. 2010. *On the beaches: Annual recreational water quality monitoring report for the Wellington region, 2009/10.* Greater Wellington Regional Council, Publication No. GW/EMI-G-10/68, Wellington.

Sen PK. 1968. Estimates of the regression coefficient based on Kendall's tau. *Journal of the American Statistical Association,* 63: 1,379–1,389.

SKM. 2011. *Stormwater discharge consents monitoring – compliance monitoring results and investigations 2010–2011*. Report prepared for Kapiti Coast District Council. SKM project no. AEO3928, Wellington.

Smith DG, McBride GB, Bryers GG, Wisse J and Mink DFJ. 1996. Trends in New Zealand's river water quality network. *New Zealand Journal of Marine and Freshwater Research*, 30: 485–500.

Sorensen PG and Milne JR. 2009. *Porirua Harbour targeted intertidal sediment quality assessment.* Greater Wellington Regional Council, Publication No. GW/EMI-T-09-136, Wellington.

Stansfield B. 2000. *Wairarapa Rivers bacteriological monitoring programme annual report, December 1999–March 2000*. Wellington Regional Council, Technical Report No. 98/8, Masterton.

Thompson M and Gordon M. 2010. *Periphyton accrual period estimates for RSoE sites*. Unpublished internal report, Document reference #870495. Greater Wellington Regional Council, Wellington.

Warr S. 2009. *On the beaches: Annual recreational water quality monitoring report for the Wellington region, 2008/09.* Greater Wellington Regional Council, Publication No. GW/EMI-T-09/130, Wellington.

Watts L and Gordon G. 2007. *Annual hydrology monitoring report for the Wellington region 2006/07.* Greater Wellington Regional Council, Publication No. GW/EMI-T-07/221, Wellington.

Wellington Regional Council. 1995. *Regional Policy Statement for the Wellington region*. Wellington Regional Council, Publication No. WRC/PP-G-95/28, Wellington.

Wellington Regional Council. 1999. *Regional Freshwater Plan for the Wellington region.* Wellington Regional Council, Publication No. WRC/PP-G-99/31, Wellington.

Wellington Regional Council. 2000. *Regional Coastal Plan for the Wellington region.* Wellington Regional Council, Publication No. WRC/RP-G-00/02, Wellington.

Wood SA, Selwood AI, Rueckert A, Holland PT, Milne JR, Smith KF, Smits B, Watts LF and Cary CS. 2007. First report of homoanatoxin-a and associated dog neurotoxicosis in New Zealand. *Toxicon*, 50: 292–301.

Wood SA and Young R. 2011. *Benthic cyanobacteria and toxin production in the Manawatu-Wanganui region.* Report No. 1959 prepared for Horizons Regional Council by the Cawthron Institute, Nelson.

Acknowledgements

Recreational water quality monitoring in the Wellington region is a joint effort involving Greater Wellington and its constituent local councils, in particular the Kapiti Coast District Council, Porirua City Council, Wellington City Council and Hutt City Council.

We would like to thank the following people for providing comments on the draft version of this report:

- Anne Robertson, Kapiti Coast District Council
- Geoff Charleson, Hutt Valley Water Services
- Iqbal Idris, Capacity
- Jill McKenzie, Regional Public Health
- Jim Sutton, Porirua City Council
- Kaine Jaquiery, Masterton District Council
- Michelle Malcolm, SKM
- Nicci Wood, Wellington City Council
- Nick MacDonald, Porirua City Council
- Paul Schuchmann, Hutt City Council
- Steve Hutchison, MWH
- Ted Taylor, Greater Wellington

Thanks also to Brent King (Ministry for the Environment) for providing data used in the national comparison in Section 5.2 and Mike Gordon (Greater Wellington) for providing river flow estimates.

Appendix 1: Monitoring sites

Area	Site name	NZTM co-ordinates		Type
		Easting	Northing	
Kapiti	Otaki River @ State Highway 1	1781309	5484406	Freshwater
Kapiti	Otaki River @ Pots	1785444	5478749	Freshwater
Kapiti	Waikanae River @ Jim Cooke Park	1772155	5472377	Freshwater
Kapiti	Waikanae River @ State Highway 1	1773752	5472296	Freshwater
Kapiti	Otaki Beach @ Surf Club	1778622	5488330	Coastal[1]
Kapiti	Otaki Beach @ Rangiuru Road	1778010	5487069	Coastal
Kapiti	Te Horo Beach S of Mangaone Stream	1775779	5482478	Coastal
Kapiti	Te Horo Beach @ Kitchener Street	1775495	5481933	Coastal
Kapiti	Peka Peka Beach @ Road End	1773215	5477905	Coastal[1]
Kapiti	Waikanae Beach @ William Street	1771388	5475584	Coastal
Kapiti	Waikanae Beach @ Tutere St Tennis Courts	1770655	5474862	Coastal
Kapiti	Waikanae Beach @ Ara Kuaka Carpark	1769514	5473978	Coastal
Kapiti	Paraparaumu Beach @ Ngapotiki Street	1767543	5472762	Coastal
Kapiti	Paraparaumu Beach @ Nathan Avenue	1767033	5472174	Coastal
Kapiti	Paraparaumu Beach @ Maclean Park	1766694	5471267	Coastal
Kapiti	Paraparaumu Beach @ Toru Road	1766577	5470715	Coastal
Kapiti	Paraparaumu Beach @ Wharemauku Road	1766503	5470070	Coastal
Kapiti	Raumati Beach @ Tainui Street	1766531	5469229	Coastal
Kapiti	Raumati Beach @ Marine Gardens	1766516	5468441	Coastal
Kapiti	Raumati Beach @ Aotea Road	1766414	5467529	Coastal
Kapiti	Raumati Beach @ Hydes Road	1766318	5466835	Coastal[1]
Kapiti	Paekakariki Beach @ Whareroa Road	1765598	5464128	Coastal
Kapiti	Paekakariki Beach @ Surf Club	1764791	5462273	Coastal
Porirua	Pukerua Bay	1759058[2]	5456278	Coastal
Porirua	Karehana Bay @ Cluny Road	1756093	5451360	Coastal
Porirua	Plimmerton Beach @ Bath Street	1756706	5450316	Coastal
Porirua	Plimmerton Beach @ Queens Avenue	1756758	5450177	Coastal
Porirua	South Beach @ Plimmerton	1756810	5449874	Coastal
Porirua	Paremata Beach @ Pascoe Avenue	1757116	5448733	Coastal
Porirua	Pauatahanui Inlet @ Water Ski Club	1758074	5449593	Coastal
Porirua	Pauatahanui Inlet @ Motukaraka Point	1759486	5449338	Coastal[1]
Porirua	Pauatahanui Inlet @ Browns Bay	1758039	5447833	Coastal[1]
Porirua	Porirua Harbour @ Rowing Club	1754891	5446947	Coastal[1]
Porirua	Titahi Bay @ Bay Drive	1754132	5448169	Coastal
Porirua	Titahi Bay at Toms Road	1754110	5447857	Coastal
Porirua	Titahi Bay @ South Beach Access Road	1753906	5447682	Coastal
Porirua	Onehunga Bay	1755796	5449181	Coastal
Porirua	Pauatahanui Inlet @ Paremata Bridge	1757153	5448284	Coastal
Wellington	Aotea Lagoon	1748985	5427683	Coastal
Wellington	Oriental Bay @ Freyberg Beach	1749920	5427464	Coastal
Wellington	Oriental Bay @ Wishing Well	1750118	5427386	Coastal
Wellington	Oriental Bay @ Band Rotunda	1750243	5427375	Coastal
Wellington	Balaena Bay	1750958	5427267	Coastal
Wellington	Kio Bay	1751139	5426602	Coastal
Wellington	Hataitai Beach	1750632	5425730	Coastal
Wellington	Shark Bay	1752211	5426197	Coastal[1]
Wellington	Mahanga Bay	1753468	5427115	Coastal[1]
Wellington	Scorching Bay	1753517	5426647	Coastal
Wellington	Worser Bay	1753074	5424823	Coastal

Area	Site name	NZTM co-ordinates		Type
		Easting	Northing	
Wellington	Seatoun Beach @ Wharf	1753129	5424234	Coastal
Wellington	Seatoun Beach @ Inglis Street	1753405	5423994	Coastal
Wellington	Breaker Bay	1753312	5422970	Coastal
Wellington	Lyall Bay @ Tirangi Road	1750747	5423230	Coastal
Wellington	Lyall Bay @ Onepu Road	1750286	5423116	Coastal
Wellington	Lyall Bay @ Queens Drive	1749990	5422868	Coastal
Wellington	Princess Bay	1749586	5421504	Coastal
Wellington	Island Bay @ Surf Club	1748377	5421590	Coastal
Wellington	Island Bay @ Reef St Recreation Ground	1748229	5421542	Coastal
Wellington	Island Bay @ Derwent Street	1748155	5421415	Coastal
Wellington	Owhiro Bay	1747122	5421463	Coastal
Hutt	Hutt River @ Birchville	1776196	5449091	Freshwater
Hutt	Hutt River @ Boulcott	1760920	5437569	Freshwater
Hutt	Hutt River @ Maoribank Corner	1775882	5446696	Freshwater
Hutt	Hutt River @ Poets Park	1771461	5446092	Freshwater
Hutt	Hutt River @ Silverstream Bridge	1767598	5443172	Freshwater
Hutt	Pakuratahi River @ Forks	1784288	5452620	Freshwater
Hutt	Wainuiomata River @ Richard Prouse Park	1764536	5429141	Freshwater
Hutt	Petone Beach @ Water Ski Club	1755744	5434591	Coastal
Hutt	Petone Beach @ Sydney Street	1757045	5434248	Coastal
Hutt	Petone Beach @ Settlers Museum	1757555	5434056	Coastal
Hutt	Petone Beach @ Kiosk	1758326	5433711	Coastal
Hutt	Sorrento Bay	1759632	5431384	Coastal[1]
Hutt	Lowry Bay @ Cheviot Road	1760206	5430891	Coastal
Hutt	York Bay	1759977	5430160	Coastal
Hutt	Days Bay @ Wellesley College	1759616	5428529	Coastal
Hutt	Days Bay @ Wharf	1759654	5428313	Coastal
Hutt	Days Bay @ Moana Road	1759582	5428120	Coastal
Hutt	Rona Bay @ N end of Cliff Bishop Park	1759109	5427654	Coastal
Hutt	Rona Bay @ Wharf	1758730	5427371	Coastal
Hutt	Robinson Bay @ HW Shortt Rec Ground	1758519	5426674	Coastal
Hutt	Robinson Bay @ Nikau Street	1758131	5425856	Coastal
Hutt	Camp Bay	1756990	5424288	Coastal
Wairarapa	Ruamahanga River @ Bentleys Beach	1800534	5432813	Freshwater
Wairarapa	Ruamahanga River @ Double Bridges	1824350	5471775	Freshwater
Wairarapa	Ruamahanga River @ Kokotau	1815756	5447191	Freshwater
Wairarapa	Ruamahanga River @ Morrisons Bush	1808918	5441108	Freshwater
Wairarapa	Ruamahanga River @ Te Ore Ore	1825529	5462917	Freshwater
Wairarapa	Ruamahanga River @ The Cliffs	1821476	5452180	Freshwater
Wairarapa	Ruamahanga River @ Waihenga	1804610	5436461	Freshwater
Wairarapa	Waingawa River @ Kaituna	1810326	5471149	Freshwater
Wairarapa	Waingawa River @ South Road	1820550	5460878	Freshwater
Wairarapa	Waiohine River @ Gorge	1801853	5455936	Freshwater
Wairarapa	Waiohine River @ State Highway 2	1809665	5451711	Freshwater
Wairarapa	Waipoua River @ Colombo Road	1824996	5462889	Freshwater
Wairarapa	Castlepoint Beach @ Castlepoint Stream	1871366	5467559	Coastal
Wairarapa	Castlepoint Beach @ Smelly Creek	1871670	5467202	Coastal
Wairarapa	Riversdale Beach @ Lagoon Mouth	1858965	5447543	Coastal
Wairarapa	Riversdale Beach Between the Flags	1858435	5446948	Coastal
Wairarapa	Riversdale Beach South	1857834	5445514	Coastal

[1] Water quality is also monitored for recreational shellfish gathering purposes.

Appendix 2: Suitability for recreation grades

(Source: pp. H20-21, MfE/MoH 2003)

Beaches are graded by considering microbiological monitoring results from previous years in combination with the factors in the catchment that may contribute faecal contamination to the beach[24]. It is a risk-associated grading of the beach, meaning that it provides an indication of what the likely condition of the beach will be on any day. The following general explanation provides a description of each of the beach grades.

Very good

Water quality tests and assessment of potential contamination sources indicate beaches within this category are considered to have very good water quality. This suggests there may be some indirect run-off from low intensity agricultural/urban/rural/bush catchments, but there are likely to be no significant sources of faecal contamination.

Recommendation: Considered satisfactory for swimming at all times, and therefore may not require monitoring on a regular basis.

Good

Water quality tests and assessment of potential contamination sources indicate beaches within this category are considered to have generally good water quality. On occasions (such as after high rainfall) there may be an increased risk of contamination from run-off. Such sites receive run-off from one or more of the following sources which may contain animal or human faecal material:

- River discharges impacted by tertiary treated wastewater, combined sewer overflows, sewer overflows, intensive agricultural/rural catchments, significant feral/bird/animal populations
- River discharges impacted by; run-off from low-intensity agricultural/urban/rural catchment
- Direct discharges from stormwater not contaminated by sewage, boat moorings or marinas
- Direct discharges from low-intensity agriculture.

Recommendation: Satisfactory for swimming most of the time. Exceptions may include following rainfall. Such beaches are monitored regularly throughout the summer season and warning signs will be erected if water quality deteriorates.

Fair

Water quality tests and assessment of potential contamination sources indicate beaches within this category are considered to have generally fair water quality. However, events such as high rainfall increase the risk of contamination levels from run-off. Such sites receive run-off from one or more of the following sources which may contain animal or human faecal material:

- River discharges impacted by tertiary treated wastewater, combined sewer overflows, sewer overflows, intensive agricultural/rural catchments, significant feral bird/animal populations

[24] Note that 'beach' refers to both freshwater and marine bathing areas.

- River discharges impacted by; run-off from low-intensity agricultural/urban/rural catchment
- Direct discharges from stormwater not contaminated by sewage, boat moorings or marinas
- Direct discharges from low-intensity agriculture.

Recommendation: Generally satisfactory for swimming, though there may be potential sources of faecal material. Caution should be taken during periods of high rainfall, and swimming should be avoided if water is discoloured. Sites are monitored weekly throughout the summer season and warning signs erected if water quality deteriorates.

Poor

Water quality tests and assessment of potential contamination sources indicate beaches within this category are considered to have generally poor water quality. These sites receive run-off from one or more of the following sources which may contain animal or human faecal material:

- Tertiary treated wastewater
- Urban stormwater, intensive agriculture, unrestricted stock access, dense bird populations
- Low-intensity agriculture, marinas or boat moorings, urban stormwater not contaminated by sewage
- River discharges containing untreated/primary/secondary treated wastewater or on-site waste treatment systems
- River discharges impacted by tertiary treated wastewater, combined sewer overflows, intensive agricultural/rural catchments, feral bird/animal populations.

Recommendation: Generally not okay for swimming, as indicated by historical water quality results. Swimming should be avoided, particularly by the very young, the very old and those with compromised immunity. Permanent warning signs may be erected at these sites, although councils may monitor these sites weekly and post temporary warnings.

Very poor

Water quality tests and assessment of potential contamination sources indicate beaches within this category are considered to have very poor water quality. These sites receive run-off from one or more of the following sources which may contain animal or human faecal material:

- Untreated/primary/secondary treated wastewater
- On-site waste treatment systems.
- Tertiary treated wastewater
- Urban stormwater, intensive agriculture, unrestricted stock access, dense bird populations
- River discharges containing untreated/primary/secondary treated wastewater or on-site waste treatment systems.

Recommendation: Avoid swimming, as there are direct discharges of faecal material. Permanent signage will be erected at the beach stating that swimming is not recommended.

Appendix 3: Laboratory and field methods

Kapiti Coast District Council collected and analysed water samples collected in their district. Water samples collected in Porirua, Wellington city, Hutt city and the Wairarapa were analysed by Environmental Laboratory Services (ELS).

Table A3.1: Methods and detection limits

Determinant	Method	Detection limit
Escherichia coli at 44.5°C	APHA Standard Methods (20th Ed.) 9213D, Membrane filter on mTEC agar, Urea substrate.	1-4/100mL
Enterococci at 41°C	US EPA Method 1600, Membrane filter on mEI agar.	1-5 cfu/100mL
Faecal coliforms at 44.5°C	APHA Standard Methods (20th Ed.) 9222D, Membrane filter on mFC agar.	1-5 cfu/100mL
Water temperature	Field meter or digital thermometer.	0.1°C
Turbidity	APHA Standard Methods (20th Ed.) 2130B.	0.1 NTU
Periphyton cover (Nov 2005–Nov 2009)	Mean % of algae visually estimated (using a 20 cm diameter hoop) at 10 points on a single transect (or 5 points on two transects) across the river. Filamentous and mat periphyton (as defined by the NZ Periphyton guidelines) were assessed separately apart from at western sites between November 2005 and March 2006 when total periphyton cover was assessed.	5%
Periphyton cover (Dec 2009 onwards)	Cover of cyanobacteria as well as filamentous and mat-forming algae was assessed using the method outlined in Section 4.4.3 of the interim Cyanobacteria Guidelines (MfE&MoH 2009). Until December 2009, cyanobacteria cover was included in the assessment of periphyton mat (for diatoms and cyanobacteria mats >0.3 mm thick) although in most instances these mats were dominated by cyanobacteria. Since December 2009 cyanobacteria mats (>1mm thick) have been assessed separately.	5%
Seaweed cover	Visual estimate within 5 m radius around sample point, including both floating and attached seaweed.	5%

Rainfall stations

Freshwater recreational sites

- Kapiti Coast District – Taungata Peak (Otaki River) and Waikanae Water Treatment Plant (Waikanae River)
- Hutt – Kaitoke Headworks (Pakuratahi River), Te Marua (Hutt River), Wainuiomata Reservoir (Wainuiomata River)
- Wairarapa – Mount Bruce (Ruamahanga River), Kaituna (Waipoua River, Waingawa River), Phelps (Waiohine River), Angle Knob (located in the upper Waingawa catchment and used as indicator of rainfall high in Tararua Range).

Coastal recreational sites

- Kapiti Coast District – Otaki Depot (Otaki Beach, Te Horo Beach), Waikanae Water Treatment Plant (Peka Peka Beach, Waikanae Beach), Paraparaumu Aerodrome* (Paraparaumu Beach, Raumati Beach, Paekakariki Beach)
- Porirua city – Whenua Tapu
- Hutt city – Shandon
- Wellington city – Wellington Airport*
- Wairarapa – Castlepoint*

* NIWA rainfall stations

Appendix 4: Summary of compliance with MfE/MoH (2003) guidelines

(a) Recreational water quality in fresh waters

Analysis of *E. coli* counts obtained from routine weekly monitoring during the 2001/02 to 2010/11 summer bathing seasons against the MfE/MoH (2003) surveillance, alert and action levels for freshwater recreational waters. Although this report focused on the 2005/06 to 2009/10 seasons, results from earlier seasons are included for completeness of record while results from the 2010/11 summer bathing season are included as they were used by Greenfield et al. (2012) to calculate updated SFRGs.

(i) Kapiti Coast

Bathing season	Surveillance		Alert		Action		Total	
	No.	%	No.	%	No.	%	No.	%
OTAKI RIVER AT THE POTS								
2001/02	19	90.5	2	9.5	0	0.0	21	100
2002/03	20	95.2	0	0.0	1	4.8	21	100
2003/04	20	95.2	1	4.8	0	0.0	21	100
2004/05	22	100.0	0	0.0	0	0.0	22	100
2005/06	22	100.0	0	0.0	0	0.0	22	100
2006/07	5	100.0	0	0.0	0	0.0	5	100
2007/08	5	100.0	0	0.0	0	0.0	5	100
2008/09	5	100.0	0	0.0	0	0.0	5	100
2009/10	5	100.0	0	0.0	0	0.0	5	100
2010/11	5	100.0	0	0.0	0	0.0	5	100
Total	128	97.0	3	2.3	1	0.8	132	
OTAKI RIVER AT STATE HIGHWAY 1								
2001/02	18	85.7	3	14.3	0	0.0	21	100
2002/03	20	95.2	1	4.8	0	0.0	21	100
2003/04	18	85.7	3	14.3	0	0.0	21	100
2004/05	20	90.9	1	4.5	1	4.5	22	100
2005/06	21	95.5	1	4.5	0	0.0	22	100
2006/07	19	90.5	2	9.5	0	0.0	21	100
2007/08	21	100.0	0	0.0	0	0.0	21	100
2008/09	21	100.0	0	0.0	0	0.0	21	100
2009/10	20	100.0	0	0.0	0	0.0	20	100
2010/11	18	90.0	1	5.0	1	5.0	20	100
Total	196	93.3	12	5.7	2	1.0	210	
WAIKANAE RIVER AT STATE HIGHWAY 1								
2001/02	17	81.0	2	9.5	2	9.5	21	100
2002/03	19	90.5	1	4.8	1	4.8	21	100
2003/04	16	76.2	2	9.5	3	14.3	21	100
2004/05	20	90.9	1	4.5	1	4.5	22	100
2005/06	19	86.4	3	13.6	0	0.0	22	100
2006/07	19	90.5	1	4.8	1	4.8	21	100
2007/08	20	95.2	1	4.8	0	0.0	21	100
2008/09	20	95.2	0	0.0	1	4.8	21	100
2009/10	18	90.0	1	5.0	1	5.0	20	100
2010/11	19	95.0	1	5.0	0	0.0	20	100
Total	187	89.0	13	6.2	10	4.8	210	

Bathing season	Surveillance		Alert		Action		Total	
	No.	%	No.	%	No.	%	No.	%
WAIKANAE RIVER AT JIM COOKE PARK								
2001/02	NS	-	NS	-	NS	-	-	-
2002/03	NS	-	NS	-	NS	-	-	-
2003/04	NS	-	NS	-	NS	-	-	-
2004/05	NS	-	NS	-	NS	-	-	-
2005/06	NS	-	NS	-	NS	-	-	-
2006/07	NS	-	NS	-	NS	-	-	-
2007/08	21	100.0	0	0.0	0	0.0	21	100
2008/09	19	90.5	1	4.8	1	4.8	21	100
2009/10	17	85.0	2	10.0	1	5.0	20	100
2010/11	19	95.0	1	5.0	0	0.0	20	100
Total	76	92.7	4	4.9	2	2.4	82	

(ii) Hutt River catchment

Bathing season	Surveillance		Alert		Action		Total	
	No.	%	No.	%	No.	%	No.	%
PAKURATAHI RIVER AT FORKS								
2001/02	17	81.0	2	9.5	2	9.5	21	100
2002/03	19	90.5	1	4.8	1	4.8	21	100
2003/04	19	86.4	1	4.5	2	9.1	22	100
2004/05	18	81.8	3	13.6	1	4.5	22	100
2005/06	17	81.0	4	19.0	0	0.0	21	100
2006/07	19	90.5	0	0.0	2	9.5	21	100
2007/08	19	90.5	1	4.8	1	4.8	21	100
2008/09	18	85.7	1	4.8	2	9.5	21	100
2009/10	19	95.0	0	0.0	1	5.0	20	100
2010/11	19	95.0	1	5.0	0	0.0	20	100
Total	184	87.6	14	6.7	12	5.7	210	
HUTT RIVER AT BIRCHVILLE								
2001/02	14	66.7	4	19.0	3	14.3	21	100
2002/03	19	90.5	1	4.8	1	4.8	21	100
2003/04	18	81.8	1	4.5	3	13.6	22	100
2004/05	15	68.2	5	22.7	2	9.1	22	100
2005/06	18	85.7	1	4.8	2	9.5	21	100
2006/07	20	95.2	0	0.0	1	4.8	21	100
2007/08	19	90.5	1	4.8	1	4.8	21	100
2008/09	18	85.7	1	4.8	2	9.5	21	100
2009/10	18	90.0	0	0.0	2	10.0	20	100
2010/11	18	90.0	1	5.0	1	5.0	20	100
Total	177	84.3	15	7.1	18	8.6	210	
HUTT RIVER AT MAORIBANK CORNER								
2001/02	16	76.2	3	14.3	2	9.5	21	100
2002/03	19	90.5	1	4.8	1	4.8	21	100
2003/04	17	77.3	2	9.1	3	13.6	22	100
2004/05	18	81.8	3	13.6	1	4.5	22	100
2005/06	18	85.7	0	0.0	3	14.3	21	100
2006/07	19	90.5	1	4.8	1	4.8	21	100
2007/08	19	90.5	0	0.0	2	9.5	21	100
2008/09	18	85.7	1	4.8	2	9.5	21	100
2009/10	18	90.0	1	5.0	1	5.0	20	100
2010/11	18	90.0	0	0.0	2	10.0	20	100
Total	180	85.7	12	5.7	18	8.6	210	
HUTT RIVER AT POETS PARK								
2001/02	18	85.7	2	9.5	1	4.8	21	100
2002/03	20	95.2	0	0.0	1	4.8	21	100

Bathing season	Surveillance		Alert		Action		Total	
	No.	%	No.	%	No.	%	No.	%
2003/04	20	90.9	0	0.0	2	9.1	22	100
2004/05	20	90.9	1	4.5	1	4.5	22	100
2005/06	17	81.0	3	14.3	1	4.8	21	100
2006/07	19	90.5	1	4.8	1	4.8	21	100
2007/08	20	95.2	0	0.0	1	4.8	21	100
2008/09	19	90.5	0	0.0	2	9.5	21	100
2009/10	19	95.0	1	5.0	0	0.0	20	100
2010/11	19	95.0	1	5.0	0	0.0	20	100
Total	191	91.0	9	4.3	10	4.8	210	
HUTT RIVER AT SILVERSTREAM								
2001/02	15	71.4	3	14.3	3	14.3	21	100
2002/03	19	90.5	0	0.0	2	9.5	21	100
2003/04	15	68.2	4	18.2	3	13.6	22	100
2004/05	19	86.4	2	9.1	1	4.5	22	100
2005/06	9	42.9	6	28.6	6	28.6	21	100
2006/07	18	85.7	0	0.0	3	14.3	21	100
2007/08	18	85.7	2	9.5	1	4.8	21	100
2008/09	15	71.4	2	9.5	4	19.0	21	100
2009/10	19	95.0	1	5.0	0	0.0	20	100
2010/11	18	90.0	0	0.0	2	10.0	20	100
Total	165	78.6	20	9.5	25	11.9	210	
HUTT RIVER AT BOULCOTT								
2001/02	16	76.2	1	4.8	4	19.0	21	100
2002/03	20	95.2	0	0.0	1	4.8	21	100
2003/04	16	72.7	4	18.2	2	9.1	22	100
2004/05	18	81.8	2	9.1	2	9.1	22	100
2005/06	14	66.7	4	19.0	3	14.3	21	100
2006/07	18	85.7	0	0.0	3	14.3	21	100
2007/08	12	57.1	6	28.6	3	14.3	21	100
2008/09	18	85.7	0	0.0	3	14.3	21	100
2009/10	19	95.0	0	0.0	1	5.0	20	100
2010/11	18	90.0	0	0.0	2	10.0	20	100
Total	169	80.5	17	8.1	24	11.4	210	
WAINUIOMATA RIVER AT RICHARD PROUSE PARK								
2001/02	NS	-	NS	-	NS	-	-	-
2002/03	NS	-	NS	-	NS	-	-	-
2003/04	NS	-	NS	-	NS	-	-	-
2004/05	NS	-	NS	-	NS	-	-	-
2005/06	NS	-	NS	-	NS	-	-	-
2006/07	NS	-	NS	-	NS	-	-	-
2007/08	18	85.7	1	4.8	2	9.5	21	100
2008/09	17	81.0	0	0.0	4	19.0	21	100
2009/10	19	95.0	0	0.0	1	5.0	20	100
2010/11	17	85.0	2	10.0	1	5.0	20	100
Total	71	86.6	3	3.7	8	9.8	82	

(iii) Wairarapa

Bathing season	Surveillance		Alert		Action		Total	
	No.	%	No.	%	No.	%	No.	%
RUAMAHANGA RIVER AT DOUBLE BRIDGES								
2001/02	18	90.0	1	5.0	1	5.0	20	100
2002/03	16	76.2	4	19.0	1	4.8	21	100
2003/04	15	75.0	3	15.0	2	10.0	20	100
2004/05	10	47.6	8	38.1	3	14.3	21	100
2005/06	16	76.2	3	14.3	2	9.5	21	100
2006/07	19	90.5	1	4.8	1	4.8	21	100
2007/08	19	90.5	0	0.0	2	9.5	21	100
2008/09	21	100.0	0	0.0	0	0.0	21	100
2009/10	19	95.0	0	0.0	1	5.0	20	100
2010/11	20	100.0	0	0.0	0	0.0	20	100
Total	173	84.0	20	9.7	13	6.3	206	
RUAMAHANGA RIVER AT TE ORE ORE								
2001/02	12	60.0	4	20.0	4	20.0	20	100
2002/03	20	95.2	1	4.8	0	0.0	21	100
2003/04	14	70.0	4	20.0	2	10.0	20	100
2004/05	17	81.0	1	4.8	3	14.3	21	100
2005/06	13	61.9	6	28.6	2	9.5	21	100
2006/07	15	71.4	1	4.8	5	23.8	21	100
2007/08	19	90.5	1	4.8	1	4.8	21	100
2008/09	20	95.2	0	0.0	1	4.8	21	100
2009/10	18	90.0	1	5.0	1	5.0	20	100
2010/11	18	90.0	1	5.0	1	5.0	20	100
Total	166	80.6	20	9.7	20	9.7	206	
RUAMAHANGA RIVER AT THE CLIFFS								
2001/02	14	70.0	3	15.0	3	15.0	20	100
2002/03	21	100.0	0	0.0	0	0.0	21	100
2003/04	16	80.0	1	5.0	3	15.0	20	100
2004/05	18	85.7	2	9.5	1	4.8	21	100
2005/06	19	90.5	0	0.0	2	9.5	21	100
2006/07	19	90.5	0	0.0	2	9.5	21	100
2007/08	20	95.2	0	0.0	1	4.8	21	100
2008/09	20	95.2	1	4.8	0	0.0	21	100
2009/10	20	100.0	0	0.0	0	0.0	20	100
2010/11	17	85.0	1	5.0	2	10.0	20	100
Total	184	89.3	8	3.9	14	6.8	206	
RUAMAHANGA RIVER AT KOKOTAU								
2001/02	13	65.0	2	10.0	5	25.0	20	100
2002/03	20	95.2	1	4.8	0	0.0	21	100
2003/04	16	80.0	1	5.0	3	15.0	20	100
2004/05	18	85.7	3	14.3	0	0.0	21	100
2005/06	17	81.0	2	9.5	2	9.5	21	100
2006/07	17	81.0	2	9.5	2	9.5	21	100
2007/08	19	90.5	0	0.0	2	9.5	21	100
2008/09	20	95.2	1	4.8	0	0.0	21	100
2009/10	16	80.0	1	5.0	3	15.0	20	100
2010/11	18	90.0	0	0.0	2	10.0	20	100
Total	174	84.5	13	6.3	19	9.2	206	
RUAMAHANGA RIVER AT MORRISONS BUSH								
2001/02	14	70.0	1	5.0	5	25.0	20	100
2002/03	20	95.2	1	4.8	0	0.0	21	100
2003/04	15	75.0	3	15.0	2	10.0	20	100

Bathing season	Surveillance		Alert		Action		Total	
	No.	%	No.	%	No.	%	No.	%
2004/05	20	95.2	0	0.0	1	4.8	21	100
2005/06	19	90.5	0	0.0	2	9.5	21	100
2006/07	20	95.2	1	4.8	0	0.0	21	100
2007/08	18	85.7	2	9.5	1	4.8	21	100
2008/09	20	95.2	1	4.8	0	0.0	21	100
2009/10	18	90.0	1	5.0	1	5.0	20	100
2010/11	17	85.0	1	5.0	2	10.0	20	100
Total	181	87.9	11	5.3	14	6.8	206	
RUAMAHANGA RIVER AT WAIHENGA								
2001/02	14	70.0	2	10.0	4	20.0	20	100
2002/03	18	85.7	2	9.5	1	4.8	21	100
2003/04	14	70.0	3	15.0	3	15.0	20	100
2004/05	20	95.2	1	4.8	0	0.0	21	100
2005/06	17	81.0	2	9.5	2	9.5	21	100
2006/07	19	90.5	0	0.0	2	9.5	21	100
2007/08	18	85.7	2	9.5	1	4.8	21	100
2008/09	21	100.0	0	0.0	0	0.0	21	100
2009/10	18	90.0	0	0.0	2	10.0	20	100
2010/11	17	85.0	1	5.0	2	10.0	20	100
Total	176	85.4	13	6.3	17	8.3	206	
RUAMAHANGA RIVER AT BENTLEYS BEACH								
2001/02	NS	-	NS	-	NS	-	-	-
2002/03	13	86.7	2	13.3	0	0.0	15	100
2003/04	15	75.0	1	5.0	4	20.0	20	100
2004/05	17	81.0	3	14.3	1	4.8	21	100
2005/06	16	76.2	2	9.5	3	14.3	21	100
2006/07	19	90.5	1	4.8	1	4.8	21	100
2007/08	18	85.7	1	4.8	2	9.5	21	100
2008/09	19	90.5	1	4.8	1	4.8	21	100
2009/10	18	90.0	1	5.0	1	5.0	20	100
2010/11	17	85.0	1	5.0	2	10.0	20	100
Total	152	84.4	13	7.2	15	8.3	180	
WAIPOUA RIVER AT COLOMBO ROAD								
2001/02	NS	-	NS	-	NS	-	-	-
2002/03	19	90.5	1	4.8	1	4.8	21	100
2003/04	10	50.0	3	15.0	7	35.0	20	100
2004/05	18	85.7	2	9.5	1	4.8	21	100
2005/06	16	76.2	3	14.3	2	9.5	21	100
2006/07	18	85.7	2	9.5	1	4.8	21	100
2007/08	18	85.7	2	9.5	1	4.8	21	100
2008/09	21	100.0	0	0.0	0	0.0	21	100
2009/10	19	95.0	0	0.0	1	5.0	20	100
2010/11	17	85.0	0	0.0	3	15.0	20	100
Total	156	83.9	13	7.0	17	9.1	186	
WAINGAWA RIVER AT KAITUNA								
2001/02	20	100.0	0	0.0	0	0.0	20	100
2002/03	21	100.0	0	0.0	0	0.0	21	100
2003/04	17	85.0	2	10.0	1	5.0	20	100
2004/05	19	90.5	2	9.5	0	0.0	21	100
2005/06	21	100.0	0	0.0	0	0.0	21	100
2006/07	19	90.5	1	4.8	1	4.8	21	100
2007/08	20	95.2	1	4.8	0	0.0	21	100
2008/09	21	100.0	0	0.0	0	0.0	21	100
2009/10	20	100.0	0	0.0	0	0.0	20	100

Bathing season	Surveillance		Alert		Action		Total	
	No.	%	No.	%	No.	%	No.	%
2010/11	20	100.0	0	0.0	0	0.0	20	100
Total	198	96.1	6	2.9	2	1.0	206	
WAINGAWA RIVER AT SOUTH ROAD								
2001/02	19	95.0	1	5.0	0	0.0	20	100
2002/03	21	100.0	0	0.0	0	0.0	21	100
2003/04	18	90.0	0	0.0	2	10.0	20	100
2004/05	19	90.5	1	4.8	1	4.8	21	100
2005/06	20	95.2	1	4.8	0	0.0	21	100
2006/07	20	95.2	1	4.8	0	0.0	21	100
2007/08	21	100.0	0	0.0	0	0.0	21	100
2008/09	21	100.0	0	0.0	0	0.0	21	100
2009/10	20	100.0	0	0.0	0	0.0	20	100
2010/11	18	90.0	0	0.0	2	10.0	20	100
Total	197	95.6	4	1.9	5	2.4	206	
WAIOHINE RIVER AT GORGE								
2001/02	19	95.0	1	5.0	0	0.0	20	100
2002/03	21	100.0	0	0.0	0	0.0	21	100
2003/04	19	95.0	1	5.0	0	0.0	20	100
2004/05	21	100.0	0	0.0	0	0.0	21	100
2005/06	21	100.0	0	0.0	0	0.0	21	100
2006/07	5	100.0	0	0.0	0	0.0	5	100
2007/08	5	100.0	0	0.0	0	0.0	5	100
2008/09	5	100.0	0	0.0	0	0.0	5	100
2009/10	5	100.0	0	0.0	0	0.0	5	100
2010/11	4	80	0	0	1	20	5	4
Total	125	97.7	2	1.6	1	0.8	128	125
WAIOHINE RIVER AT STATE HIGHWAY 2								
2001/02	20	100.0	0	0.0	0	0.0	20	100
2002/03	21	100.0	0	0.0	0	0.0	21	100
2003/04	18	90.0	0	0.0	2	10.0	20	100
2004/05	21	100.0	0	0.0	0	0.0	21	100
2005/06	20	95.2	1	4.8	0	0.0	21	100
2006/07	21	100.0	0	0.0	0	0.0	21	100
2007/08	20	95.2	0	0.0	1	4.8	21	100
2008/09	21	100.0	0	0.0	0	0.0	21	100
2009/10	20	100.0	0	0.0	0	0.0	20	100
2010/11	19	95.0	0	0.0	1	5.0	20	100
Total	201	97.6	1	0.5	4	1.9	206	

(b) Recreational water quality in coastal waters

Analysis of enterococci counts obtained from routine weekly monitoring during the 2001/02 to 2010/11 summer bathing seasons against the MfE/MoH (2003) surveillance, alert and action levels for coastal recreational waters. Although this report focused on the 2005/06 to 2009/10 seasons, results from earlier seasons are included for completeness of record while results from the 2010/11 summer bathing season are included as they were used by Greenfield et al. (2012) to calculate updated SFRGs.

(i) Kapiti Coast

Bathing season	Surveillance		Alert		Action		Total	
	No.	%	No.	%	No.	%	No.	%
OTAKI BEACH AT SURF CLUB								
2001/02	20	95.2	1	4.8	0	0.0	21	100
2002/03	21	100.0	0	0.0	0	0.0	21	100
2003/04	20	95.2	0	0.0	1	4.8	21	100
2004/05	21	95.5	0	0.0	1	4.5	22	100
2005/06	20	90.9	2	9.1	0	0.0	22	100
2006/07	19	90.5	1	4.8	1	4.8	21	100
2007/08	20	95.2	0	0.0	1	4.8	21	100
2008/09	20	95.2	0	0.0	1	4.8	21	100
2009/10	19	95.0	1	5.0	0	0.0	20	100
2010/11	19	95.0	0	0.0	1	5.0	20	100
Total/average	199	94.8	5	2.4	6	2.9	210	
OTAKI BEACH AT RANGIURU ROAD								
2001/02	19	90.5	2	9.5	0	0.0	21	100
2002/03	21	100.0	0	0.0	0	0.0	21	100
2003/04	19	90.5	1	4.8	1	4.8	21	100
2004/05	20	90.9	0	0.0	2	9.1	22	100
2005/06	20	90.9	1	4.5	1	4.5	22	100
2006/07	19	90.5	0	0.0	2	9.5	21	100
2007/08	20	95.2	1	4.8	0	0.0	21	100
2008/09	21	100.0	0	0.0	0	0.0	21	100
2009/10	19	95.0	0	0.0	1	5.0	20	100
2010/11	19	95.0	0	0.0	1	5.0	20	100
Total/average	197	93.8	5	2.4	8	3.8	210	
TE HORO BEACH SOUTH OF MANGAONE STREAM								
2001/02	19	90.5	1	4.8	1	4.8	21	100
2002/03	21	100.0	0	0.0	0	0.0	21	100
2003/04	18	85.7	0	0.0	3	14.3	21	100
2004/05	18	81.8	2	9.1	2	9.1	22	100
2005/06	18	81.8	1	4.5	3	13.6	22	100
2006/07	16	76.2	4	19.0	1	4.8	21	100
2007/08	19	90.5	0	0.0	2	9.5	21	100
2008/09	21	100.0	0	0.0	0	0.0	21	100
2009/10	18	90.0	0	0.0	2	10.0	20	100
2010/11	16	80.0	2	10.0	2	10.0	20	100
Total/average	184	87.6	10	4.8	16	7.6	210	
TE HORO BEACH AT KITCHENER STREET								
2001/02	19	90.5	2	9.5	0	0.0	21	100
2002/03	21	100.0	0	0.0	0	0.0	21	100
2003/04	18	85.7	1	4.8	2	9.5	21	100
2004/05	21	95.5	0	0.0	1	4.5	22	100
2005/06	20	90.9	1	4.5	1	4.5	22	100
2006/07	19	90.5	1	4.8	1	4.8	21	100
2007/08	20	95.2	0	0.0	1	4.8	21	100

Bathing season	Surveillance		Alert		Action		Total	
	No.	%	No.	%	No.	%	No.	%
2008/09	21	100.0	0	0.0	0	0.0	21	100
2009/10	19	95.0	0	0.0	1	5.0	20	100
2010/11	18	90.0	0	0.0	2	10.0	20	100
Total/average	196	93.3	5	2.4	9	4.3	210	
PEKA PEKA BEACH								
2001/02	21	100.0	0	0.0	0	0.0	21	100
2002/03	21	100.0	0	0.0	0	0.0	21	100
2003/04	20	95.2	0	0.0	1	4.8	21	100
2004/05	21	95.5	1	4.5	0	0.0	22	100
2005/06	21	95.5	1	4.5	0	0.0	22	100
2006/07	20	95.2	0	0.0	1	4.8	21	100
2007/08	20	95.2	1	4.8	0	0.0	21	100
2008/09	21	100.0	0	0.0	0	0.0	21	100
2009/10	19	95.0	0	0.0	1	5.0	20	100
2010/11	19	95.0	0	0.0	1	5.0	20	100
Total/average	203	96.7	3	1.4	4	1.9	210	
WAIKANAE BEACH AT WILLIAM STREET								
2001/02	21	100.0	0	0.0	0	0.0	21	100
2002/03	21	100.0	0	0.0	0	0.0	21	100
2003/04	18	85.7	2	9.5	1	4.8	21	100
2004/05	21	95.5	0	0.0	1	4.5	22	100
2005/06	20	90.9	1	4.5	1	4.5	22	100
2006/07	21	100.0	0	0.0	0	0.0	21	100
2007/08	20	95.2	1	4.8	0	0.0	21	100
2008/09	21	100.0	0	0.0	0	0.0	21	100
2009/10	19	95.0	0	0.0	1	5.0	20	100
2010/11	18	90.0	1	5.0	1	5.0	20	100
Total/average	200	95.2	5	2.4	5	2.4	210	
WAIKANAE BEACH AT TUTERE STREET TENNIS COURTS								
2001/02	21	100.0	0	0.0	0	0.0	21	100
2002/03	21	100.0	0	0.0	0	0.0	21	100
2003/04	19	90.5	0	0.0	2	9.5	21	100
2004/05	21	95.5	0	0.0	1	4.5	22	100
2005/06	20	90.9	2	9.1	0	0.0	22	100
2006/07	21	100.0	0	0.0	0	0.0	21	100
2007/08	20	95.2	1	4.8	0	0.0	21	100
2008/09	21	100.0	0	0.0	0	0.0	21	100
2009/10	18	90.0	1	5.0	1	5.0	20	100
2010/11	19	95.0	0	0.0	1	5.0	20	100
Total/average	201	95.7	4	1.9	5	2.4	210	
WAIKANAE BEACH AT ARA KUAKA CARPARK								
2001/02	20	95.2	1	4.8	0	0.0	21	100
2002/03	21	100.0	0	0.0	0	0.0	21	100
2003/04	18	85.7	1	4.8	2	9.5	21	100
2004/05	21	95.5	0	0.0	1	4.5	22	100
2005/06	19	86.4	1	4.5	2	9.1	22	100
2006/07	20	95.2	1	4.8	0	0.0	21	100
2007/08	20	95.2	0	0.0	1	4.8	21	100
2008/09	21	100.0	0	0.0	0	0.0	21	100
2009/10	19	95.0	0	0.0	1	5.0	20	100
2010/11	20	100.0	0	0.0	0	0.0	20	100
Total/average	199	94.8	4	1.9	7	3.3	210	

Bathing season	Surveillance		Alert		Action		Total	
	No.	%	No.	%	No.	%	No.	%
PARAPARAUMU BEACH AT NGAPOTIKI STREET								
2001/02	18	85.7	2	9.5	1	4.8	21	100
2002/03	18	85.7	1	4.8	2	9.5	21	100
2003/04	20	95.2	1	4.8	0	0.0	21	100
2004/05	19	86.4	3	13.6	0	0.0	22	100
2005/06	16	72.7	1	4.5	5	22.7	22	100
2006/07	18	85.7	2	9.5	1	4.8	21	100
2007/08	19	90.5	1	4.8	1	4.8	21	100
2008/09	21	100.0	0	0.0	0	0.0	21	100
2009/10	18	90.0	1	5.0	1	5.0	20	100
2010/11	19	95.0	1	5.0	0	0.0	20	100
Total/average	186	88.6	13	6.2	11	5.2	210	
PARAPARAUMU BEACH AT NATHAN AVENUE								
2001/02	19	90.5	1	4.8	1	4.8	21	100
2002/03	19	90.5	2	9.5	0	0.0	21	100
2003/04	20	95.2	0	0.0	1	4.8	21	100
2004/05	19	86.4	2	9.1	1	4.5	22	100
2004/06	17	77.3	2	9.1	3	13.6	22	100
2006/07	21	100.0	0	0.0	0	0.0	21	100
2007/08	18	85.7	1	4.8	2	9.5	21	100
2008/09	20	95.2	1	4.8	0	0.0	21	100
2009/10	18	90.0	1	5.0	1	5.0	20	100
2010/11	19	95.0	1	5.0	0	0.0	20	100
Total/average	190	90.5	11	5.2	9	4.3	210	
PARAPARAUMU BEACH AT MACLEAN PARK								
2001/02	18	85.7	3	14.3	0	0.0	21	100
2002/03	19	90.5	2	9.5	0	0.0	21	100
2003/04	18	85.7	2	9.5	1	4.8	21	100
2004/05	19	86.4	1	4.5	2	9.1	22	100
2004/06	18	81.8	2	9.1	2	9.1	22	100
2006/07	19	90.5	0	0.0	2	9.5	21	100
2007/08	19	90.5	2	9.5	0	0.0	21	100
2008/09	19	90.5	2	9.5	0	0.0	21	100
2009/10	19	95.0	1	5.0	0	0.0	20	100
2010/11	18	90.0	1	5.0	1	5.0	20	100
Total/average	186	88.6	16	7.6	8	3.8	210	
PARAPARAUMU BEACH AT TORU ROAD								
2001/02	19	90.5	2	9.5	0	0.0	21	100
2002/03	19	90.5	2	9.5	0	0.0	21	100
2003/04	20	95.2	0	0.0	1	4.8	21	100
2004/05	20	90.9	1	4.5	1	4.5	22	100
2005/06	18	81.8	0	0.0	4	18.2	22	100
2006/07	21	100.0	0	0.0	0	0.0	21	100
2007/08	21	100.0	0	0.0	0	0.0	21	100
2008/09	20	95.2	1	4.8	0	0.0	21	100
2009/10	18	90.0	0	0.0	2	10.0	20	100
2010/11	18	90.0	1	5.0	1	5.0	20	100
Total/average	194	92.4	7	3.3	9	4.3	210	
PARAPARAUMU BEACH AT WHAREMAUKU ROAD								
2001/02	19	90.5	2	9.5	0	0.0	21	100
2002/03	20	95.2	1	4.8	0	0.0	21	100
2003/04	20	95.2	0	0.0	1	4.8	21	100
2004/05	21	95.5	0	0.0	1	4.5	22	100
2005/06	19	86.4	1	4.5	2	9.1	22	100
2006/07	21	100.0	0	0.0	0	0.0	21	100
2007/08	19	90.5	2	9.5	0	0.0	21	100

Bathing season	Surveillance		Alert		Action		Total	
	No.	%	No.	%	No.	%	No.	%
2008/09	21	100.0	0	0.0	0	0.0	21	100
2009/10	17	85.0	3	15.0	0	0.0	20	100
2010/11	19	95.0	0	0.0	1	5.0	20	100
Total/average	196	93.3	9	4.3	5	2.4	210	
RAUMATI BEACH AT TAINUI STREET								
2001/02	20	95.2	0	0.0	1	4.8	21	100
2002/03	20	95.2	1	4.8	0	0.0	21	100
2003/04	19	90.5	0	0.0	2	9.5	21	100
2004/05	22	100.0	0	0.0	0	0.0	22	100
2005/06	19	86.4	1	4.5	2	9.1	22	100
2006/07	21	100.0	0	0.0	0	0.0	21	100
2007/08	19	90.5	1	4.8	1	4.8	21	100
2008/09	21	100.0	0	0.0	0	0.0	21	100
2009/10	20	100.0	0	0.0	0	0.0	20	100
2010/11	19	95.0	0	0.0	1	5.0	20	100
Total/average	200	95.2	3	1.4	7	3.3	210	
RAUMATI BEACH AT MARINE GARDENS								
2001/02	18	85.7	3	14.3	0	0.0	21	100
2002/03	18	85.7	3	14.3	0	0.0	21	100
2003/04	16	76.2	4	19.0	1	4.8	21	100
2004/05	21	95.5	0	0.0	1	4.5	22	100
2005/06	19	86.4	1	4.5	2	9.1	22	100
2006/07	20	95.2	1	4.8	0	0.0	21	100
2007/08	19	90.5	0	0.0	2	9.5	21	100
2008/09	19	90.5	2	9.5	0	0.0	21	100
2009/10	19	95.0	0	0.0	1	5.0	20	100
2010/11	18	90.0	0	0.0	2	10.0	20	100
Total/average	187	89.0	14	6.7	9	4.3	210	
RAUMATI BEACH AT AOTEA STREET								
2001/02	20	95.2	1	4.8	0	0.0	21	100
2002/03	21	100.0	0	0.0	0	0.0	21	100
2003/04	19	90.5	0	0.0	2	9.5	21	100
2004/05	22	100.0	0	0.0	0	0.0	22	100
2005/06	20	90.9	1	4.5	1	4.5	22	100
2006/07	21	100.0	0	0.0	0	0.0	21	100
2007/08	19	90.5	1	4.8	1	4.8	21	100
2008/09	21	100.0	0	0.0	0	0.0	21	100
2009/10	19	95.0	0	0.0	1	5.0	20	100
2010/11	18	90.0	2	10.0	0	0.0	20	100
Total/average	200	95.2	5	2.4	5	2.4	210	
RAUMATI BEACH AT HYDES ROAD								
2001/02	21	100.0	0	0.0	0	0.0	21	100
2002/03	21	100.0	0	0.0	0	0.0	21	100
2003/04	18	85.7	1	4.8	2	9.5	21	100
2004/05	20	90.9	0	0.0	2	9.1	22	100
2005/06	18	81.8	3	13.6	1	4.5	22	100
2006/07	21	100.0	0	0.0	0	0.0	21	100
2007/08	19	90.5	2	9.5	0	0.0	21	100
2008/09	21	100.0	0	0.0	0	0.0	21	100
2009/10	19	95.0	1	5.0	0	0.0	20	100
2010/11	18	90.0	1	5.0	1	5.0	20	100
Total/average	196	93.3	8	3.8	6	2.9	210	
PAEKAKARIKI BEACH AT WHAREROA ROAD								
2001/02	20	95.2	1	4.8	0	0.0	21	100
2002/03	21	100.0	0	0.0	0	0.0	21	100
2003/04	19	90.5	2	9.5	0	0.0	21	100

Bathing season	Surveillance		Alert		Action		Total	
	No.	%	No.	%	No.	%	No.	%
2004/05	21	95.5	0	0.0	1	4.5	22	100
2005/06	22	100.0	0	0.0	0	0.0	22	100
2006/07	21	100.0	0	0.0	0	0.0	21	100
2007/08	21	100.0	0	0.0	0	0.0	21	100
2008/09	21	100.0	0	0.0	0	0.0	21	100
2009/10	19	95.0	1	5.0	0	0.0	20	100
2010/11	20	100.0	0	0.0	0	0.0	20	100
Total/average	205	97.6	4	1.9	1	0.5	210	
PAEKAKARIKI BEACH AT SURF CLUB								
2001/02	21	100.0	0	0.0	0	0.0	21	100
2002/03	21	100.0	0	0.0	0	0.0	21	100
2003/04	21	100.0	0	0.0	0	0.0	21	100
2004/05	22	100.0	0	0.0	0	0.0	22	100
2005/06	22	100.0	0	0.0	0	0.0	22	100
2006/07	21	100.0	0	0.0	0	0.0	21	100
2007/08	21	100.0	0	0.0	0	0.0	21	100
2008/09	21	100.0	0	0.0	0	0.0	21	100
2009/10	19	95.0	0	0.0	1	5.0	20	100
2010/11	19	95.0	0	0.0	1	5.0	20	100
Total/average	208	99.0	0	0.0	2	1.0	210	
PAEKAKARIKI BEACH AT MEMORIAL HALL								
2001/02	20	95.2	1	4.8	0	0.0	21	100
2002/03	21	100.0	0	0.0	0	0.0	21	100
2003/04	21	100.0	0	0.0	0	0.0	21	100
2004/05	21	95.5	0	0.0	1	4.5	22	100
2005/06	22	100.0	0	0.0	0	0.0	22	100
2006/07	21	100.0	0	0.0	0	0.0	21	100
2007/08	21	100.0	0	0.0	0	0.0	21	100
2008/09	21	100.0	0	0.0	0	0.0	21	100
2009/10	20	100.0	0	0.0	0	0.0	20	100
2010/11	19	95.0	1	5.0	0	0.0	20	100
Total/average	207	98.6	2	1.0	1	0.5	210	

(ii) Porirua city

Bathing season	Surveillance		Alert		Action		Total	
	No.	%	No.	%	No.	%	No.	%
PUKERUA BAY								
2001/02	18	90.0	1	5.0	1	5.0	20	100
2002/03	21	100.0	0	0.0	0	0.0	21	100
2003/04	19	90.5	0	0.0	2	9.5	21	100
2004/05	22	100.0	0	0.0	0	0.0	22	100
2005/06	22	100.0	0	0.0	0	0.0	22	100
2006/07	19	90.5	1	4.8	1	4.8	21	100
2007/08	20	95.2	0	0.0	1	4.8	21	100
2008/09	20	95.2	0	0.0	1	4.8	21	100
2009/10	19	95.0	0	0.0	1	5.0	20	100
2010/11	19	95.0	0	0.0	1	5.0	20	100
Total/average	199	95.2	2	1.0	8	3.8	209	

Bathing season	Surveillance		Alert		Action		Total	
	No.	%	No.	%	No.	%	No.	%
KAREHANA BAY								
2001/02	17	81.0	1	4.8	3	14.3	21	100
2002/03	21	100.0	0	0.0	0	0.0	21	100
2003/04	18	85.7	2	9.5	1	4.8	21	100
2004/05	21	95.5	1	4.5	0	0.0	22	100
2005/06	22	100.0	0	0.0	0	0.0	22	100
2006/07	18	85.7	2	9.5	1	4.8	21	100
2007/08	20	95.2	1	4.8	0	0.0	21	100
2008/09	17	81.0	2	9.5	2	9.5	21	100
2009/10	18	90.0	0	0.0	2	10.0	20	100
2010/11	20	100.0	0	0.0	0	0.0	20	100
Total/average	192	91.4	9	4.3	9	4.3	210	
PLIMMERTON BEACH AT BATH STREET								
2001/02	18	85.7	1	4.8	2	9.5	21	100
2002/03	19	90.5	1	4.8	1	4.8	21	100
2003/04	16	76.2	2	9.5	3	14.3	21	100
2004/05	20	90.9	1	4.5	1	4.5	22	100
2005/06	22	100.0	0	0.0	0	0.0	22	100
2006/07	18	85.7	1	4.8	2	9.5	21	100
2007/08	21	100.0	0	0.0	0	0.0	21	100
2008/09	19	90.5	0	0.0	2	9.5	21	100
2009/10	19	95.0	1	5.0	0	0.0	20	100
2010/11	17	85.0	1	5.0	2	10.0	20	100
Total/average	189	90.0	8	3.8	13	6.2	210	
PLIMMERTON BEACH AT QUEENS AVENUE								
2001/02	17	81.0	2	9.5	2	9.5	21	100
2002/03	19	90.5	2	9.5	0	0.0	21	100
2003/04	19	90.5	0	0.0	2	9.5	21	100
2004/05	20	90.9	2	9.1	0	0.0	22	100
2005/06	22	100.0	0	0.0	0	0.0	22	100
2006/07	18	85.7	1	4.8	2	9.5	21	100
2007/08	20	95.2	1	4.8	0	0.0	21	100
2008/09	19	90.5	1	4.8	1	4.8	21	100
2009/10	NS	-	NS	-	NS	-	-	-
2010/11	NS	-	NS	-	NS	-	-	-
Total/average	154	90.6	9	5.3	7	4.1	170	
SOUTH BEACH AT PLIMMERTON								
2001/02	17	81.0	1	4.8	3	14.3	21	100
2002/03	18	85.7	0	0.0	3	14.3	21	100
2003/04	18	85.7	0	0.0	3	14.3	21	100
2004/05	19	86.4	1	4.5	2	9.1	22	100
2005/06	22	100.0	0	0.0	0	0.0	22	100
2006/07	16	76.2	2	9.5	3	14.3	21	100
2007/08	20	95.2	0	0.0	1	4.8	21	100
2008/09	16	76.2	2	9.5	3	14.3	21	100
2009/10	13	65.0	3	15.0	4	20.0	20	100
2010/11	16	80.0	1	5.0	3	15.0	20	100
Total/average	175	83.3	10	4.8	25	11.9	210	
PAUATAHANUI INLET AT WATER SKI CLUB								
2001/02	19	90.5	0	0.0	2	9.5	21	100
2002/03	21	100.0	0	0.0	0	0.0	21	100
2003/04	17	81.0	1	4.8	3	14.3	21	100
2004/05	20	90.9	1	4.5	1	4.5	22	100
2005/06	22	100.0	0	0.0	0	0.0	22	100
2006/07	20	95.2	0	0.0	1	4.8	21	100
2007/08	21	100.0	0	0.0	0	0.0	21	100

Bathing season	Surveillance		Alert		Action		Total	
	No.	%	No.	%	No.	%	No.	%
2008/09	16	76.2	2	9.5	3	14.3	21	100
2009/10	19	95.0	0	0.0	1	5.0	20	100
2010/11	17	85.0	3	15.0	0	0.0	20	100
Total/average	192	91.4	7	3.3	11	5.2	210	
PAUATAHANUI INLET AT MOTUKARAKA POINT								
2001/02	18	85.7	0	0.0	3	14.3	21	100
2002/03	19	90.5	2	9.5	0	0.0	21	100
2003/04	19	90.5	1	4.8	1	4.8	21	100
2004/05	21	95.5	1	4.5	0	0.0	22	100
2005/06	22	100.0	0	0.0	0	0.0	22	100
2006/07	19	90.5	1	4.8	1	4.8	21	100
2007/08	20	95.2	1	4.8	0	0.0	21	100
2008/09	17	81.0	3	14.3	1	4.8	21	100
2009/10	19	95.0	1	5.0	0	0.0	20	100
2010/11	18	90.0	1	5.0	1	5.0	20	100
Total/average	192	91.4	11	5.2	7	3.3	210	
PAUATAHANUI INLET AT BROWNS BAY								
2001/02	NS	-	NS	-	NS	-	-	100
2002/03	17	81.0	1	4.8	3	14.3	21	100
2003/04	12	57.1	3	14.3	6	28.6	21	100
2004/05	21	95.5	1	4.5	0	0.0	22	100
2005/06	21	95.5	1	4.5	0	0.0	22	100
2006/07	16	76.2	4	19.0	1	4.8	21	100
2007/08	20	95.2	0	0.0	1	4.8	21	100
2008/09	15	71.4	4	19.0	2	9.5	21	100
2009/10	19	95.0	0	0.0	1	5.0	20	100
2010/11	9	90.0	0	0.0	1	10.0	10	100
Total/average	150	83.8	14	7.8	15	8.4	179	
PAREMATA BEACH AT PASCOE AVENUE								
2001/02	17	81.0	2	9.5	2	9.5	21	100
2002/03	20	95.2	1	4.8	0	0.0	21	100
2003/04	16	76.2	2	9.5	3	14.3	21	100
2004/05	21	95.5	0	0.0	1	4.5	22	100
2005/06	22	100.0	0	0.0	0	0.0	22	100
2006/07	20	95.2	0	0.0	1	4.8	21	100
2007/08	20	95.2	0	0.0	1	4.8	21	100
2008/09	18	85.7	2	9.5	1	4.8	21	100
2009/10	NS	-	NS	-	NS	-	-	-
2010/11	NS	-	NS	-	NS	-	-	-
Total/average	154	90.6	7	4.1	9	5.3	170	
PAUATAHANUI INLET AT PAREMATA BRIDGE								
2001/02	NS	-	NS	-	NS	-	-	-
2002/03	NS	-	NS	-	NS	-	-	-
2003/04	NS	-	NS	-	NS	-	-	-
2004/05	NS	-	NS	-	NS	-	-	-
2005/06	NS	-	NS	-	NS	-	-	-
2006/07	NS	-	NS	-	NS	-	-	-
2007/08	20	95.2	0	0.0	1	4.8	21	100
2008/09	21	100.0	0	0.0	0	0.0	21	100
2009/10	20	100.0	0	0.0	0	0.0	20	100
2010/11	18	94.7	0	0.0	1	5.3	19	100
Total/average	79	97.5	0	0.0	2	2.5	81	100
PORIRUA HARBOUR AT THE ROWING CLUB								
2001/02	17	81.0	1	4.8	3	14.3	21	100
2002/03	20	95.2	0	0.0	1	4.8	21	100
2003/04	17	81.0	1	4.8	3	14.3	21	100

Bathing season	Surveillance		Alert		Action		Total	
	No.	%	No.	%	No.	%	No.	%
2004/05	17	77.3	4	18.2	1	4.5	22	100
2005/06	21	95.5	1	4.5	0	0.0	22	100
2006/07	20	95.2	1	4.8	0	0.0	21	100
2007/08	17	81.0	1	4.8	3	14.3	21	100
2008/09	13	61.9	3	14.3	5	23.8	21	100
2009/10	16	80.0	1	5.0	3	15.0	20	100
2010/11	12	60.0	2	10.0	6	30.0	20	100
Total/average	170	81.0	15	7.1	25	11.9	210	
PORIRUA HARBOUR AT TE HIKO STREET								
2001/02	9	40.9	1	4.5	12	54.5	22	100
2002/03	NS	-	NS	-	NS	-	-	-
2003/04	NS	-	NS	-	NS	-	-	-
2004/05	NS	-	NS	-	NS	-	-	-
2005/06	NS	-	NS	-	NS	-	-	-
2006/07	NS	-	NS	-	NS	-	-	-
2007/08	NS	-	NS	-	NS	-	-	-
2008/09	NS	-	NS	-	NS	-	-	-
2009/10	NS	-	NS	-	NS	-	-	-
2010/11	NS	-	NS	-	NS	-	-	-
Total/average	9	-	1	-	12	-	22	
TITAHI BAY AT BAY DRIVE								
2001/02	15	71.4	1	4.8	5	23.8	21	100
2002/03	18	85.7	1	4.8	2	9.5	21	100
2003/04	15	71.4	3	14.3	3	14.3	21	100
2004/05	19	86.4	1	4.5	2	9.1	22	100
2005/06	22	100.0	0	0.0	0	0.0	22	100
2006/07	18	85.7	2	9.5	1	4.8	21	100
2007/08	19	90.5	1	4.8	1	4.8	21	100
2008/09	18	85.7	2	9.5	1	4.8	21	100
2009/10	18	90.0	0	0.0	2	10.0	20	100
2010/11	17	85.0	0	0.0	3	15.0	20	100
Total/average	179	85.2	11	5.2	20	9.5	210	
TITAHI BAY AT TOMS ROAD								
2001/02	NS	-	NS	-	NS	-	-	-
2002/03	19	90.5	1	4.8	1	4.8	21	100
2003/04	17	81.0	1	4.8	3	14.3	21	100
2004/05	22	100.0	0	0.0	0	0.0	22	100
2005/06	21	95.5	1	4.5	0	0.0	22	100
2006/07	18	85.7	1	4.8	2	9.5	21	100
2007/08	18	85.7	2	9.5	1	4.8	21	100
2008/09	20	95.2	0	0.0	1	4.8	21	100
2009/10	19	95.0	0	0.0	1	5.0	20	100
2010/11	19	95.0	0	0.0	1	5.0	20	100
Total/average	173	91.5	6	3.2	10	5.3	189	
TITAHI BAY AT SOUTH BEACH ACCESS ROAD								
2001/02	16	76.2	1	4.8	4	19.0	21	100
2002/03	17	81.0	3	14.3	1	4.8	21	100
2003/04	17	81.0	1	4.8	3	14.3	21	100
2004/05	21	95.5	1	4.5	0	0.0	22	100
2005/06	21	95.5	1	4.5	0	0.0	22	100
2006/07	19	90.5	1	4.8	1	4.8	21	100
2007/08	19	90.5	2	9.5	0	0.0	21	100
2008/09	18	85.7	0	0.0	3	14.3	21	100
2009/10	15	75.0	1	5.0	4	20.0	20	100
2010/11	13	65.0	2	10.0	5	25.0	20	100
Total/average	176	83.8	13	6.2	21	10.0	210	

Bathing season	Surveillance		Alert		Action		Total	
	No.	%	No.	%	No.	%	No.	%
ONEHUNGA BAY								
2001/02	16	76.2	3	14.3	2	9.5	21	100
2002/03	19	90.5	1	4.8	1	4.8	21	100
2003/04	18	85.7	0	0.0	3	14.3	21	100
2004/05	21	95.5	0	0.0	1	4.5	22	100
2005/06	21	95.5	1	4.5	0	0.0	22	100
2006/07	21	100.0	0	0.0	0	0.0	21	100
2007/08	21	100.0	0	0.0	0	0.0	21	100
2008/09	21	100.0	0	0.0	0	0.0	21	100
2009/10	19	95.0	1	5.0	0	0.0	20	100
2010/11	20	100.0	0	0.0	0	0.0	20	100
Total/average	197	93.8	6	2.9	7	3.3	210	

(iv) Wellington city

Bathing season	Surveillance		Alert		Action		Total	
	No.	%	No.	%	No.	%	No.	%
AOTEA LAGOON								
2001/02	20	95.2	0	0.0	1	4.8	21	100
2002/03	21	100.0	0	0.0	0	0.0	21	100
2003/04	19	90.5	2	9.5	0	0.0	21	100
2004/05	21	95.5	0	0.0	1	4.5	22	100
2005/06	22	100.0	0	0.0	0	0.0	22	100
2006/07	21	100.0	0	0.0	0	0.0	21	100
2007/08	18	85.7	0	0.0	3	14.3	21	100
2008/09	21	100.0	0	0.0	0	0.0	21	100
2009/10	18	90.0	2	10.0	0	0.0	20	100
2010/11	19	95.0	0	0.0	1	5.0	20	100
Total/average	200	95.2	4	1.9	6	2.9	210	
ORIENTAL BAY AT FREYBERG BEACH								
2001/02	20	95.2	1	4.8	0	0.0	21	100
2002/03	5	100.0	0	0.0	0	0.0	5	100
2003/04	9	81.8	2	18.2	0	0.0	11	100
2004/05	21	95.5	0	0.0	1	4.5	22	100
2005/06	21	95.5	1	4.5	0	0.0	22	100
2006/07	21	100.0	0	0.0	0	0.0	21	100
2007/08	20	95.2	0	0.0	1	4.8	21	100
2008/09	21	100.0	0	0.0	0	0.0	21	100
2009/10	20	100.0	0	0.0	0	0.0	20	100
2010/11	20	100.0	0	0.0	0	0.0	20	100
Total/average	178	96.7	4	2.2	2	1.1	184	
ORIENTAL BAY AT WISHING WELL								
2001/02	20	95.2	1	4.8	0	0.0	21	100
2002/03	16	100.0	0	0.0	0	0.0	16	100
2003/04	16	80.0	0	0.0	4	20.0	20	100
2004/05	19	86.4	1	4.5	2	9.1	22	100
2005/06	19	86.4	2	9.1	1	4.5	22	100
2006/07	20	95.2	1	4.8	0	0.0	21	100
2007/08	18	85.7	1	4.8	2	9.5	21	100
2008/09	20	95.2	1	4.8	0	0.0	21	100
2009/10	20	100.0	0	0.0	0	0.0	20	100
2010/11	19	95.0	1	5.0	0	0.0	20	100
Total/average	187	91.7	8	3.9	9	4.4	204	

Bathing season	Surveillance		Alert		Action		Total	
	No.	%	No.	%	No.	%	No.	%
ORIENTAL BAY AT BAND ROTUNDA								
2001/02	20	95.2	1	4.8	0	0.0	21	100
2002/03	14	100.0	0	0.0	0	0.0	14	100
2003/04	18	85.7	1	4.8	2	9.5	21	100
2004/05	19	86.4	1	4.5	2	9.1	22	100
2005/06	20	90.9	1	4.5	1	4.5	22	100
2006/07	21	100.0	0	0.0	0	0.0	21	100
2007/08	19	90.5	1	4.8	1	4.8	21	100
2008/09	21	100.0	0	0.0	0	0.0	21	100
2009/10	20	100.0	0	0.0	0	0.0	20	100
2010/11	19	95.0	0	0.0	1	5.0	20	100
Total/average	191	94.1	5	2.5	7	3.4	203	
BALAENA BAY								
2001/02	21	100.0	0	0.0	0	0.0	21	100
2002/03	21	100.0	0	0.0	0	0.0	21	100
2003/04	20	95.2	0	0.0	1	4.8	21	100
2004/05	21	95.5	1	4.5	0	0.0	22	100
2005/06	22	100.0	0	0.0	0	0.0	22	100
2006/07	21	100.0	0	0.0	0	0.0	21	100
2007/08	20	95.2	0	0.0	1	4.8	21	100
2008/09	20	95.2	1	4.8	0	0.0	21	100
2009/10	20	100.0	0	0.0	0	0.0	20	100
2010/11	20	100.0	0	0.0	0	0.0	20	100
Total/average	206	98.1	2	1.0	2	1.0	210	
KIO BAY								
2001/02	20	95.2	0	0.0	1	4.8	21	100
2002/03	21	100.0	0	0.0	0	0.0	21	100
2003/04	19	90.5	2	9.5	0	0.0	21	100
2004/05	21	95.5	1	4.5	0	0.0	22	100
2005/06	21	95.5	0	0.0	1	4.5	22	100
2006/07	21	100.0	0	0.0	0	0.0	21	100
2007/08	20	95.2	1	4.8	0	0.0	21	100
2008/09	21	100.0	0	0.0	0	0.0	21	100
2009/10	NS	-	NS	-	NS	-	-	-
2010/11	NS	-	NS	-	NS	-	-	-
Total/average	164	96.5	4	2.4	2	1.2	170	
HATAITAI BEACH								
2001/02	18	85.7	2	9.5	1	4.8	21	100
2002/03	20	95.2	1	4.8	0	0.0	21	100
2003/04	17	81.0	3	14.3	1	4.8	21	100
2004/05	18	81.8	2	9.1	2	9.1	22	100
2005/06	21	95.5	1	4.5	0	0.0	22	100
2006/07	21	100.0	0	0.0	0	0.0	21	100
2007/08	21	100.0	0	0.0	0	0.0	21	100
2008/09	21	100.0	0	0.0	0	0.0	21	100
2009/10	20	100.0	0	0.0	0	0.0	20	100
2010/11	20	100.0	0	0.0	0	0.0	20	100
Total/average	197	93.8	9	4.3	4	1.9	210	
SHARK BAY								
2001/02	20	95.2	0	0.0	1	4.8	21	100
2002/03	20	95.2	1	4.8	0	0.0	21	100
2003/04	21	100.0	0	0.0	0	0.0	21	100
2004/05	21	95.5	0	0.0	1	4.5	22	100
2005/06	22	100.0	0	0.0	0	0.0	22	100
2006/07	21	100.0	0	0.0	0	0.0	21	100
2007/08	21	100.0	0	0.0	0	0.0	21	100

Bathing season	Surveillance		Alert		Action		Total	
	No.	%	No.	%	No.	%	No.	%
2008/09	21	100.0	0	0.0	0	0.0	21	100
2009/10	20	100.0	0	0.0	0	0.0	20	100
2010/11	18	90.0	1	5.0	1	5.0	20	100
Total/average	205	97.6	2	1.0	3	1.4	210	
MAHANGA BAY								
2001/02	21	100.0	0	0.0	0	0.0	21	100
2002/03	20	95.2	0	0.0	1	4.8	21	100
2003/04	21	100.0	0	0.0	0	0.0	21	100
2004/05	18	81.8	3	13.6	1	4.5	22	100
2005/06	20	90.9	1	4.5	1	4.5	22	100
2006/07	21	100.0	0	0.0	0	0.0	21	100
2007/08	21	100.0	0	0.0	0	0.0	21	100
2008/09	20	95.2	0	0.0	1	4.8	21	100
2009/10	20	100.0	0	0.0	0	0.0	20	100
2010/11	20	100.0	0	0.0	0	0.0	20	100
Total/average	202	96.2	4	1.9	4	1.9	210	
SCORCHING BAY								
2001/02	21	100.0	0	0.0	0	0.0	21	100
2002/03	21	100.0	0	0.0	0	0.0	21	100
2003/04	21	100.0	0	0.0	0	0.0	21	100
2004/05	21	95.5	1	4.5	0	0.0	22	100
2005/06	22	100.0	0	0.0	0	0.0	22	100
2006/07	21	100.0	0	0.0	0	0.0	21	100
2007/08	20	95.2	1	4.8	0	0.0	21	100
2008/09	21	100.0	0	0.0	0	0.0	21	100
2009/10	20	100.0	0	0.0	0	0.0	20	100
2010/11	19	95.0	0	0.0	1	5.0	20	100
Total/average	207	98.6	2	1.0	1	0.5	210	
WORSER BAY								
2001/02	21	100.0	0	0.0	0	0.0	21	100
2002/03	21	100.0	0	0.0	0	0.0	21	100
2003/04	21	100.0	0	0.0	0	0.0	21	100
2004/05	21	95.5	0	0.0	1	4.5	22	100
2005/06	22	100.0	0	0.0	0	0.0	22	100
2006/07	21	100.0	0	0.0	0	0.0	21	100
2007/08	21	100.0	0	0.0	0	0.0	21	100
2008/09	21	100.0	0	0.0	0	0.0	21	100
2009/10	19	95.0	1	5.0	0	0.0	20	100
2010/11	19	95.0	0	0.0	1	5.0	20	100
Total/average	207	98.6	1	0.5	2	1.0	210	
SEATOUN BEACH AT WHARF								
2001/02	19	90.5	2	9.5	0	0.0	21	100
2002/03	21	100.0	0	0.0	0	0.0	21	100
2003/04	21	100.0	0	0.0	0	0.0	21	100
2004/05	20	90.9	1	4.5	1	4.5	22	100
2005/06	22	100.0	0	0.0	0	0.0	22	100
2006/07	21	100.0	0	0.0	0	0.0	21	100
2007/08	20	95.2	0	0.0	1	4.8	21	100
2008/09	21	100.0	0	0.0	0	0.0	21	100
2009/10	19	95.0	1	5.0	0	0.0	20	100
2010/11	20	100.0	0	0.0	0	0.0	20	100
Total/average	204	97.1	4	1.9	2	1.0	210	
SEATOUN BEACH AT INGLIS STREET								
2001/02	19	90.5	1	4.8	1	4.8	21	100
2002/03	21	100.0	0	0.0	0	0.0	21	100
2003/04	20	95.2	0	0.0	1	4.8	21	100

Bathing season	Surveillance		Alert		Action		Total	
	No.	%	No.	%	No.	%	No.	%
2004/05	22	100.0	0	0.0	0	0.0	22	100
2005/06	21	95.5	1	4.5	0	0.0	22	100
2006/07	21	100.0	0	0.0	0	0.0	21	100
2007/08	20	95.2	0	0.0	1	4.8	21	100
2008/09	21	100.0	0	0.0	0	0.0	21	100
2009/10	19	95.0	1	5.0	0	0.0	20	100
2010/11	19	95.0	0	0.0	1	5.0	20	100
Total/average	203	96.7	3	1.4	4	1.9	210	
BREAKER BAY								
2001/02	21	100.0	0	0.0	0	0.0	21	100
2002/03	21	100.0	0	0.0	0	0.0	21	100
2003/04	21	100.0	0	0.0	0	0.0	21	100
2004/05	21	95.5	0	0.0	1	4.5	22	100
2005/06	22	100.0	0	0.0	0	0.0	22	100
2006/07	11	100.0	0	0.0	0	0.0	11	100
2007/08	11	100.0	0	0.0	0	0.0	11	100
2008/09	11	100.0	0	0.0	0	0.0	11	100
2009/10	10	100.0	0	0.0	0	0.0	10	100
2010/11	10	100.0	0	0.0	0	0.0	10	100
Total/average	159	99.4	0	0.0	1	0.6	160	
LYALL BAY AT TIRANGI ROAD								
2001/02	20	95.2	1	4.8	0	0.0	21	100
2002/03	20	95.2	1	4.8	0	0.0	21	100
2003/04	20	95.2	0	0.0	1	4.8	21	100
2004/05	18	81.8	4	18.2	0	0.0	22	100
2005/06	21	95.5	0	0.0	1	4.5	22	100
2006/07	20	95.2	1	4.8	0	0.0	21	100
2007/08	19	90.5	0	0.0	2	9.5	21	100
2008/09	21	100.0	0	0.0	0	0.0	21	100
2009/10	20	100.0	0	0.0	0	0.0	20	100
2010/11	19	95.0	0	0.0	1	5.0	20	100
Total/average	198	94.3	7	3.3	5	2.4	210	
LYALL BAY AT ONEPU ROAD								
2001/02	20	95.2	1	4.8	0	0.0	21	100
2002/03	21	100.0	0	0.0	0	0.0	21	100
2003/04	21	100.0	0	0.0	0	0.0	21	100
2004/05	21	95.5	1	4.5	0	0.0	22	100
2005/06	21	95.5	1	4.5	0	0.0	22	100
2006/07	20	95.2	0	0.0	1	4.8	21	100
2007/08	21	100.0	0	0.0	0	0.0	21	100
2008/09	21	100.0	0	0.0	0	0.0	21	100
2009/10	20	100.0	0	0.0	0	0.0	20	100
2010/11	19	95.0	1	5.0	0	0.0	20	100
Total/average	205	97.6	4	1.9	1	0.5	210	
LYALL BAY AT QUEENS DRIVE								
2001/02	18	85.7	2	9.5	1	4.8	21	100
2002/03	21	100.0	0	0.0	0	0.0	21	100
2003/04	21	100.0	0	0.0	0	0.0	21	100
2004/05	21	95.5	1	4.5	0	0.0	22	100
2005/06	22	100.0	0	0.0	0	0.0	22	100
2006/07	20	95.2	1	4.8	0	0.0	21	100
2007/08	21	100.0	0	0.0	0	0.0	21	100
2008/09	21	100.0	0	0.0	0	0.0	21	100
2009/10	20	100.0	0	0.0	0	0.0	20	100
2010/11	20	100.0	0	0.0	0	0.0	20	100
Total/average	205	97.6	4	1.9	1	0.5	210	

Bathing season	Surveillance		Alert		Action		Total	
	No.	%	No.	%	No.	%	No.	%
PRINCESS BAY								
2001/02	21	100.0	0	0.0	0	0.0	21	100
2002/03	21	100.0	0	0.0	0	0.0	21	100
2003/04	19	90.5	0	0.0	2	9.5	21	100
2004/05	22	100.0	0	0.0	0	0.0	22	100
2005/06	22	100.0	0	0.0	0	0.0	22	100
2006/07	11	100.0	0	0.0	0	0.0	11	100
2007/08	11	100.0	0	0.0	0	0.0	11	100
2008/09	11	100.0	0	0.0	0	0.0	11	100
2009/10	10	100.0	0	0.0	0	0.0	10	100
2010/11	10	100.0	0	0.0	0	0.0	10	100
Total/average	158	98.8	0	0.0	2	1.3	160	
ISLAND BAY AT OLD BAIT SHED								
2001/02	17	81.0	2	9.5	2	9.5	21	100
2002/03	20	95.2	1	4.8	0	0.0	21	100
2003/04	20	95.2	0	0.0	1	4.8	21	100
2004/05	22	100.0	0	0.0	0	0.0	22	100
2005/06	NS	-	NS	-	NS	-	-	-
2006/07	NS	-	NS	-	NS	-	-	-
2007/08	NS	-	NS	-	NS	-	-	-
2008/09	NS	-	NS	-	NS	-	-	-
2009/10	NS	-	NS	-	NS	-	-	-
2010/11	NS	-	NS	-	NS	-	-	-
Total/average	79	92.9	3	3.5	3	3.5	85	
ISLAND BAY AT SURF CLUB								
2001/02	19	90.5	2	9.5	0	0.0	21	100
2002/03	21	100.0	0	0.0	0	0.0	21	100
2003/04	20	95.2	0	0.0	1	4.8	21	100
2004/05	20	90.9	1	4.5	1	4.5	22	100
2005/06	21	95.5	1	4.5	0	0.0	22	100
2006/07	20	95.2	0	0.0	1	4.8	21	100
2007/08	19	90.5	0	0.0	2	9.5	21	100
2008/09	21	100.0	0	0.0	0	0.0	21	100
2009/10	18	90.0	1	5.0	1	5.0	20	100
2010/11	19	95.0	0	0.0	1	5.0	20	100
Total/average	198	94.3	5	2.4	7	3.3	210	
ISLAND BAY AT REEF STREET REC GROUND								
2001/02	20	95.2	1	4.8	0	0.0	21	100
2002/03	21	100.0	0	0.0	0	0.0	21	100
2003/04	20	95.2	0	0.0	1	4.8	21	100
2004/05	17	77.3	3	13.6	2	9.1	22	100
2005/06	21	95.5	1	4.5	0	0.0	22	100
2006/07	20	95.2	0	0.0	1	4.8	21	100
2007/08	20	95.2	0	0.0	1	4.8	21	100
2008/09	21	100.0	0	0.0	0	0.0	21	100
2009/10	18	90.0	1	5.0	1	5.0	20	100
2010/11	19	95.0	0	0.0	1	5.0	20	100
Total/average	197	93.8	6	2.9	7	3.3	210	
ISLAND BAY AT DERWENT STREET								
2001/02	NS	-	NS	-	NS	-	-	-
2002/03	NS	-	NS	-	NS	-	-	-
2003/04	NS	-	NS	-	NS	-	-	-
2004/05	9	90.0	0	0.0	1	10.0	10	100
2005/06	21	95.5	1	4.5	0	0.0	22	100
2006/07	21	100.0	0	0.0	0	0.0	21	100
2007/08	20	95.2	1	4.8	0	0.0	21	100

Bathing season	Surveillance		Alert		Action		Total	
	No.	%	No.	%	No.	%	No.	%
2008/09	21	100.0	0	0.0	0	0.0	21	100
2009/10	20	100.0	0	0.0	0	0.0	20	100
2010/11	20	100.0	0	0.0	0	0.0	20	100
Total/average	132	97.8	2	1.5	1	0.7	135	
OWHIRO BAY								
2001/02	19	90.5	1	4.8	1	4.8	21	100
2002/03	21	100.0	0	0.0	0	0.0	21	100
2003/04	19	90.5	1	4.8	1	4.8	21	100
2004/05	18	81.8	1	4.5	3	13.6	22	100
2005/06	22	100.0	0	0.0	0	0.0	22	100
2006/07	18	85.7	3	14.3	0	0.0	21	100
2007/08	17	81.0	1	4.8	3	14.3	21	100
2008/09	19	90.5	0	0.0	2	9.5	21	100
2009/10	8	40.0	3	15.0	9	45.0	20	100
2010/11	14	70.0	4	20.0	2	10.0	20	100
Total/average	175	83.3	14	6.7	21	10.0	210	

(iii) Hutt city

Bathing season	Surveillance		Alert		Action		Total	
	No.	%	No.	%	No.	%	No.	%
PETONE BEACH AT WATER SKI CLUB								
2001/02	19	90.5	2	9.5	0	0.0	21	100
2002/03	19	90.5	0	0.0	2	9.5	21	100
2003/04	19	90.5	1	4.8	1	4.8	21	100
2004/05	22	100.0	0	0.0	0	0.0	22	100
2005/06	20	90.9	0	0.0	2	9.1	22	100
2006/07	19	90.5	1	4.8	1	4.8	21	100
2007/08	19	90.5	0	0.0	2	9.5	21	100
2008/09	21	100.0	0	0.0	0	0.0	21	100
2009/10	20	100.0	0	0.0	0	0.0	20	100
2010/11	18	90.0	0	0.0	2	10.0	20	100
Total/average	196	93.3	4	1.9	10	4.8	210	
PETONE BEACH AT SYDNEY STREET								
2001/02	19	90.5	1	4.8	1	4.8	21	100
2002/03	20	95.2	0	0.0	1	4.8	21	100
2003/04	14	66.7	2	9.5	5	23.8	21	100
2004/05	22	100.0	0	0.0	0	0.0	22	100
2005/06	21	95.5	1	4.5	0	0.0	22	100
2006/07	20	95.2	0	0.0	1	4.8	21	100
2007/08	19	90.5	0	0.0	2	9.5	21	100
2008/09	21	100.0	0	0.0	0	0.0	21	100
2009/10	18	90.0	0	0.0	2	10.0	20	100
2010/11	18	90.0	0	0.0	2	10.0	20	100
Total/average	192	91.4	4	1.9	14	6.7	210	
PETONE BEACH AT SETTLERS MUSEUM								
2001/02	19	90.5	2	9.5	0	0.0	21	100
2002/03	21	100.0	0	0.0	0	0.0	21	100
2003/04	19	90.5	2	9.5	0	0.0	21	100
2004/05	21	95.5	1	4.5	0	0.0	22	100
2005/06	21	95.5	1	4.5	0	0.0	22	100
2006/07	19	90.5	1	4.8	1	4.8	21	100
2007/08	19	90.5	0	0.0	2	9.5	21	100
2008/09	20	95.2	1	4.8	0	0.0	21	100
2009/10	19	95.0	1	5.0	0	0.0	20	100

Bathing season	Surveillance		Alert		Action		Total	
	No.	%	No.	%	No.	%	No.	%
2010/11	18	90.0	0	0.0	2	10.0	20	100
Total/average	196	93.3	9	4.3	5	2.4	210	
PETONE BEACH AT KIOSK								
2001/02	18	85.7	2	9.5	1	4.8	21	100
2002/03	21	100.0	0	0.0	0	0.0	21	100
2003/04	20	95.2	0	0.0	1	4.8	21	100
2004/05	22	100.0	0	0.0	0	0.0	22	100
2005/06	21	95.5	0	0.0	1	4.5	22	100
2006/07	19	90.5	1	4.8	1	4.8	21	100
2007/08	19	90.5	0	0.0	2	9.5	21	100
2008/09	21	100.0	0	0.0	0	0.0	21	100
2009/10	18	90.0	2	10.0	0	0.0	20	100
2010/11	19	95.0	1	5.0	0	0.0	20	100
Total/average	198	94.3	6	2.9	6	2.9	210	
SORRENTO BAY								
2001/02	19	90.5	2	9.5	0	0.0	21	100
2002/03	20	95.2	1	4.8	0	0.0	21	100
2003/04	20	95.2	0	0.0	1	4.8	21	100
2004/05	22	100.0	0	0.0	0	0.0	22	100
2005/06	22	100.0	0	0.0	0	0.0	22	100
2006/07	21	100.0	0	0.0	0	0.0	21	100
2007/08	20	95.2	0	0.0	1	4.8	21	100
2008/09	21	100.0	0	0.0	0	0.0	21	100
2009/10	19	95.0	0	0.0	1	5.0	20	100
2010/11	17	85.0	3	15.0	0	0.0	20	100
Total/average	201	95.7	6	2.9	3	1.4	210	
LOWRY BAY								
2001/02	20	95.2	0	0.0	1	4.8	21	100
2002/03	20	95.2	1	4.8	0	0.0	21	100
2003/04	17	81.0	1	4.8	3	14.3	21	100
2004/05	21	95.5	1	4.5	0	0.0	22	100
2005/06	20	90.9	1	4.5	1	4.5	22	100
2006/07	21	100.0	0	0.0	0	0.0	21	100
2007/08	18	85.7	0	0.0	3	14.3	21	100
2008/09	21	100.0	0	0.0	0	0.0	21	100
2009/10	19	95.0	0	0.0	1	5.0	20	100
2010/11	19	95.0	0	0.0	1	5.0	20	100
Total/average	196	93.3	4	1.9	10	4.8	210	
YORK BAY								
2001/02	19	90.5	2	9.5	0	0.0	21	100
2002/03	21	100.0	0	0.0	0	0.0	21	100
2003/04	20	95.2	0	0.0	1	4.8	21	100
2004/05	22	100.0	0	0.0	0	0.0	22	100
2005/06	21	95.5	0	0.0	1	4.5	22	100
2006/07	20	95.2	1	4.8	0	0.0	21	100
2007/08	19	90.5	1	4.8	1	4.8	21	100
2008/09	21	100.0	0	0.0	0	0.0	21	100
2009/10	19	95.0	0	0.0	1	5.0	20	100
2010/11	19	95.0	0	0.0	1	5.0	20	100
Total/average	201	95.7	4	1.9	5	2.4	210	

Bathing season	Surveillance		Alert		Action		Total	
	No.	%	No.	%	No.	%	No.	%
DAYS BAY AT WELLESLEY COLLEGE								
2001/02	21	100.0	0	0.0	0	0.0	21	100
2002/03	20	95.2	0	0.0	1	4.8	21	100
2003/04	21	100.0	0	0.0	0	0.0	21	100
2004/05	22	100.0	0	0.0	0	0.0	22	100
2005/06	22	100.0	0	0.0	0	0.0	22	100
2006/07	21	100.0	0	0.0	0	0.0	21	100
2007/08	19	90.5	0	0.0	2	9.5	21	100
2008/09	20	95.2	0	0.0	1	4.8	21	100
2009/10	19	95.0	0	0.0	1	5.0	20	100
2010/11	19	95.0	0	0.0	1	5.0	20	100
Total/average	204	97.1	0	0.0	6	2.9	210	
DAYS BAY AT WHARF								
2001/02	20	95.2	1	4.8	0	0.0	21	100
2002/03	20	95.2	0	0.0	1	4.8	21	100
2003/04	21	100.0	0	0.0	0	0.0	21	100
2004/05	22	100.0	0	0.0	0	0.0	22	100
2005/06	20	90.9	1	4.5	1	4.5	22	100
2006/07	21	100.0	0	0.0	0	0.0	21	100
2007/08	18	85.7	0	0.0	3	14.3	21	100
2008/09	21	100.0	0	0.0	0	0.0	21	100
2009/10	19	95.0	0	0.0	1	5.0	20	100
2010/11	19	95.0	0	0.0	1	5.0	20	100
Total/average	201	95.7	2	1.0	7	3.3	210	
DAYS BAY AT MOANA ROAD								
2001/02	20	95.2	1	4.8	0	0.0	21	100
2002/03	20	95.2	1	4.8	0	0.0	21	100
2003/04	21	100.0	0	0.0	0	0.0	21	100
2004/05	21	95.5	1	4.5	0	0.0	22	100
2005/06	21	95.5	1	4.5	0	0.0	22	100
2006/07	19	90.5	2	9.5	0	0.0	21	100
2007/08	20	95.2	0	0.0	1	4.8	21	100
2008/09	21	100.0	0	0.0	0	0.0	21	100
2009/10	18	90.0	2	10.0	0	0.0	20	100
2010/11	19	95.0	1	5.0	0	0.0	20	100
Total/average	200	95.2	9	4.3	1	0.5	210	
RONA BAY AT NORTH END OF CLIFF BISHOP PARK								
2001/02	21	100.0	0	0.0	0	0.0	21	100
2002/03	20	95.2	0	0.0	1	4.8	21	100
2003/04	18	85.7	0	0.0	3	14.3	21	100
2004/05	21	95.5	0	0.0	1	4.5	22	100
2005/06	20	90.9	1	4.5	1	4.5	22	100
2006/07	20	95.2	0	0.0	1	4.8	21	100
2007/08	20	95.2	0	0.0	1	4.8	21	100
2008/09	21	100.0	0	0.0	0	0.0	21	100
2009/10	17	85.0	1	5.0	2	10.0	20	100
2010/11	19	95.0	0	0.0	1	5.0	20	100
Total/average	197	93.8	2	1.0	11	5.2	210	

Bathing season	Surveillance		Alert		Action		Total	
	No.	%	No.	%	No.	%	No.	%
RONA BAY AT WHARF								
2001/02	19	90.5	1	4.8	1	4.8	21	100
2002/03	18	85.7	1	4.8	2	9.5	21	100
2003/04	21	100.0	0	0.0	0	0.0	21	100
2004/05	21	95.5	1	4.5	0	0.0	22	100
2005/06	20	90.9	1	4.5	1	4.5	22	100
2006/07	19	90.5	2	9.5	0	0.0	21	100
2007/08	19	90.5	1	4.8	1	4.8	21	100
2008/09	21	100.0	0	0.0	0	0.0	21	100
2009/10	18	90.0	1	5.0	1	5.0	20	100
2010/11	17	85.0	1	5.0	2	10.0	20	100
Total/average	193	91.9	9	4.3	8	3.8	210	
ROBINSON BAY AT HW SHORTT REC GROUND								
2001/02	20	95.2	0	0.0	1	4.8	21	100
2002/03	20	95.2	0	0.0	1	4.8	21	100
2003/04	18	85.7	2	9.5	1	4.8	21	100
2004/05	21	95.5	1	4.5	0	0.0	22	100
2005/06	20	90.9	1	4.5	1	4.5	22	100
2006/07	18	85.7	0	0.0	3	14.3	21	100
2007/08	17	81.0	1	4.8	3	14.3	21	100
2008/09	21	100.0	0	0.0	0	0.0	21	100
2009/10	16	80.0	2	10.0	2	10.0	20	100
2010/11	20	100.0	0	0.0	0	0.0	20	100
Total/average	191	91.0	7	3.3	12	5.7	210	
ROBINSON BAY AT NIKAU STREET								
2001/02	21	100.0	0	0.0	0	0.0	21	100
2002/03	20	95.2	1	4.8	0	0.0	21	100
2003/04	17	81.0	1	4.8	3	14.3	21	100
2004/05	21	95.5	1	4.5	0	0.0	22	100
2005/06	21	95.5	1	4.5	0	0.0	22	100
2006/07	20	95.2	1	4.8	0	0.0	21	100
2007/08	19	90.5	1	4.8	1	4.8	21	100
2008/09	21	100.0	0	0.0	0	0.0	21	100
2009/10	20	100.0	0	0.0	0	0.0	20	100
2010/11	20	100.0	0	0.0	0	0.0	20	100
Total/average	200	95.2	6	2.9	4	1.9	210	
CAMP BAY								
2001/02	21	100.0	0	0.0	0	0.0	21	100
2002/03	20	95.2	0	0.0	1	4.8	21	100
2003/04	19	90.5	2	9.5	0	0.0	21	100
2004/05	21	95.5	0	0.0	1	4.5	22	100
2005/06	22	100.0	0	0.0	0	0.0	22	100
2006/07	10	90.9	0	0.0	1	9.1	11	100
2007/08	11	100.0	0	0.0	0	0.0	11	100
2008/09	11	100.0	0	0.0	0	0.0	11	100
2009/10	5	100.0	0	0.0	0	0.0	5	100
2010/11	5	9.1	0	0.0	0	0.0	5	100
Total/average	145	96.7	2	1.3	3	2.0	150	

(v) Wairarapa

Bathing season	Surveillance		Alert		Action		Total	
	No.	%	No.	%	No.	%	No.	%
CASTLEPOINT BEACH AT CASTLEPOINT STREAM								
2001/02	19	95.0	1	5.0	0	0.0	20	100
2002/03	19	90.5	2	9.5	0	0.0	21	100
2003/04	17	89.5	1	5.3	1	5.3	19	100
2004/05	21	95.5	0	0.0	1	4.5	22	100
2005/06	21	95.5	0	0.0	1	4.5	22	100
2006/07	19	90.5	2	9.5	0	0.0	21	100
2007/08	21	100.0	0	0.0	0	0.0	21	100
2008/09	19	90.5	1	4.8	1	4.8	21	100
2009/10	18	90.0	1	5.0	1	5.0	20	100
2010/11	20	100.0	0	0.0	0	0.0	20	100
Total/average	194	93.7	8	3.9	5	2.4	207	
CASTLEPOINT BEACH AT SMELLY CREEK								
2001/02	20	100.0	0	0.0	0	0.0	20	100
2002/03	18	90.0	2	10.0	0	0.0	20	100
2003/04	18	94.7	0	0.0	1	5.3	19	100
2004/05	22	100.0	0	0.0	0	0.0	22	100
2005/06	19	86.4	2	9.1	1	4.5	22	100
2006/07	20	95.2	0	0.0	1	4.8	21	100
2007/08	21	100.0	0	0.0	0	0.0	21	100
2008/09	21	100.0	0	0.0	0	0.0	21	100
2009/10	18	90.0	1	5.0	1	5.0	20	100
2010/11	20	100.0	0	0.0	0	0.0	20	100
Total/average	197	95.6	5	2.4	4	1.9	206	
RIVERSDALE BEACH AT LAGOON MOUTH								
2001/02	17	85.0	1	5.0	2	10.0	20	100
2002/03	21	100.0	0	0.0	0	0.0	21	100
2003/04	19	95.0	0	0.0	1	5.0	20	100
2004/05	21	95.5	0	0.0	1	4.5	22	100
2005/06	22	100.0	0	0.0	0	0.0	22	100
2006/07	21	100.0	0	0.0	0	0.0	21	100
2007/08	20	95.2	0	0.0	1	4.8	21	100
2008/09	21	100.0	0	0.0	0	0.0	21	100
2009/10	19	95.0	0	0.0	1	5.0	20	100
2010/11	19	95.0	1	5.0	0	0.0	20	100
Total/average	200	96.2	2	1.0	6	2.9	208	
RIVERSDALE BEACH BETWEEN THE FLAGS								
2001/02	19	95.0	1	5.0	0	0.0	20	100
2002/03	21	100.0	0	0.0	0	0.0	21	100
2003/04	20	100.0	0	0.0	0	0.0	20	100
2004/05	21	95.5	0	0.0	1	4.5	22	100
2005/06	22	100.0	0	0.0	0	0.0	22	100
2006/07	21	100.0	0	0.0	0	0.0	21	100
2007/08	21	100.0	0	0.0	0	0.0	21	100
2008/09	21	100.0	0	0.0	0	0.0	21	100
2009/10	19	95.0	0	0.0	1	5.0	20	100
2010/11	20	100.0	0	0.0	0	0.0	20	100
Total/average	205	98.6	1	0.5	2	1.0	208	
RIVERSDALE BEACH SOUTH								
2001/02	20	100.0	0	0.0	0	0.0	20	100
2002/03	20	95.2	1	4.8	0	0.0	21	100
2003/04	19	100.0	0	0.0	0	0.0	19	100
2004/05	22	100.0	0	0.0	0	0.0	22	100
2005/06	22	100.0	0	0.0	0	0.0	22	100

Bathing season	Surveillance		Alert		Action		Total	
	No.	%	No.	%	No.	%	No.	%
2006/07	10	100.0	0	0.0	0	0.0	10	100
2007/08	11	100.0	0	0.0	0	0.0	11	100
2008/09	11	100.0	0	0.0	0	0.0	11	100
2009/10	12	100.0	0	0.0	0	0.0	12	100
2010/11	10	100.0	0	0.0	0	0.0	10	100
Total/average	157	99.4	1	0.6	0	0.0	158	

Appendix 5: River flow estimation methods

Site name	Corresponding flow site(s) and derivation
Otaki R at Pots	= Otaki R at Pukehinau
Otaki R at SH1	= Otaki R at Pukehinau lag (1 hours)
Waikanae R at SH1	= Waikanae R at Water Treatment Plant lag (0.33 hours)
Waikanae R at Jim Cooke Park	= Waikanae R at Water Treatment Plant lag (0.5 hours)
Pakuratahi R at Forks	= Pakuratahi R at Truss Bridge lag (3 hours)
Hutt R at Birchville	= Hutt R at Birchville
Hutt R at Maoribank	= Hutt R at Birchville lag (0.5 hours)
Hutt R at Poets Park	= Hutt R at Birchville lag (0.75 hours)
Hutt R at Silverstream	= Hutt R at Taita Gorge lag (-0.5 hours)
Hutt R at Boulcott	= Hutt R at Taita Gorge Lag (1 hours) If Taita Gorge flow <12 m^3/s then Boulcott = Taita Gorge flow * 1.0873 – 1.1234 If Taita Gorge flow ≥ 12 m^3/s then Boulcott = Taita Gorge flow * 1.1122 – 1.9398
Wainuiomata R at Richard Prouse Park	= Wainuiomata R at Manuka Track lag (0.5 hours)
Waipoua R at Colombo Rd	= Mikimiki lag (3 hours) * 1.547 - 0.2754
Waingawa R at Kaituna	= Waingawa R at Kaituna
Waingawa R at South Rd	= Waingawa R at Kaituna lag (1.5 hours) * 1.3743 - 0.914
Waiohine R at Gorge	= Waiohine R at Gorge
Waiohine R at SH2	= Waiohine R at Gorge lag (3 hours) * 1.057 - 1.69
Ruamahanga R at Double Bridges	= Ruamahanga R at Mt Bruce lag (2 hours)
Ruamahanga R at Te Ore Ore	= ((Ruamahanga R at Mt Bruce lag [3 hours] + Ruamahanga R at Wardells lag [-1 hours]) / 2) * 1.308 - 1.218
Ruamahanga R at Cliffs	= Waingawa R at Kaituna lag (2.7 hours) * 1.3 + Ruamahanga R at Wardells lag (0.7 hours)
Ruamahanga R at Kokotau	= Waingawa R at Kaituna lag (4 hours) * 1.3 + Ruamahanga R at Wardells lag (2.0 hours)
Ruamahanga R at Morrisons Bush	= Ruamahanga R at Waihenga Bridge lag (-1.5 hours)
Ruamahanga R at Waihenga	= Ruamahanga R at Waihenga Bridge
Ruamahanga R at Bentleys Beach	= Ruamahanga R at Waihenga Bridge lag (3 hours)

Appendix 6: Land cover upstream of freshwater monitoring sites

Site	Indigenous forest (%)	Exotic forest (%)	Pasture – high producing (%)	Pasture – low producing (%)	Horticulture (%)	Urban (%)	Wetland & open water (%)	Other (%)
Otaki R at Pots	96.1	1.5	0.0	2.0	0.0	0.0	0.3	0.0
Otaki R at SH1	89.0	1.7	3.3	5.0	0.3	0.0	0.4	0.3
Waikanae R at Jim Cooke Park	67.8	12.4	4.1	15.0	0.0	0.6	0.0	0.0
Waikanae R at SH1	68.8	12.5	3.3	14.9	0.0	0.4	0.0	0.0
Hutt R at Birchville	78.9	8.8	6.1	5.5	0.0	0.6	0.2	0.0
Hutt R at Boulcott	70.8	11.0	4.7	7.3	0.0	6.0	0.3	0.0
Hutt R at Maoribank	78.2	9.1	6.0	5.4	0.0	1.1	0.2	0.0
Hutt R at Poets Park	75.8	11.2	5.2	5.8	0.0	1.7	0.2	0.0
Hutt R at Silverstream	73.5	11.6	5.0	6.2	0.0	3.4	0.2	0.0
Pakuratahi R at Forks	80.1	6.6	9.3	3.6	0.0	0.0	0.2	0.1
Wainuiomata R at RP Park	91.1	2.2	2.2	4.0	0.0	0.5	0.0	0.0
Waipoua R at Colombo Rd	22.6	0.5	47.7	24.1	1.3	3.5	0.4	0.0
Waingawa R at Kaituna	97.5	0.1	0.0	2.2	0.0	0.0	0.3	0.0
Waingawa R at South Rd	75.8	1.7	5.8	15.3	0.1	0.2	0.6	0.4
Waiohine R at Gorge	98.5	0.6	0.0	0.5	0.0	0.0	0.4	0.0
Waiohine R at SH2	91.9	1.0	3.2	2.9	0.1	0.0	0.7	0.3
Ruamahanga R at Bentleys Beach	23.1	4.8	36.9	32.6	1.2	0.8	0.5	0.1
Ruamahanga R at the Cliffs	27.3	2.1	36.5	30.6	1.0	1.7	0.6	0.2
Ruamahanga R at Double Bridges	68.9	2.5	12.0	15.4	0.1	0.0	1.0	0.2
Ruamahanga R at Kokotau	17.0	6.4	37.2	36.6	1.2	1.0	0.5	0.1
Ruamahanga R at Morrison's Bush	25.0	5.2	37.1	30.1	1.1	1.0	0.5	0.1
Ruamahanga R at Te Ore Ore	24.9	2.3	33.8	37.4	0.1	0.7	0.6	0.1
Ruamahanga R at Waihenga	23.3	4.8	36.6	32.8	1.1	0.8	0.5	0.1

Water, air, earth and energy – elements in Greater Wellington's logo that combine to create and sustain life. Greater Wellington promotes **Quality for Life** by ensuring our environment is protected while meeting the economic, cultural and social needs of the community

For more information, contact Greater Wellington:

Wellington office
PO Box 11646
Manners Street
Wellington 6142
T 04 384 5708
F 04 385 6960

Masterton office
PO Box 41
Masterton 5840
T 06 378 2484
F 06 378 2146

www.gw.govt.nz

April 2012
GW/EMI-T-12/142