

Freshwater contact recreational
water quality at selected Taranaki sites
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Executive summary

This survey of sixteen freshwater contact recreational sites in the Taranaki region was the seventeenth of an on-going programme designed to annually monitor the bacteriological quality of lakes, rivers and streams at popular contact recreational sites during each bathing season. It forms a component of the State of the Environment bathing beaches trend monitoring programme, which commenced in the 1995-1996 summer period. Two sites (at Lakes Ratapiko and Opunake) were monitored in this programme during this 2012-2013 period for the seventh time, partly as a component of the more recently instituted cyanobacteria programme (covering four lakes and one river site) instigated after consultation with Taranaki Healthcare. A site in the lower Waitara River was added in the 2010-2011 period at the joint request of Taranaki Healthcare and NPDC. Two additional sites in the lower reaches of the Waiwhakaiho River and Te Henui Stream (both adjacent to the New Plymouth walkway) were included in the current programme while the Waimoku Stream monitoring has been reduced to a three-yearly frequency. The sixteen sites have been graded for recreational suitability (SFRG) according to MfE, 2003 guidelines, in part based upon the immediately preceding five seasons of monitoring data (where such data existed) although short-comings of this grading methodology are acknowledged. A further site (Lake Rotokare) has been monitored since 2007, principally for cyanobacteria. (Additional flowing water benthic cyanobacteria monitoring will be reported within the appropriate periphyton state of the environment programme). A re-assessed SFRG also has been provided by inclusion of the current season's data for comparative purposes and this showed minimal change.

The results of the 2012-2013 survey have continued to illustrate variability in bacteriological water quality, with the highest water quality achieved at the Urenui River estuary and lower Patea River sites where marked seawater intrusion is the norm (under high tide conditions), Lake Ratapiko, and Waiwhakaiho River (at Merrilands Domain). Impacts on bacteriological water quality at some sites, particularly the lower reaches of the Waiwhakaiho River and Te Henui Stream and Lakes Opunake and Rotomanu, were due principally to resident wild fowl populations in the vicinity of recreational usage sites.

It is particularly noticeable that bacteriological contamination in the Waiwhakaiho River and Te Henui Stream increases sharply as these waterways flow through urban areas from upstream agricultural areas, because of water fowl in the lower reaches.

In terms of *E. coli*, bacteriological water quality showed some improvements in the latest survey period in comparison with historical surveys. The total number of samples falling within the "Alert" or "Action" categories (28% of samples) was equal with the average of all the previous seasons but this was heavily influenced by two urban sites where bird life were mainly responsible for these exceedances (12% of all sites' samples).

One site (Te Henui Stream near East End beach) recorded all of its single samples in either the 'Alert' or the 'Action' mode of the MfE, 2003 guidelines while another site (Waiwhakaiho River opposite Lake Rotomanu) recorded twelve single samples in the 'Action' mode. Eleven other sites exhibited occasional single sample entries into the 'Alert' or 'Action' modes of the 2003 guidelines at some time during the season. However, only four of these sites had counts which entered the 'Action' mode, a decrease in the number and frequency of exceedances in comparison with most previous seasons' results.

To a certain extent these exceedances were probably a feature common to the mid and lower reaches of rivers and streams draining developed (particularly agricultural) catchments throughout New Zealand.

Birdlife contributed to exceedances from time to time particularly at two sites where recreationalists often fed the birds. Limited follow-up sampling was performed when deemed necessary following exceedances of the 'Action' limit as in most cases bacteriological quality was found to have returned to typical levels within short time frames. Permanent health warning signage had been erected at two sites by the New Plymouth District Council (on the direction of Taranaki District Health Board) following past exceedances of 'Alert' levels (at Oakura (for past Waimoku Stream issues) and Waitara (where vandalism of signage has been an issue)) and signage was required at the lower Waiwhakaiho River and Te Henui Stream sites but sporadic single sample 'Alert' level exceedances at other sites were not necessarily signposted.

DNA marker tracking investigations in the lower Oakura and Waingongoro Rivers and Timaru and Kaupokonui Streams found that the principal faecal contributions were sourced from wildfowl and from ruminants. There were a total of nine exceedances of the 'Alert' mode and two of the 'Action' mode recorded during the season at these sites.

Temporal trends over the 1996-2013 period have been evaluated for the twelve sites that have with ten years or more data (and will continue to be assessed annually). Three sites (Te Henui Stream, lower Waiwhakaiho River, and Oakura River) have shown statistically significant increasing trends while another site (Waingongoro River at Ohawe Beach) has shown a significant decreasing trend in median *E. coli* counts, but median counts have reached 'Alert' or 'Action' levels at only the two urban sites where birdlife issues have been documented. No other sites have shown significant trends (positive or negative) in seasonal median *E. coli* counts although these counts have trended upward in the Waimoku Stream at Oakura Beach, a site which is now monitored at three-yearly intervals (next due in the 2013-2014 season).

Elevated enterococci to faecal coliform ratios typified ponded sites near the stream/river mouths possibly as a result of vegetative sources of enterococci and/or more prolonged survival in ponded freshwater environments, under high tidal conditions and often where saltwater penetration occurred.

Additional sampling (in accordance with the MfE, 2003 guidelines) at two principal usage sites (Lake Rotomanu and Waiwhakaiho River) coincided on several occasions with wet weather conditions and resulted in increases in the overall median bacteriological numbers at both sites. Four additional exceedances of limits occurred at the river site but not at the lake site as poorer river bacteriological quality followed the wet weather events.

Cyanobacteria blooms were recorded at Lake Rotokare from near mid-season with numbers peaking in mid to late summer and again in autumn. These numbers necessitated warning notices to avoid contact recreation on these waters during summer but levels had fallen to low numbers toward the end of the survey period where the lake was able to be re-opened for contact recreation. Minimal cyanobacteria were found in Lake Rotomanu and only very early in the season.

Timely reporting of the results of bacteriological water quality and cyanobacteria presence/absence was undertaken by use of the Taranaki Regional Council website (www.trc.govt.nz) as well as liaison with territorial local authorities and the Health Protection Unit of Taranaki District Health Board (who also utilised its website) throughout the survey season of 2012-2013.

It is recommended that annual bacteriological monitoring of selected freshwater sites be continued (in conjunction with the coastal bathing water programme) by use of a similar sampling format over a five month (November to March inclusive) contact recreational period to provide information for trend detection purposes and for assessment of suitability for contact recreational usage. Cyanobacteria monitoring at the four lakes sites at a lesser frequency is also recommended to continue. A further recommendation involves appropriate scheduling of the annual round of dairy wastes disposal systems and advice provided in relation to stock access to watercourses to attempt to reduce the frequency of exceedances of recreational limits particularly in catchments where historical problems from this source have been located.

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1. Introduction

The microbiological water quality at bathing beaches along the Taranaki coast has been monitored by the Taranaki Regional Council (and its predecessors) since 1979, with systematic surveys undertaken since 1987. A more comprehensive annual bathing beach monitoring programme was first implemented during the 1995-1996 summer as an ongoing component of the state of the environment monitoring (SEM) programme for the Taranaki region.

Freshwater bathing and recreational sites were added during the 1996-1997 summer and integrated within the bathing beach bacteriological water quality monitoring programme in order to maximise the efficiency of field sampling procedures and protocols. This format has been continued in the summer periods since this date with an additional component of cyanobacteria monitoring instituted at one river and three lake sites since the 2006-2007 summer and an additional lake site in 2007-2008. The river site has since been transferred to the benthic cyanobacteria component of the SEM periphyton programme.

The SEM bacteriological bathing water quality programme has three objectives:

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

[Note: Contact recreation concerns water-based activities involving a high probability of accidental water ingestion. This mainly applies to bathing, but may also include water- and jet-skiing, surfing, boardsailing etc. Bathing, kayaking, and water skiing are the principal freshwater contact recreational usages identified.]

2. Contact recreation water quality standards and guidelines

Prior to 2003, the Council has used guidelines for the management of recreational and marine shellfish-gathering waters (MfE, 1998) which replaced the provisional guidelines (DOH, 1992). These guidelines were developed (by MfE and MoH) to assist water managers to implement the Resource Management Act (1991) and the Health Act (1956) for the purposes of shellfish-gathering and contact recreation (refer to previous annual reports for more information on these historical guidelines). Since 2003 new guidelines are now relevant to this programme. These guidelines are detailed below.

2.1 Freshwater microbiological water quality guidelines (2003)

Guidelines have been prepared by Ministry for the Environment in conjunction with the Ministry of Health (MfE, 2003). Components of these guidelines include sanitary surveys/inspections together with assessments of historical microbiological data which, when combined, provide an overall suitability for recreation grade, which describes the general condition of a site based on both risk and indicator bacteria counts. Changes to the *E. coli* freshwater recreational guideline values have been made for the purpose of regularly assessing single samples against suitability for recreation. The new freshwater guidelines are now more reflective of New Zealand conditions. 'Alert' and 'Action' guideline levels are used for surveillance throughout the bathing season. They may be summarised as follows (with the marine levels included as some of the Taranaki sites monitored are in the lower, tidal reaches of rivers and streams).

Mode	Acceptable (green)	Alert (amber)	Action (red)
Freshwater (<i>E. coli</i> /100mls)	≤260	261-550	>550
Marine (enterococci/100mls)	≤140	141-280	>280 (2 consecutive samples)

2.2 Suitability for recreation grading (SFRG) of sites

The 2003 Microbiological Water Quality Guidelines (MfE, 2003) provide for the grading of recreational water bodies utilising Microbiological Assessment Categories (using historical data), and Sanitary Inspection Categories which generate a measure of the susceptibility of water bodies to faecal contamination (ranging from high to low risk). The SFRG therefore describes the general condition of a site based on both risk and indicator bacteria water quality. A grade is established on the basis of the most recent five years' data and recalculation of a grade may be performed annually although grades should be reassessed on a five-yearly basis.

SFRGs categories are very good, good, fair, poor, and very poor. Sites graded very good, are those where it is believed they will almost always comply with the guideline values for recreation, and there are few sources of faecal contamination in the catchment. Consequently there is a low risk of illness from bathing. Sites graded very poor are in catchments with significant sources of faecal contamination, and it is generically considered that they will rarely pass the guidelines.

The risk of illness from bathing at these sites is deemed within the Guidelines to be high, and swimming is not recommended. For the remaining beaches (good, fair and poor) it is recommended that weekly monitoring be carried out during the bathing season. The public will be informed when guideline values are exceeded and swimming is not recommended (MfE, 2003).

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

All of the freshwater sites included in the bathing sites programme have been graded by the Council according to these criteria, using all historical SEM microbiological water quality data extending over the November 2007 to March 2012 period (i.e. the five years immediately preceding the current season as required by the Guidelines). The single site added in 2009-2010 and one of the two sites added to the programme in 2011-2012 have limited historical bacteriological data and only a maximum of three year's data have been collected for two of these sites over the recent five year period. The relevant information is provided in Appendix 1 and is summarised in Table 1.

Table 1 Suitability for recreation grade for freshwater sites for the period November 2007 to March 2012

Site	Sanitary Inspection Category	Microbiological assessment <i>E.coli</i> (nos/100ml)			SFR Grade	% of all samples not exceeding 'Action' level (ie: ≤ 550 <i>E.coli</i>)
		95 %ile	Number of samples	Category		
L Rotomanu: western beach	High	2625	65	D	Very poor	81
Waiwhakaiho R: Merrilands domain	High	170	65	B	Poor	98
Waiwhakaiho R at L.Rotomanu	High	2710	39	D	Very poor	51
Te Henui S: mouth	High	4640	66	D	Very poor	18
Patea R: King Edward Park	High	668	65	D	Very poor	87
Patea R. boatramp, Patea	High	83	65	A	Poor	100
Waingongoro R: Eltham camp	High	360	65	C	Poor	100
Waingongoro R: Ohawe beach	High	1200	65	D	Very poor	90
Kaupokonui R: Beach domain	High	465	65	C	Poor	96
L Opuake: adjacent boatramp	High	1625	65	D	Very poor	87

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

Site	Sanitary Inspection Category	Microbiological assessment <i>E.coli</i> (nos/100ml)			SFR Grade	% of all samples not exceeding 'Action' level (ie: ≤ 550 <i>E.coli</i>)
		95 %ile	Number of samples	Category		
Timaru S: Lower Weld Road	High	565	65	D	Very poor	93
Oakura R: d/s SH45	High	443	65	C	Poor	96
Waitara R: Town wharf	High	1081	39	D	Very poor	89
Urenui R: estuary	High	51	65	A	Poor	100
Manganui R: Everett Park	High	413	65	C	Poor	98
L Ratapiko: boatramp	High	140	62	A	Poor	100
L Rotokare: adjacent boatramp	Low	103	46	A	Very good	100

Although all but one of the sites' SFRGs indicate possible high risks associated with contact recreational usage, the poor to very poor gradings have been very strongly influenced by the agricultural nature of the catchments in question (within the SI category). The 5-year microbiological data however, indicate that all but two sites (Te Henui Stream and lower Waiwhakaiho River) would not have entered the 'Action' guideline (ie would have exceeded guidelines) on more than 19% of all sampling occasions, with fourteen sites achieving the guideline on 87% or more of occasions (ie less than 13% exceedance).

The Eltham camp site in the mid reaches of the Waingongoro River, the Urenui River estuary site, the Patea River estuary site, and the Lake Ratapiko site have not reached the 'Action' mode during the previous five seasons, under the sampling protocols of the SEM programme, and the Merrilands Domain site in the lower reaches of the Waiwhakaiho River, and Everett Park site in the Manganui River entered this 'Action' level on only one occasion.

As explained above, in general, these data indicate shortcomings in the grading system set out within the Guidelines for these sites based upon landuse/perceived impacts and the use of extremes (95 % confidence levels) in bacteriological quality data (ie the 'worst case' data), rather than actual monitoring data measured throughout the bathing seasons. Council's contact recreational water quality programme results confirm that the Guideline gradings do not reflect the recreational water quality experienced by recreational users. They show only susceptibility and predominantly reflect perceptions and suppositions about how some land uses might influence quality, as designated 'risk factors'. It is the view of the Council that when there is regular and systematic testing of the actual quality, those results reflect actual levels and are far more informative to recreational water users. Gradings should not be used to make any statement about how safe water actually is for recreational purposes. Rather, the Council emphasises the importance of results of systematic and on-going testing and public notification in terms of the reporting of actual contact recreational water quality and assessments against guidelines.

2.3 Programme design

2.3.1 Trend detection

It should be noted that the existing programme was designed and implemented prior to the release of the 1998 and 2003 guidelines. Therefore, for trend detection monitoring purposes, consistency in programme design is essential and will be maintained where possible. Results are interpreted in this report with reference to the 2003 guidelines for the purposes of comparative assessment with contact recreational guidelines.

The locations of the seventeen sites sampled by the various components of the 2012-2013 programme are shown in Figure 1 and summarised in Table 2.

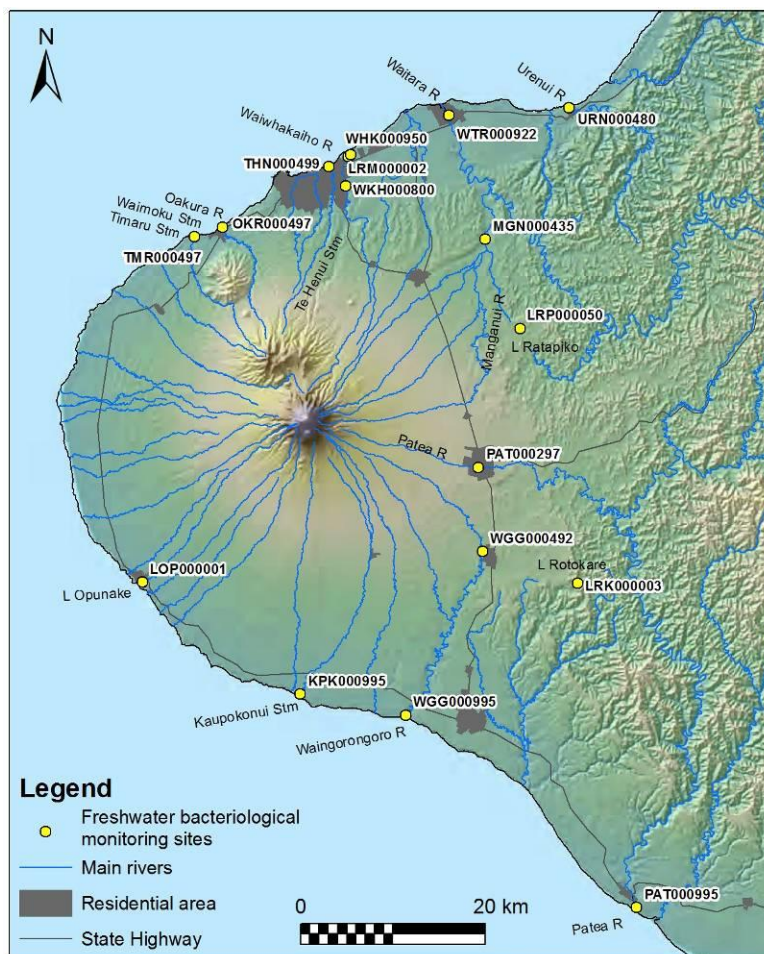


Figure 1 Location of freshwater contact recreation survey sites in 2012-2013

Having established its general state, sampling of the Waimoku Stream site at Oakura Beach has been reduced in intensity by removing it from the 2011-2012 and 2012-2013 programmes with future sampling programmed for every third season (ie next in 2013-2014). Two sites (Te Henui Stream at the mouth and lower Waiwhakaiti River adjacent to Lake Rotomanu) were added to the 2011-2012 programme, in recognition of recreational usage of these areas.

For sampling convenience all sites were included with the (three) coastal bathing beaches runs undertaken over the same five month period from early November

2012 to late March 2013. Eight sites, relatively close to stream mouths, were potentially affected by tidal influences (see conductivity data later in this report).

Table 2 Location of bathing water bacteriological and cyanobacteria sampling sites

Site	Location	GPS Location		Site code
Te Henui Stream	Mouth, East End	E 1694213	N 5677047	THN000499
Lake Rotomanu	Western beach	E 1696309	N 5678128	LRM000002
Waiwhakaiho River	Merrilands Domain	E 1696059	N 5674931	WKH000800
Waiwhakaiho River	Adjacent to Lake Rotomanu	E 1696587	N 5678336	WKH000950
Patea River	King Edward Park, Stratford	E 1710433	N 5644464	PAT000297
Patea River	Boatrap, Patea	E 1727517	N 5596784	PAT000995
Waingongoro River	Eltham Presbyterian Camp	E 1710861	N 5635349	WGG000492
Waingongoro River	Ohawe Beach	E1702531	N 5617624	WGG000995
Kaupokonui River	Beach domain	E 1691110	N 5619893	KPK000995
Lake Opunake	adjacent to boatrap	E 1674029	N 5632022	LOP000001
Timaru Stream	end of Weld Road	E 1697622	N 5669438	TMR000497
Waimoku Stream	Oakura Beach	E 1681725	N 5669851	WMK000298
Oakura River	d/s SH45 bridge	E1682721	N 5670440	OKR000497
Waitara River	Town wharf	E 1707203	N 5682572	WTR000922
Urenui River	Urenui estuary	E 1720245	N 5683370	URN000480
Manganui River	Everett Park (d/s Kurapete S)	E1711149	N 5669127	MGN000435
Lake Ratapiko	Boatrap	E1714913	N 5659488	LRP000050
Lake Rotokare	Adjacent to boatrap	E 1721182	N5631898	LRK000003

Sample collection, field measurements, and analyses were undertaken according to documented Taranaki Regional Council procedures. It was intended that on average, three samples would be collected from each of the sites in each month when hydrological flow conditions permitted, within two hours of high tide (due to the format of the coastal programme). However, late spring and early summer wet weather affected the frequency of sample collection earlier in the period. Sampling commenced in early November 2012 with only three of the sampling surveys performed prior to January 2013 due to a very wet late spring-early summer period. The majority of the surveys were performed over the latter half of the summer and early autumn period. Bathing water samples were normally taken between the hours of 0900 and 1800 hours (NZDST) with none collected within a three day period following significant river/stream fresh conditions. [NB: regional differences in rainfall patterns have caused difficulties at various sites in the past as localised rainfall may impact on bacteriological quality on isolated occasions]. Where necessary, a 2 metre sampling pole was used for bacteriological sample collection immediately beneath the water surface and at a minimum of calf depth at the sites. Thirteen samples were collected from all but one site (12 samples) during the season.

Samples were analysed for enterococci, *E. coli* and faecal coliform bacteria, turbidity and conductivity. In addition, at each of the sites the following information was recorded: time, water temperature, weather, colour/appearance, estimation of algal cover on the streambed, number of bathers and other users, presence of wildfowl etc., and flow characteristics. All sites' locations (map references and GPS) and descriptions are stored in the Council's Taradise and ESAM computer databases and

all analytical results were stored in the Lab database following standard sample registration procedures.

After consultation with Taranaki District Healthboard, cyanobacteria monitoring commenced at each of the three lake sites in the 2006-2007 bathing season and has continued to date including an additional lake site. Cyanobacteria can produce toxicity in recreational waters which pose risks to humans and animals by contact or consumption during recreational activities. Visual checks for surface scums were made on each sampling occasion and lake samples were collected for microscopic analysis and enumeration which were performed in the TRC biological laboratory. A more comprehensive benthic cyanobacteria monitoring programme for the river sites was instigated over the 2012-2013 period, the results of which will be reported separately.

Results were posted on the Taranaki Regional Council website (www.trc.govt.nz) for public and local health authority notification in particular, as soon as checking had been completed. Mapping of the results was also included on the more recently established Taranaki District Health Board website (www.tdhb.org.nz) in the 2012-2013 season. Where results fell in the 'Action' mode, further investigations (e.g. sampling and inspections) were performed when considered necessary i.e.: where historical databases and staff expertise indicated this was warranted. Cyanobacteria information was included on the websites for all lake sites.

2.3.2 Additional monitoring (MfE guidelines)

The revised guidelines (MfE, 2003) require weekly surveillance monitoring during the 5-month recreational period, with a minimum of 20 data points collected, regardless of weather conditions or state of the tide. Following consultation with the three territorial local authorities and Taranaki District Health Board, TRC undertook to add seven sampling occasions to the SEM protocol (13 dry weather samples per season) at two of the most popular freshwater recreational sites (Lake Rotomanu and Waiwhakaiho River at Merrilands Domain) in the 2003-04 period and this additional monitoring has continued annually since. These seven sampling occasions were systematically selected (one per week), where possible in weeks not sampled by the SEM programme and were performed regardless of prior weather conditions or tides but adhering to all other SEM programme protocols and using documented sampling methods. Both sites were signposted advising the public of monitoring activity. Also, the additional data were included on the TRC website [Note: These data will not be used for future trend detection purposes as they do not comply with the format of the originally established SEM programme].

3. Results

3.1 Introduction

Sampling times in relation to tidal conditions (particularly for estuarine sites, see Appendix II), weather conditions and sites' usage information are contained in Appendix III and IV. Timing of sampling in relation to river flows is illustrated by Figures 7, 13, 18, 20 and 25. Those illustrate that the majority of the sampling occasions coincided with steady to low river recession flow conditions. Very occasionally sampling was affected by localised rainfall and/or a prior increase in river flows. However, where possible no sampling was undertaken within three days following significant river freshes. A total of 13 samples were collected at each site during the period from early November 2012 to late March 2013 (with the exception of Lake Ratapiko where the very low lake level prevented sample collection on one occasion).

Sampling was confined entirely to weekdays during the period with no public holidays included due to sampling personnel and laboratory schedules' requirements. For these reasons, recreational usage of the waters was generally less intensive, often with no apparent usage at the time of sampling. However, all sites are known to be regularly utilised for bathing and other contact recreational activities, particularly at weekends, dependent on suitable weather conditions (see Appendix IV of TRC, 1999). The two additional sites included in the 2001-2002 programme (Patea River at Stratford and Waingongoro River at Eltham), and monitored annually since then, have been identified as used locally for bathing and other recreational purposes. The two lake sites (Ratapiko and Opunake) added to the 2006-2007 programme are also used for these purposes, while Lake Rotokare (added in the 2007-2008 season for cyanobacteria monitoring) is used extensively for recreational boating activities. The lower Patea River site (added in 2007-2008 year as a result of a Patea Wastewater Treatment Plant consent monitoring condition) is used principally for boating purposes. The lower Waitara River site (added in 2009-2010) is used for boating and bathing purposes, more so recently with the construction of a new wharf in the town. The Te Henui Stream and lower Waiwhakaiho River sites (added in 2011-2012) are both used for bathing (the latter more particularly) as the New Plymouth coastal walkway has provided improved access.

3.2 Presentation of results and discussion

All results are presented and discussed on a site-by-site basis for the sampling period, which extended from 1 November 2012 to 27 March 2013 and totalled thirteen sampling occasions at each site. The results for the sites with additional (seven) sampling occasions are also presented within the discussion for the two appropriate sites.

3.2.1 Lake Rotomanu

3.2.1.1 SEM programme

At the times of the surveys there was minimal bathing usage of the lake recorded although boating, water and jet-skiing, kayaking, and/or picnicking activities were recorded at the time of several of the sampling surveys.

Ducks and gulls were present on the lake or in the vicinity of the lake edge throughout most the period and were often attracted to the immediate vicinity of the sampling site by public feeding of the ducks. Lake levels were relatively consistent throughout the period. A wetland had been created recently at Peringa Park to improve the quality of stormwater runoff entering the lake.

The data for this site are presented in Table 3 and illustrated in Figure 2, with a statistical summary provided in Table 4.

Table 3 Analytical results for Lake Rotomanu

Date	Time	Conductivity @ 20° C	Bacteria			Temperature	Turbidity
	(NZST)	(mS/m)	<i>E. coli</i> (nos/100ml)	Enterococci (nos/100ml)	Faecal coliforms (nos/100ml)	(°C)	(NTU)
01.11.12	1150	16.4	92	32	96	19.8	9.6
28.11.12	1050	16.4	190	74	190	21.4	6.8
13.12.12	1030	15.8	240	46	240	22.8	6.0
28.01.13	1045	15.4	150	88	170	24.8	12
31.01.13	0840	15.4	150	84	150	25.6	11
11.02.13	0745	15.2	430	280	450	22.5	10
14.02.13	0955	15.6	66	9	66	24.2	14
18.02.13	1250	15.6	26	5	26	24.7	8.6
25.02.13	1120	16.2	23	20	23	21.8	8.8
28.02.13	1150	16.3	60	37	60	24.1	7.4
04.03.13	1040	16.4	80	27	84	22.7	5.8
12.03.13	1045	17.1	260	90	260	22.5	9.2
27.03.13	1035	16.7	100	33	100	22.0	7.9

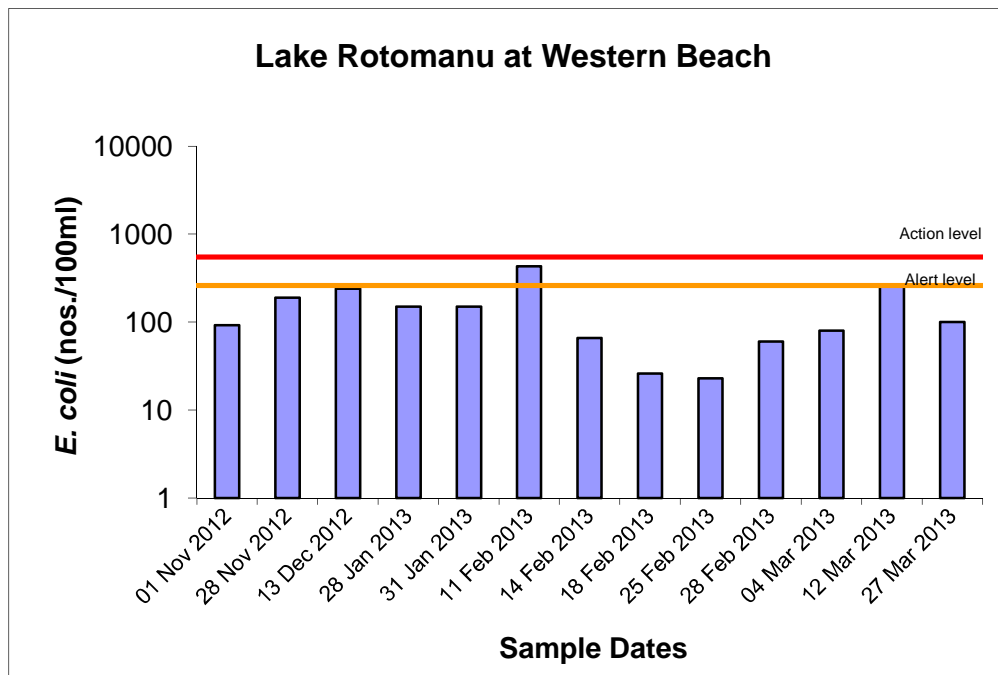


Figure 2 *E. coli* numbers for Lake Rotomanu during the regular season
(Note: Action limit >550/100 ml [single sample: Alert limit => 260 nos/100ml [single sample]])

Table 4 Statistical results summary for Lake Rotomanu

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	15.2	17.1	16.2
<i>E. coli</i>	nos/100ml	13	23	430	100
Enterococci	nos/100ml	13	5	280	37
Faecal coliforms	nos/100ml	13	23	450	100
Temperature	°C	13	19.8	25.6	22.7
Turbidity	NTU	13	5.8	14	8.8

The lake, which is close to the coast, is replenished from time to time by inflow from the nearby Waiwhakaiho River. Water quality was relatively good although clarity was poorer than usual (median turbidity: 8.8; range: 8.2 NTU) possibly as a result of some sediment disturbance or fluctuating concentrations of suspended algae. Water temperatures were relatively high (above 20°C) through most of the period with a high maximum of 25.6°C (in late January 2013) and a range of 5.8°C. Conductivity had a narrow range through the season.

Generally bacteriological quality was relatively good considering that the inflow to the lake is from the lower reaches of a river draining a developed catchment. Elevated numbers of *E. coli* (in the 'Alert' mode) were found on one occasion coincident with the wildfowl population (mainly ducks) attracted to the main public recreational area and a lower lake level during a very dry period. No counts exceeded the 'Action' mode at any time and no other bacterial counts reached the 'Alert' level. NPDC signage discouraging lake usage was not required to be erected at the lake, dissimilar to the case in most previous seasons.

3.2.1.2 Comparison with guidelines

Comparison with the 2003 guidelines for freshwater contact usage is summarised in Table 5.

Table 5 Bacterial guidelines performance at Lake Rotomanu [% of 13 samples]

Parameter	Number of exceedances of <i>E. coli</i> guidelines	
	ALERT Single sample 261-550/100ml	ACTION Single sample >550/100 ml
<i>E. coli</i>	1 [8]	0 [0]

(Designation: freshwater contact recreational area)

No single samples exceeded the 'Action' mode during the period, and one single sample was recorded within the 'Alert' mode.

3.2.1.3 Comparison with previous summers' surveys

A statistical comparison of each of the seventeen seasons' *E. coli* surveys data is presented graphically in Appendix V for all sites. These summer data for the Lake Rotomanu site are summarised in Table 6 and illustrated in Figure 3.

Table 6 Summary of *E. coli* bacteriological water quality data (nos/100ml) for all summer surveys at Lake Rotomanu to date

Summer	96/97	97/98	98/99	99/00	00/01	01/02	02/03	03/04	04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13
Minimum	3	12	7	7	1	31	9	20	<3	6	7	54	51	23	6	46	23
Maximum	899	740	200	140	90	980	2200	5500	220	380	3000	1200	6000	3600	150	2300	430
Median	32	46	79	25	14	110	92	120	11	68	72	180	220	100	34	120	100

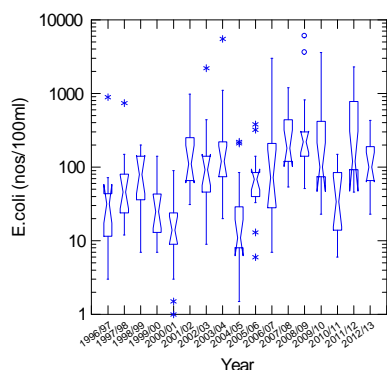
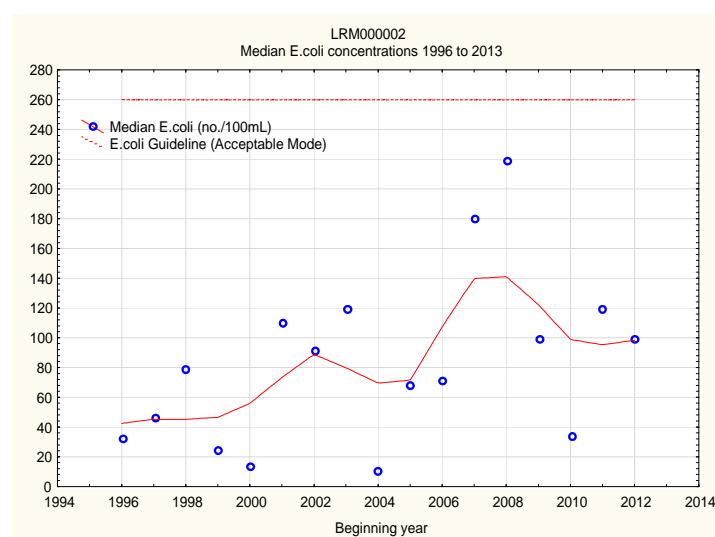


Figure 3 Box and whisker plots for all summer SEM surveys of *E. coli* bacteria numbers at Lake Rotomanu

The more recent trend of moderately high median *E. coli* numbers in recent years re-occurred over the summer of 2012-2013 but with a narrower range of counts recorded by this survey and a slightly elevated median value, the equal sixth highest to date. However, the maximum count was the sixth lowest to date and remained well below the 'Alert' level of the 2003 MfE guidelines.

Trend analysis of these median *E. coli* numbers has been performed for the seventeen seasons of data by first applying a LOWESS fit (tension 0.4) to a time scatterplot of the median numbers (Figure 4) and testing the significance of any trend using the Mann-Kendall test at the 5% level followed by Benjamini-Hochberg False Discovery Rate (FDR) analysis.



N = 16
Kendall tau = +0.326
p level = 0.068 [$>$ FDR, $p = 0.176$]
N/S at $p < 0.05$

Figure 4 LOWESS trend plot of median *E. coli* numbers (per 100ml) at Lake Rotomanu for the 1996-2013 period

Overall, a positive, but not statistically significant increase in median *E. coli* numbers has been found over the seventeen seasons of monitoring although median numbers

have trended slightly downwards over the latest four seasons. None of these seasonal medians exceeded the 'Alert' or 'Action' modes.

3.2.1.4 MfE guidelines additional sampling

Seven additional samples were collected randomly under varying weather conditions during the survey season. Limited bathing, but some boating and picnicking were noted on these occasions. Ducks were present in moderate numbers on the lake on all occasions (and sometimes fed by picnickers) and dogs were recorded on the banks infrequently. Two surveys occurred by chance soon after significant rainfall events and four others followed wet weather some time in the preceding 5 days.

The data from these additional surveys are presented in Table 7, illustrated and statistically summarised (with the 13 SEM samples' data) in Figure 5 and Table 8 respectively.

Table 7 Lake Rotomanu additional seven water quality samples' results

Date	Time	Conductivity @ 20° C	Bacteria			Temperature	Turbidity
	(NZST)	(mS/m)	<i>E. coli</i> (nos/100ml)	Enterococci (nos/100ml)	Faecal coliforms (nos/100ml)	(°C)	(NTU)
06.11.12	0955	16.1	46	8	57	17.0	8.4
19.12.12	1015	15.6	140	35	150	22.8	7.8
07.01.13	1045	15.1	80	20	92	23.3	13
22.01.13	1010	15.2	150	100	150	23.4	15
07.22.13	1025	15.1	180	40	190	23.0	10
21.02.13	1030	15.8	28	11	28	24.0	7.8
21.03.13	0910	16.5	240	100	240	18.8	11

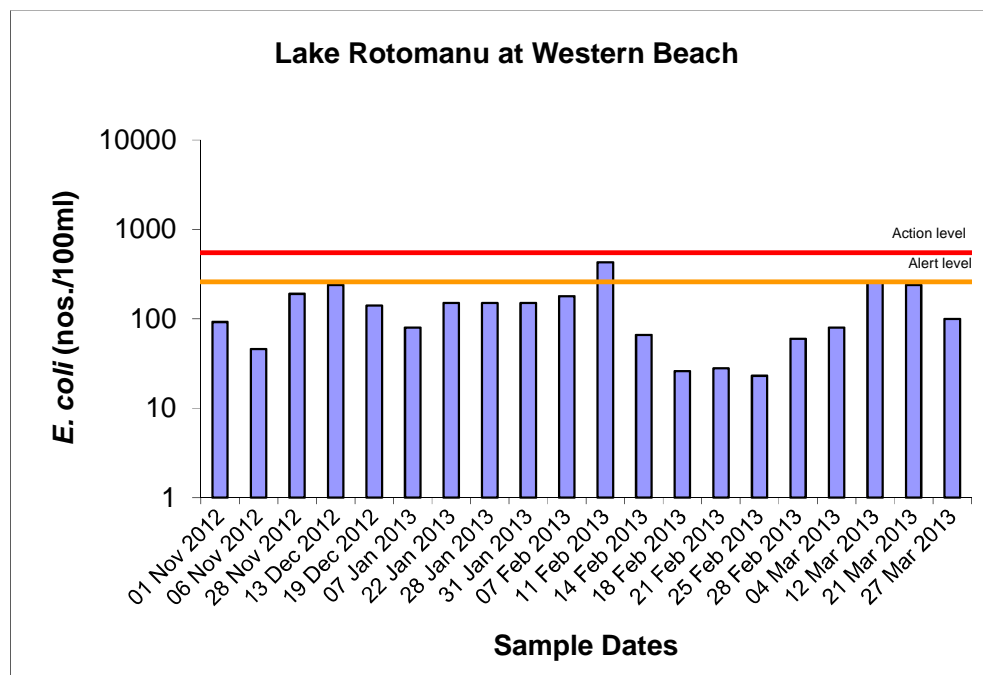


Figure 5 *E. coli* numbers for Lake Rotomanu for the 20 sample extended survey

Table 8 Summary statistics for SEM and additional samples at Lake Rotomanu

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	20	15.1	17.1	15.8
<i>E. coli</i>	nos/100ml	20	23	430	120
Enterococci	nos/100ml	20	5	280	36
Faecal coliforms	nos/100ml	20	23	450	125
Temperature	°C	20	17.0	25.6	22.8
Turbidity	NTU	20	5.8	15	9.0

The additional sampling resulted in a small increase in the overall seasonal median bacteria number of 20 *E.coli* (per 100mls). These additional surveys' bacteria counts had a relatively narrow range (46 to 240 *E. coli* per 100mls and a slightly higher median (120 *E.coli* per 100 mls) than the standard SEM sampling survey range, due to the proximity of wet weather to at least two of the sampling survey occasions.

3.2.1.5 Comparison with guidelines

Comparison with the 2003 guidelines for freshwater contact usage is summarised in Table 9.

Table 9 Bacterial guidelines performance at Lake Rotomanu [% of 20 samples]

Parameter	Number of exceedances of <i>E. coli</i> guidelines	
	ALERT Single sample 261-550/100ml	ACTION Single sample >550/100ml
<i>E. coli</i>	1 [5]	0 [0]

(Designation: freshwater contact recreational area)

There was no change in the number of exceedances of the single sample 'Alert' and 'Action' modes with the additional monitoring, as no additional exceedance of the 'Alert' level or of the 'Action' level occurred despite recent wet weather conditions and elevated river flows on occasions.

3.2.1.6 Cyanobacteria

No visual surface algal blooms were recorded during the season but slightly more turbid lake water quality, possibly due to suspended algae and/or sediment, was noted during the season. Microscopic scans of samples found no cyanobacteria present in all but one of the samples analysed during the season. There was a relatively low number of cyanobacteria detected in early November, 2012 after a short period of wet weather. On this occasion the only taxon present was *Anabaena*. There were no further cyanobacteria detections during the remainder of the period. The results of this sampling are presented in Table 10.

Table 10 Cyanobacteria counts (cells/ml) for Lake Rotomanu
[Health warning: >15,000 cells/ml]

Date	Cyanobacteria total cell count (cells/ml)	Principal species
06.11.12	750	<i>Anabaena</i>
19.12.12	nil	-
07.01.13	nil	-
22.01.13	nil	-
07.22.13	nil	-
21.02.13	nil	-
21.03.13	nil	-

Therefore, no cyanobacteria related health warning signage was required at the lake as the density remained well below the health warning high alert level of 15,000 cells/ml (TDHB, 2006), unlike during the 2008-2009 season when *Microcystis* dominated the lake and when *Anabaena* was present in moderate numbers in January 2009 (TRC, 2009). No toxin testing of the lake waters was therefore required by the Taranaki Health Board. *Microcystis* had also been found in the lake during the 2009-2010 season when cyanobacteria numbers ranged from nil to 7600 cells/ml (TRC, 2010), but no cyanobacteria were found during the 2010-2011 season (TRC, 2011). *Anabaena* was found on two occasions (in low numbers) during the 2011-2012 season (TRC, 2012).

3.2.2 Waiwhakaiho River at Merrilands Domain

3.2.2.1 SEM programme



Photo 1 Bathing in the Waiwhakaiho River at the popular Merrilands Domain site, January 2013

Minimal usage of this site was recorded at the time of the sampling surveys, with minor bathing and some of the usual walking or picnicking on the banks of the river noted. From time to time, gulls were noted in small numbers and on a few occasions dogs were swimming in the river

The data for this site are presented in Table 11 and illustrated in Figure 7, with a statistical summary provided in Table 12. River flow information is illustrated in Figure 6.

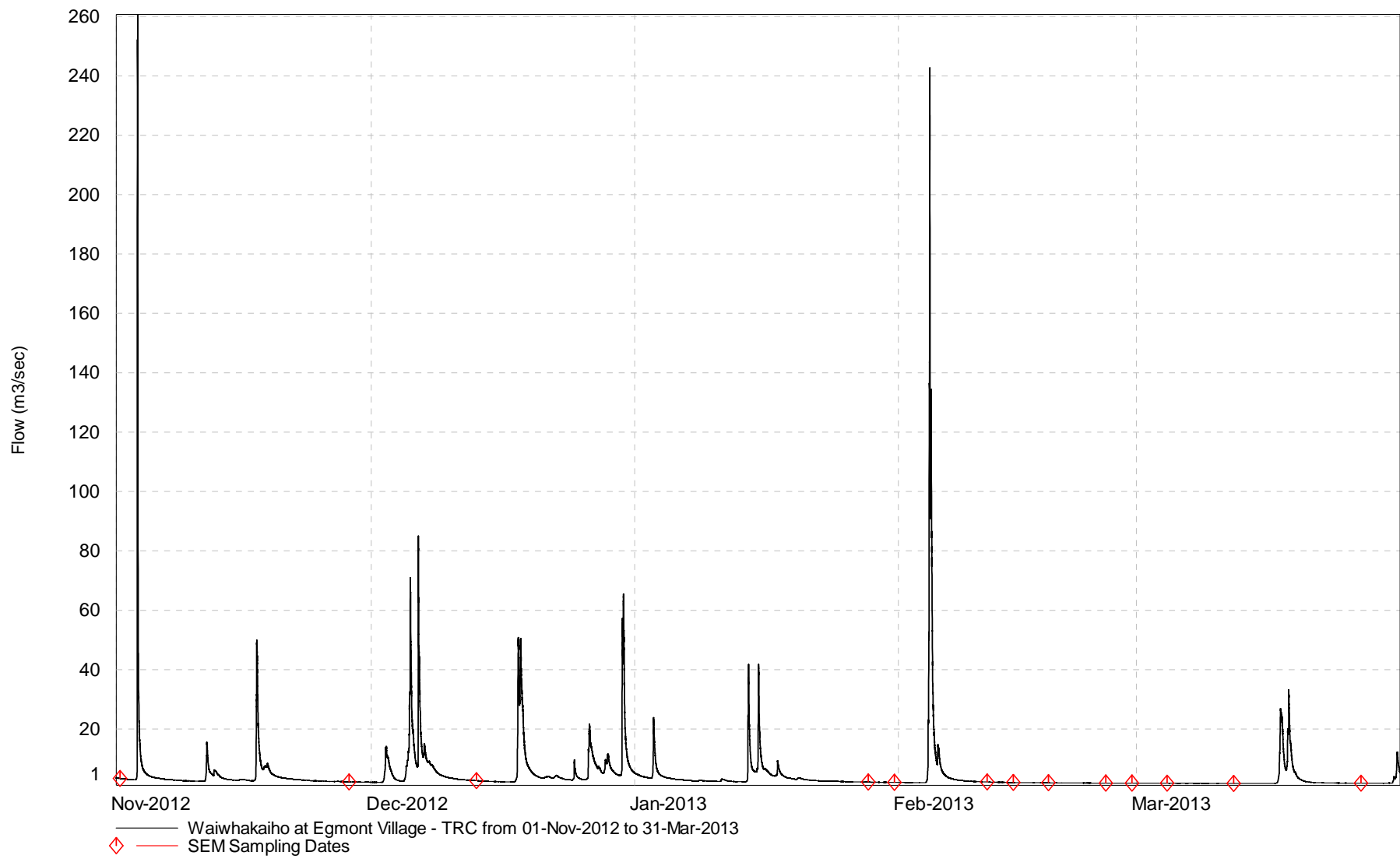
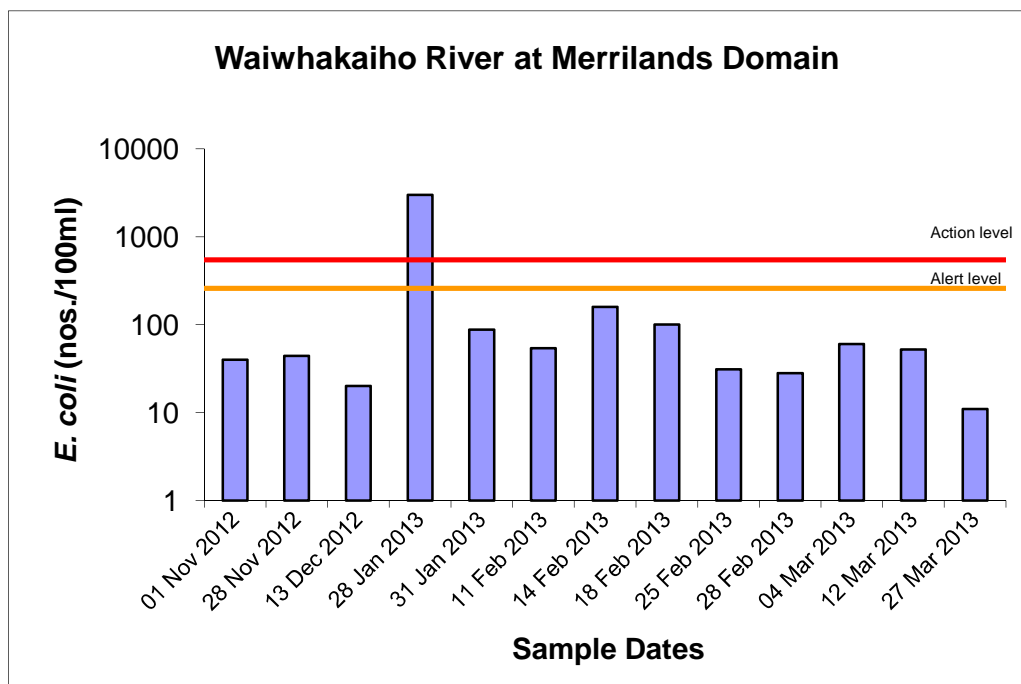


Figure 6 River flow in the Waiwhakaiho River during the survey period

Table 11 Analytical results for the Waiwhakaiho River at Merrilands Domain

Date	Time	Conductivity @ 20° C	Bacteria			Temperature	Turbidity
	(NZST)	(mS/m)	<i>E. coli</i> (nos/100ml)	Enterococci (nos/100ml)	Faecal coliforms (nos/100ml)	(°C)	(NTU)
01.11.12	1400	10.7	40	<1	40	16.3	0.6
28.11.12	1240	12.9	44	9	46	19.4	0.6
13.12.12	1145	11.7	20	4	23	19.4	0.6
28.01.13	1220	13.4	3000	5600	4500	21.6	0.8
31.01.13	0820	13.9	88	16	92	20.6	0.5
11.02.13	0715	12.0	54	92	54	17.6	0.3
14.02.13	0935	13.2	160	120	160	18.3	0.8
18.02.13	1230	13.7	100	47	100	21.6	0.3
25.02.13	1145	14.5	31	48	31	18.5	0.5
28.02.13	1320	14.8	28	24	28	21.0	0.4
04.03.13	1015	14.9	60	54	63	19.3	0.3
12.03.13	1140	15.3	52	46	52	19.4	0.4
27.03.13	1150	14.0	11	31	11	17.6	0.5

**Figure 7** *E. coli* numbers for the Waiwhakaiho River at Merrilands Domain during the regular survey season**Table 12** Statistical results summary for the Waiwhakaiho River at Merrilands Domain

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	10.7	15.3	13.7
<i>E. coli</i>	nos/100ml	13	11	3000	52
Enterococci	nos/100ml	13	1	5600	46
Faecal coliforms	nos/100ml	13	11	4500	52
Temperature	°C	13	16.3	21.6	19.4
Turbidity	NTU	13	0.3	0.8	0.5

This river drains an extensively developed farmland catchment prior to flowing through two kilometres of urban New Plymouth upstream of this popular domain and recreational area sited in the lower reaches of the river nearly 4 km from the sea.

Water temperatures varied over a relatively narrow range of 5.3°C between early November and late March, with a maximum of 21.6°C in mid February 2013. Conductivity and turbidity results were indicative of very clean, clear, relatively high water quality but moderate algal cover (up to 80% mats) was relatively common through the period.

Considering the influence of agricultural activities, particularly dairying in the catchment, bacteriological water quality was relatively high. Bacterial numbers were not excessive remaining within a relatively narrow range on all but one occasion through the season and only this one high count was recorded. This occurred in late January 2013 whereas the follow-up sample three days later found bacterial levels had returned to the normal relatively low counts.

3.2.2.2 Comparison with guidelines

Comparison with the 2003 guidelines for freshwater contact usage is summarised in Table 13.

Table 13 Bacterial guidelines performance at the Waiwhakaiho River Merrilands Domain site [% of 13 samples]

Parameter	Number of exceedances of <i>E. coli</i> guidelines	
	ALERT Single sample 261-550/100ml	ACTION Single sample >550/100 ml
<i>E. coli</i>	0 [0]	1 [8]

(Designation: freshwater contact recreational area)

One single sample was recorded within the 'Action' mode and none in the 'Alert' mode during the season. Bacteriological water quality measured at this site was therefore within the acceptable standard for contact recreational usage for almost all sampling occasions during the survey period.

3.2.2.3 Comparison with previous summers' surveys

A statistical comparison of each of the seventeen summer's surveys data is presented graphically in Appendix V for all sites. These data for the Waiwhakaiho River site are summarised in Table 14 and illustrated in Figure 8.

Table 14 Summary of *E. coli* bacteriological water quality data (nos/100 ml) for all summer surveys in the Waiwhakaiho River at Merrilands domain to date

Summer	96/97	97/98	98/99	99/00	00/01	01/02	02/03	03/04	04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13
Minimum	16	16	26	8	6	17	3	34	11	15	8	28	19	23	4	8	11
Maximum	970	1800	330	100	270	420	130	320	330	160	510	110	110	570	200	120	3000
Median	42	84	69	39	23	60	29	77	54	34	48	48	46	110	54	40	52

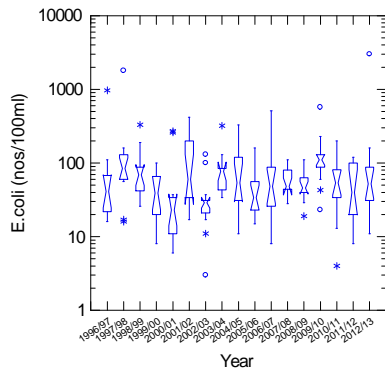
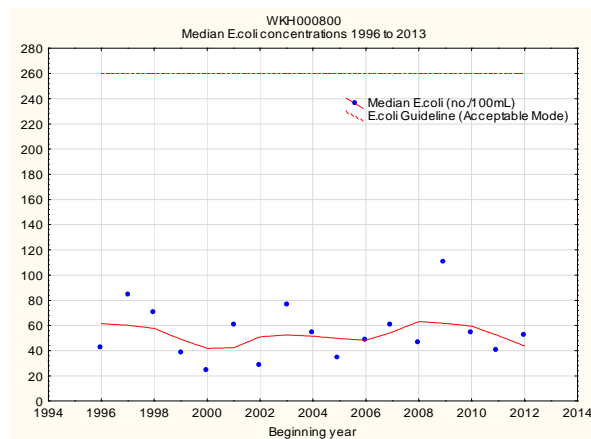


Figure 8 Box and whisker plots for all summer SEM surveys of *E. coli* bacteria numbers in the Waiwhakaiho River at Merrilands Domain

The median *E. coli* number in the 2012-2013 period was typical of most recorded to date and well below the maximum of the range of historical medians (Table 14 and Figure 8), all of which have been much lower than the 'Alert' level of the 2003 MfE guidelines.

Trend analysis of these median *E. coli* numbers has been performed for the seventeen seasons of data by first applying a LOWESS fit (tension 0.4) to a time scatterplot of the median numbers (Figure 9) and testing the significance of any trend using the Mann-Kendall test at the 5% level followed by Benjamini-Hochberg False Discovery Rate (FDR) analysis.



N = 17
Kendall tau = +0.007
p level = 0.967 [$>$ FDR, p = 0.967]
N/S at p < 0.05

Figure 9 LOWESS trend plot of median *E. coli* numbers (per 100ml) at the Waiwhakaiho River, Merrilands Domain for the 1996 to 2013 period

A statistically insignificant temporal trend of minimal change in median *E. coli* numbers was found over the seventeen seasons of monitoring. None of these seasonal medians exceeded the 'Alert' or 'Action' modes.

3.2.2.4 MfE guidelines additional sampling

Seven additional samples were collected randomly at irregular intervals and under varying weather conditions (two of which by chance were soon after significant wet weather events) during the survey season.

Recreational activities on these occasions included walking and picnicking (often with dogs present in the river or at the river's edge).

The data from these additional surveys are presented in Table 15, illustrated in Figure 10, and statistically summarised (together with the 13 SEM samples' data) in Table 16.

Table 15 Waiwhakaiho River at Merrilands Domain additional seven water quality samples' results

Date	Time	Conductivity @ 20°C	Bacteria			Temperature	Turbidity
	(NZST)	(mS/m)	<i>E. coli</i> (nos/100ml)	Enterococci (nos/100ml)	Faecal coliforms (nos/100ml)	(°C)	(NTU)
06.11.12	0935	10.4	320	9	320	12.4	1.1
19.12.12	0955	7.0	1700	590	1700	16.0	1.3
07.01.13	1030	11.2	58	21	60	19.8	1.0
22.01.13	0955	11.8	100	33	100	20.0	0.8
07.02.13	1005	9.9	280	110	300	16.3	0.7
21.02.13	1010	14.5	300	1400	310	19.5	0.5
21.03.13	0945	10.9	130	180	140	14.5	0.6

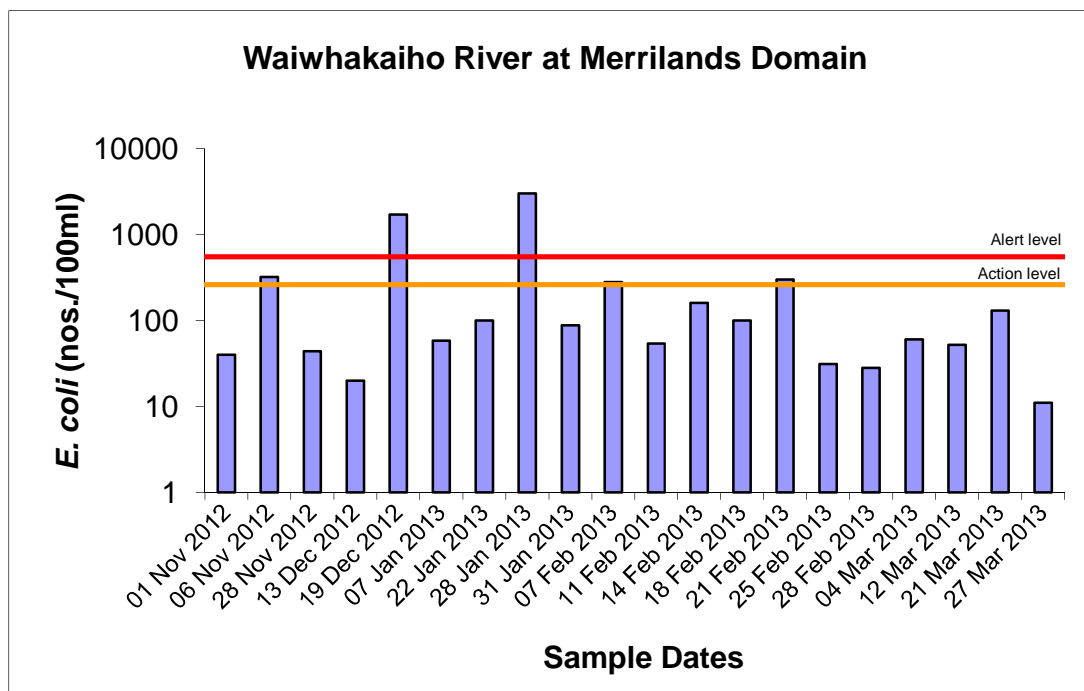


Figure 10 *E. coli* numbers for the Waiwhakaiho River at Merrilands Domain for the 20 sample extended survey

Table 16 Summary statistics for SEM and additional samples in the Waiwhakaiho River at Merrilands Domain

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	20	7.0	15.3	13.0
<i>E. coli</i>	nos/100ml	20	11	3000	74
Enterococci	nos/100ml	20	1	5600	46
Faecal coliforms	nos/100ml	20	11	4500	78
Temperature	°C	20	12.4	21.6	19.4
Turbidity	NTU	20	0.3	1.3	0.6

These seven additional samples resulted in increases in two of the seasonal median bacterial numbers in comparison with the regular SEM programme results (Table 12). However the ranges for all three bacteria species did not alter due to an elevated count recorded in late January 2013, under low river flow conditions during the dry weather SEM programme (Table 11).

3.2.2.5 Comparison with guidelines

Comparison with the 2003 guidelines for freshwater contact usage is summarised in Table 17.

Table 17 Bacterial guidelines performance in the Waiwhakaiho River at Merrilands Domain [% of 20 samples]

Parameter	Number of exceedances of <i>E. coli</i> guidelines	
	ALERT Single sample 261-550/100ml	ACTION Single sample >550/100 ml
<i>E. coli</i>	3 [15]	2 [10]

(Designation: freshwater contact recreational area)

Three exceedances of the single sample 'Alert' mode occurred and two sample counts exceeded 550 *E. coli* per 100 mls ('Action' mode). Follow-up samples collected in the course of the SEM programme after the exceedances found much lower counts which were within the guidelines. No health warning signage was displayed as exceedances were due to preceding heavy rainfall events and/or numbers fell markedly under dry weather conditions.

3.2.3 Waiwhakaiho River adjacent to Lake Rotomanu

**Photo 2** A typical gull population immediately upstream of the Waiwhakaiho River, Lake Rotomanu site, February 2013

Minimal usage of this site was recorded at the time of the sampling surveys, with no bathing but some whitebaiting (in season) on the banks of the river. Seagulls (extremely abundant) and ducks were frequently present at this site with large numbers of gulls known to be present along the lower reaches of the river upstream of this site.

The data for this site are presented in Table 18 and illustrated in Figure 11, with a statistical summary provided in Table 19. River flow information is illustrated in Figure 6 as it is also applicable to this site.

Table 18 Analytical results for the Waiwhakaiho River adjacent to Lake Rotomanu

Date	Time	Conductivity @ 20°C	Bacteria			Temperature	Turbidity
	(NZST)	(mS/m)	<i>E. coli</i> (nos/100ml)	Enterococci (nos/100ml)	Faecal coliforms (nos/100ml)	(°C)	(NTU)
01.11.12	1200	10.7	230	330	240	16.4	0.9
28.11.12	1100	13.0	1100	880	1200	19.8	0.6
13.12.12	1040	11.7	1900	1600	1900	19.9	0.9
28.01.13	1100	14.0	800	800	1000	23.2	0.8
31.01.13	0850	14.7	1100	600	1500	22.0	0.9
11.02.13	0755	13.3	670	640	820	18.7	0.4
14.02.13	1005	13.4	600	870	640	20.4	0.6
18.02.13	1400	13.6	5000	8700	5500	24.3	0.8
25.02.13	1110	15.2	930	5400	1000	20.2	0.7
28.02.13	1205	17.9	4200	4000	4900	22.3	0.9
04.03.13	1055	15.3	1800	2200	2200	19.7	0.6
12.03.13	1110	1100	970	1200	1300	19.6	1.3
27.03.13	1125	14.3	1400	2500	1600	19.0	0.5

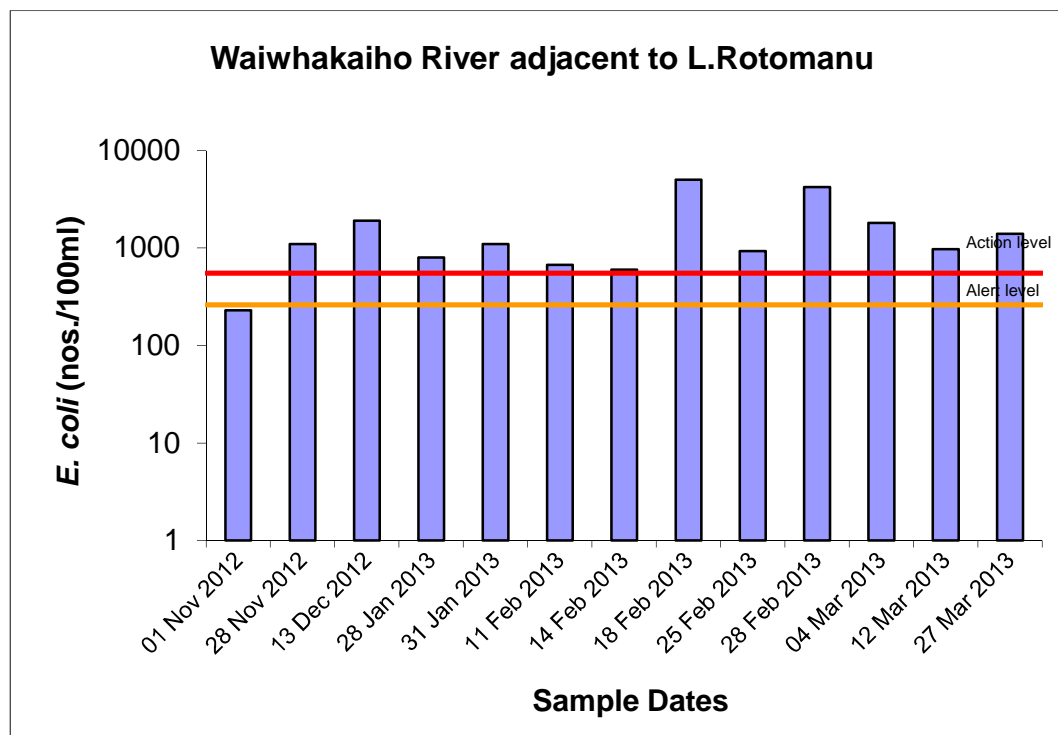


Figure 11 *E. coli* numbers for the Waiwhakaiho River adjacent to Lake Rotomanu during the regular survey season

Table 19 Statistical results summary for the Waiwhakaiho River adjacent to Lake Rotomanu

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	10.7	1100	14.0
<i>E. coli</i>	nos/100ml	13	230	5000	1100
Enterococci	nos/100ml	13	330	8700	1200
Faecal coliforms	nos/100ml	13	240	5500	1300
Temperature	°C	13	16.4	24.3	19.9
Turbidity	NTU	13	0.4	1.3	0.8

This river drains an extensively developed farmland catchment prior to flowing through six kilometres of urban New Plymouth upstream of this popular recreational area sited in the lower reaches of the river about 700m from the sea. Large flocks of seagulls are known to roost on the river bed in the lower reaches between Merrilands and this site near the recently constructed walkway bridge.

Faecal source DNA tracking marker analyses performed during the 2011-2012 period (TRC, 2012) found that the Merrilands Domain samples contained bacteria only indicative of ruminants origin on one occasion and ruminants and wildfowl origin on another occasion. However, samples from the lower river site (adjacent to Lake Rotomanu) were found to contain bacteria very specifically of gulls origin on both occasions and a faint indication of ruminants origin on the latter sampling occasion. No bacteria of human origin were found at either site on either sampling occasion.

Water temperatures varied over a range of 7.9°C between early November and late March, with a maximum of 24.3°C in mid February 2013. Conductivity and turbidity results were indicative of clean, clear, relatively high water quality but significant algal cover (widespread mats) was noted through the latter half of the period. There was one instance of partial seawater ingress during very low flow conditions in mid March 2013.

Bacteriological water quality was poor with numbers varying over very wide ranges with a high median *E. coli* value of 1100 per 100 mls particularly in comparison with numbers found at the upstream Merrilands Domain site. Individual sample *E. coli* counts exceeded 600 per 100 mls on almost all occasions coincident with the presence of large gull populations. The marked river flow fluctuations due to increased morning HEP generation could be expected to exacerbate wildfowl (gull) faecal contamination by inundation of river shingle areas where birds roost etc., during lower flow periods. Several follow-up surveys (particularly during the December-January period) also found *E. coli* numbers either in the 'Alert' mode or more predominantly in excess of the 'Action' level.

3.2.3.1 Comparison with guidelines

Comparison with the 2003 guidelines for freshwater contact usage is summarised in Table 20.

Table 20 Bacterial guidelines performance at the Waiwhakaiho River adjacent to Lake Rotomanu site [% of 13 samples]

Parameter	Number of exceedances of <i>E. coli</i> guidelines	
	ALERT Single sample 261-550/100ml	ACTION Single sample >550/100 ml
<i>E. coli</i>	0 [0]	12 [92]

(Designation: freshwater contact recreational area)

Twelve single samples were recorded within the 'Action' mode and no samples in the 'Alert' mode during the season. Bacteriological water quality measured at this site was very seldom within the acceptable standard for contact recreational usage through the survey period (see Appendix VII) and therefore appropriate warning signage was required at this site adjacent to the walkway throughout the survey period. Appropriately worded signage may be retained on a permanent basis in future.

3.2.3.2 Comparison with previous summers' surveys

A statistical comparison of ten summer's surveys data is presented graphically in Appendix V for all sites [Note: These data had been collected prior to the current year from time to time for consent monitoring purposes]. These data for the site in the Waiwhakaiho River adjacent to Lake Rotomanu are summarised in Table 21 and illustrated in Figure 12.

Table 21 Summary of *E. coli* bacteriological water quality data (nos/100ml) for all summer surveys in the Waiwhakaiho River adjacent to Lake Rotomanu

Summer	96/97	97/98	98/99	99/00	00/01	01/02	02/03	03/04	04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13
Minimum	9	-	52	-	26	-	54	-	46	-	71	-	160	-	220	77	230
Maximum	740	-	51	-	870	-	470	-	1000	-	1600	-	2600	-	3400	2000	5000
Median	72	-	120	-	110	-	210	-	270	-	320	-	490	-	885	460	1100

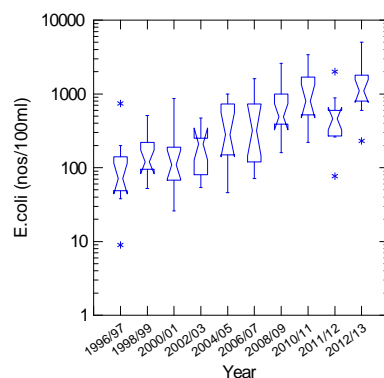
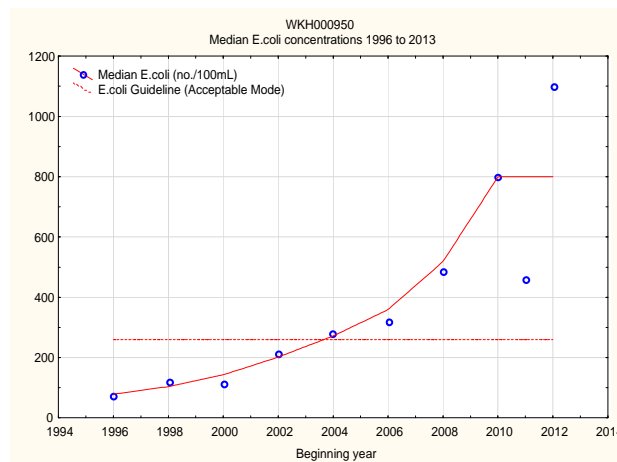


Figure 12 Box and whisker plots for all summer SEM surveys of *E. coli* bacteria numbers in the Waiwhakaiho River adjacent to Lake Rotomanu

The median *E. coli* number in the 2012-2013 period was the highest recorded to date continuing a trend of increasing medians in more recent years (Table 21 and Figure 12). Most medians have been below the 'Action' level of the 2003 MfE guidelines but

since 2003-2004 all medians have been within, or exceeded the 'Alert' level, with the latest median in excess of the 'Action' guideline. The range in 2012-2013 was also the widest seasonal range recorded to date.

Trend analysis of these median *E.coli* numbers has been performed for the ten seasons of data by applying a LOWESS fit (tension 0.4) to a time scatterplot of the median numbers (Figure 13). Testing the significance of any trend using the Mann-Kendall test at the 5% level followed by Benjamini-Hochberg False Discover Rate (FDR) analysis has been performed as there have been ten seasons monitored to date.



N = 10
 Kendall tau = +0.867
 p level = 0.0005 [FDR, p = 0.006]
 Significant at p < 0.01 after FDR

Figure 13 LOWESS trend plot of median *E.coli* numbers (per 100 ml) at the Waiwhakaiho River, adjacent to Lake Rotomanu for the 1996 to 2013 period

There has been a very significant trend ($p < 0.01$) of increasing median *E.coli* numbers over the ten seasons of monitoring with four of these seasonal medians exceeding the 'Alert' mode and two within the 'Action' mode.

3.2.4 Te Henui Stream at the mouth, East End

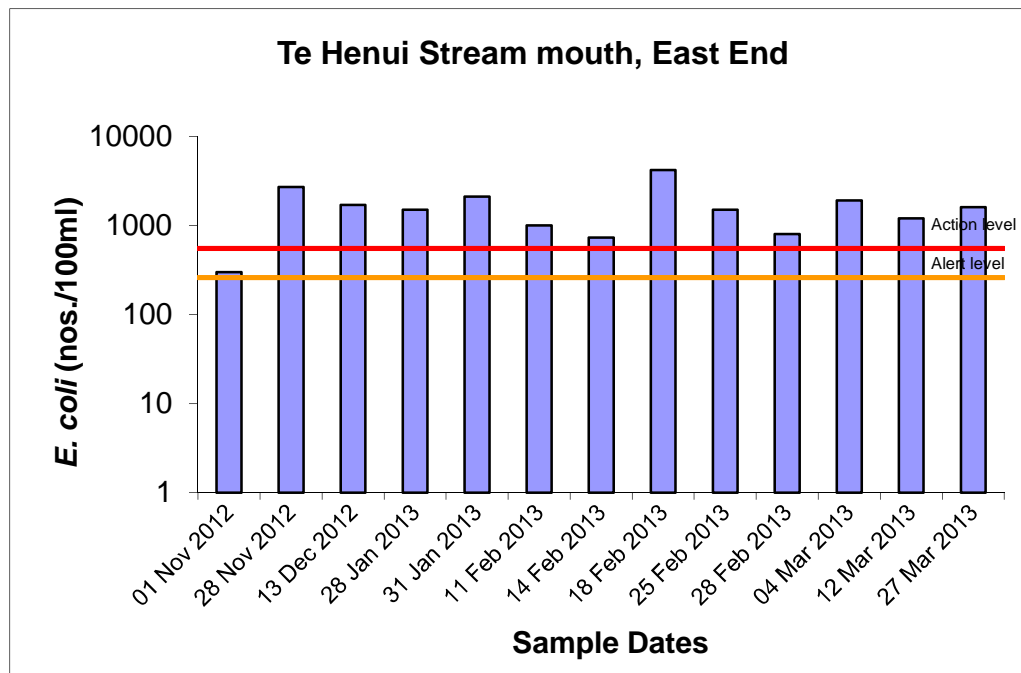
Relatively extensive usage of this site was recorded at the time of the sampling surveys, although no bathing was noted. More frequently, walking, picnicking, or whitebaiting (in season) on the banks of the stream was noted.

Ducks were common at this site on all survey occasions and gulls were present from time to time, where often they were encouraged by people feeding the wildlife.

The data for this site are presented in Table 22 and illustrated in Figure 14, with a statistical summary provided in Table 23.

Table 22 Analytical results for the Te Henui Stream at the mouth, East End

Date	Time	Conductivity @ 20°C	Bacteria			Temperature	Turbidity
	(NZST)	(mS/m)	<i>E. coli</i> (nos/100ml)	Enterococci (nos/100ml)	Faecal coliforms (nos/100ml)	(°C)	(NTU)
01.11.12	1105	54.4	300	230	300	14.8	0.5
28.11.12	1005	300	2700	1400	2700	17.0	0.6
13.12.12	0945	347	1700	1100	1800	17.6	0.6
28.01.13	0945	192	1500	1200	1500	19.8	0.5
31.01.13	1016	73.4	2100	1500	2100	21.0	0.8
11.02.13	0920	2670	1000	930	1200	19.0	1.7
14.02.13	1155	789	730	800	730	19.2	1.0
18.02.13	1505	61.7	4200	1500	4500	21.4	2.2
25.02.13	0945	782	1500	1700	1700	17.4	1.2
28.02.13	1100	2350	800	930	830	19.8	1.2
04.03.13	1405	1260	1900	930	2000	18.9	1.0
12.03.13	1000	1660	1200	1100	1300	18.0	0.9
27.03.13	0940	2870	1600	1000	1700	18.4	2.7

**Figure 14** *E. coli* numbers for the Te Henui Stream at the mouth, East End during the regular survey season**Table 23** Statistical results summary for the Te Henui Stream at the mouth, East End

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	54.4	2870	782
<i>E. coli</i>	nos/100ml	13	300	4200	1500
Enterococci	nos/100ml	13	230	1700	1100
Faecal coliforms	nos/100ml	13	300	4500	1700
Temperature	°C	13	14.8	21.4	18.9
Turbidity	NTU	13	0.5	2.7	1.0

The stream drains an extensively developed farmland catchment prior to flowing through urban New Plymouth upstream of this popular recreational area sited in the lower reaches of the stream at the coast adjacent to the walkway. Poor historical bacteriological quality, considered to be attributable mainly to wildfowl, resulted in two low tide and two high tide surveys' samples in the 2011-2012 season being forwarded to Cawthron Institute, Nelson for faecal source DNA tracking marker analyses. The initial low tide sample (which followed wet weather) contained bacteria of ruminant, gulls, and human origins while the second low tide, fine weather sample's bacteria were of ruminant, wildfowl, and human origins. The high tide, fine weather samples both contained bacteria with slight traces of ruminant origin, while only the second sample's bacteria were of wildfowl and human origins. While wildfowl, gull, and ruminant derived bacteria might have been expected in the lower reaches of this stream, the presence of bacteria from human origin warranted further investigation (which was discussed and initiated with the Taranaki Area Health Board and New Plymouth District Council). No further incidents of human markers were found at this site near the mouth of the stream nor at several sites upstream and into the rural reaches.

Water temperatures varied over a moderate range of 6.6°C between early November and late March, with a maximum of 21.4°C in mid February 2013. Conductivity and turbidity results were indicative of clean, clear, relatively high water quality subject to tidal incursions of seawater from time to time (e.g. mid February 2013 and particularly through March 2013). Extensive algal cover was recorded through most of the period.

Bacterial water quality in the 2012-2013 season was very poor with a wide range of counts and very high median *E. coli* count of 1500 per 100 mls and a relatively high minimum count.

3.2.4.1 Comparison with guidelines

Comparison with the 2003 guidelines for freshwater contact usage is summarised in Table 24.

Table 24 Bacterial guidelines performance at the Te Henui Stream mouth, East End

Parameter	Number of exceedances of <i>E. coli</i> guidelines	
	ALERT Single sample 261-550/100ml	ACTION Single sample >550/100 ml
<i>E. coli</i>	1 [8]	12 [92]

(Designation: freshwater contact recreational area)

No single sample was recorded below the 'Alert' mode during the season. Bacteriological water quality measured at this site therefore was outside the acceptable standard for contact recreational usage for the entire survey period, and almost entirely within the 'Action' mode (see Appendix VII). An additional sampling survey undertaken in late January 2013 also found a high bacterial level within the 'Action' mode. Appropriate signage therefore was required at this site adjacent to the New Plymouth walkway throughout the survey period and was the subject of a number of public enquiries. The coastal bathing waters monitored nearby at East

End beach met the enterococci guidelines on all but one occasion during the season with no occurrences within the 'Action' level. Minimal impact of the stream on the coastal East End beach water quality was indicated by the median *E.coli* number (13 per 100 mls) for the SEM season and the extended MfE additional sampling (10 per 100 mls) (TRC, 2013).

3.2.4.2 Comparison with previous summers' surveys

A statistical comparison of eleven summer's surveys data is presented graphically in Appendix V for all sites. [Note: These data had been collected prior to the 2011-2012 season to provide interpretative information for nearby coastal beach monitoring data]. These data for the Te Henui Stream site are summarised in Table 25 and illustrated in Figure 15.

Table 25 Summary of *E.coli* bacteriological water quality data (nos/100 ml) for all summer surveys in the Te Henui Stream at the mouth, East End

Summer	02/03	03/04	04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13
Minimum	150	160	220	260	220	240	550	500	69	350	300
Maximum	2600	8700	51000	9300	5200	2500	7700	3400	6800	13000	4200
Median	410	415	890	750	1100	1100	1100	930	985	1100	1500

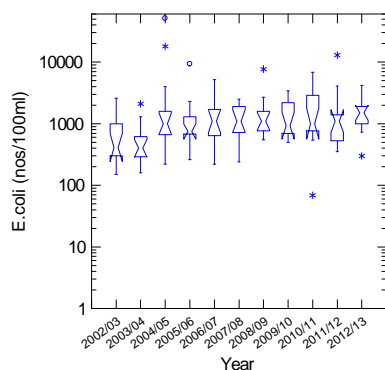
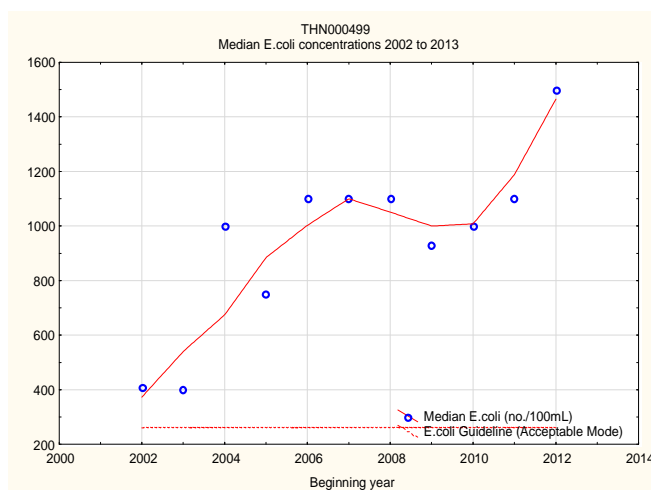


Figure 15 Box and whisker plots for all summer SEM surveys of *E. coli* bacteria numbers in the Te Henui Stream at the mouth, East End

The median *E. coli* number in the 2012-2013 period was higher than all medians recorded to date (Table 25 and Figure 15), each of which has been well above the 'Alert' level of the 2003 MfE guidelines. All but two of these median numbers have also been in the 'Action' level. The relatively wide range of numbers has also been typical for this site.

Trend analysis of these median *E. coli* numbers has been performed for the eleven seasons of data by first applying a LOWESS fit (tension 0.4) to a time scatterplot of the median numbers (Figure 16) and testing the significance of any trend using the Mann-Kendall test at the 5% level followed by Benjamini-Hochberg False Discovery Rate (FDR) analysis.



N = 11
Kendall tau = + 0.583
p level = 0.012 [$>$ FDR, $p = 0.042$]
Significant at $p < 0.05$ after FDR

Figure 16 LOWESS trend plot of median *E. coli* numbers (per 100 ml) at the Te Henui Stream mouth, East End for the 2002 to 2013 period

A significant temporal trend of increasing median *E. coli* numbers has been found over the eleven seasons of monitoring. (Note: This trend was statistically significant at $p < 0.05$ after FDR). Two of these seasonal medians were within the 'Alert' mode and all others exceeded the 'Action' mode.

3.2.5 Patea River at King Edward Park, Stratford

Limited bathing and picnicking usage of this river site was recorded at the time of sampling surveys, most of which were in the morning or early afternoon. Fishermen were noted on two occasions at this site, particularly following the release of trout into the river for the 'Take a Kid Fishing' promotion in late January 2013, and boating was noted on one occasion.

Data from the site are presented in Table 26 and illustrated in Figure 17, with a statistical summary provided in Table 27. River flow records are illustrated in Figure 18.

Table 26 Analytical results for the Patea River at Kind Edward Park, Stratford

Date	Time	Conductivity @ 20°C	Bacteria			Temperature	Turbidity
	(NZST)	(mS/m)	<i>E. coli</i> (nos/100ml)	Enterococci (nos/100ml)	Faecal coliforms (nos/100ml)	(°C)	(NTU)
01.11.12	1345	8.6	46	24	46	14.9	0.9
28.11.12	1435	8.9	37	40	37	17.5	0.8
13.12.12	1245	8.7	110	40	110	16.4	0.7
28.01.13	1325	9.3	110	170	160	18.7	0.8
31.01.13	0830	9.6	300	550	330	17.0	0.7
11.02.13	0855	8.6	320	740	320	14.1	0.5
14.02.13	0825	9.1	330	580	330	13.4	0.5
18.02.13	1315	9.2	180	560	180	16.3	0.5
25.02.13	1250	9.5	100	330	110	15.9	0.7
28.02.13	1425	9.6	80	430	80	17.3	0.5
04.03.13	1005	9.8	310	800	310	15.1	0.7
12.03.13	1250	10.0	190	370	190	16.0	0.6
27.03.13	0800	9.4	260	700	260	12.1	1.1

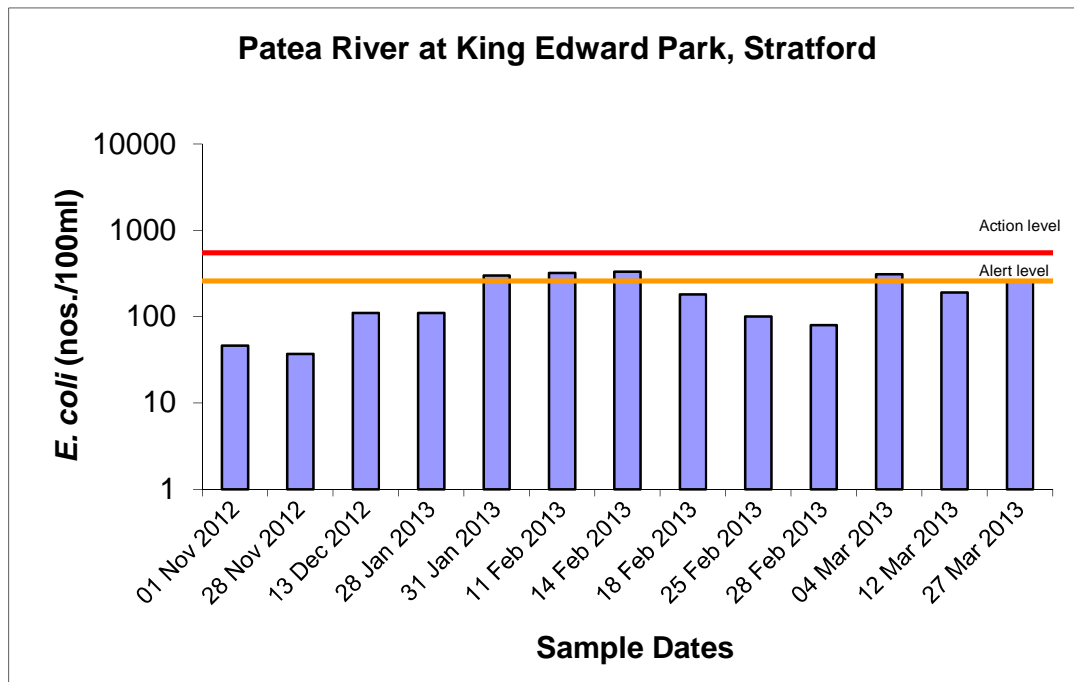


Figure 17 *E. coli* numbers for the Patea River at King Edward Park, Stratford during the survey season

Table 27 Statistical results summary for the Patea River at King Edward Park, Stratford

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	8.6	10.0	9.3
<i>E. coli</i>	nos/100ml	13	37	330	180
Enterococci	nos/100ml	13	24	800	430
Faecal coliforms	nos/100ml	13	37	330	180
Temperature	°C	13	12.1	18.7	16.0
Turbidity	NTU	13	0.5	1.1	0.7

This ring plain river drains a developed agricultural catchment. The survey site is situated within King Edward Park in Stratford township, approximately 11 km downstream of the National Park boundary, with several consented dairy ponds' treated wastes discharges in the catchment upstream of the site. River water was generally relatively clear (turbidity of < 1NTU on all but one occasion) and uncoloured or greenish in appearance with relatively low and narrow range of conductivity levels.

Water temperatures had a moderate range of 6.6°C for this site (at an elevation of 300 m asl), with a maximum of 18.7°C recorded at 1325 hrs in late January 2013. All the samples were collected before 1430 hours and therefore the maximum river temperatures (which tend to occur later in the afternoon) which this site might experience over summer were not recorded.

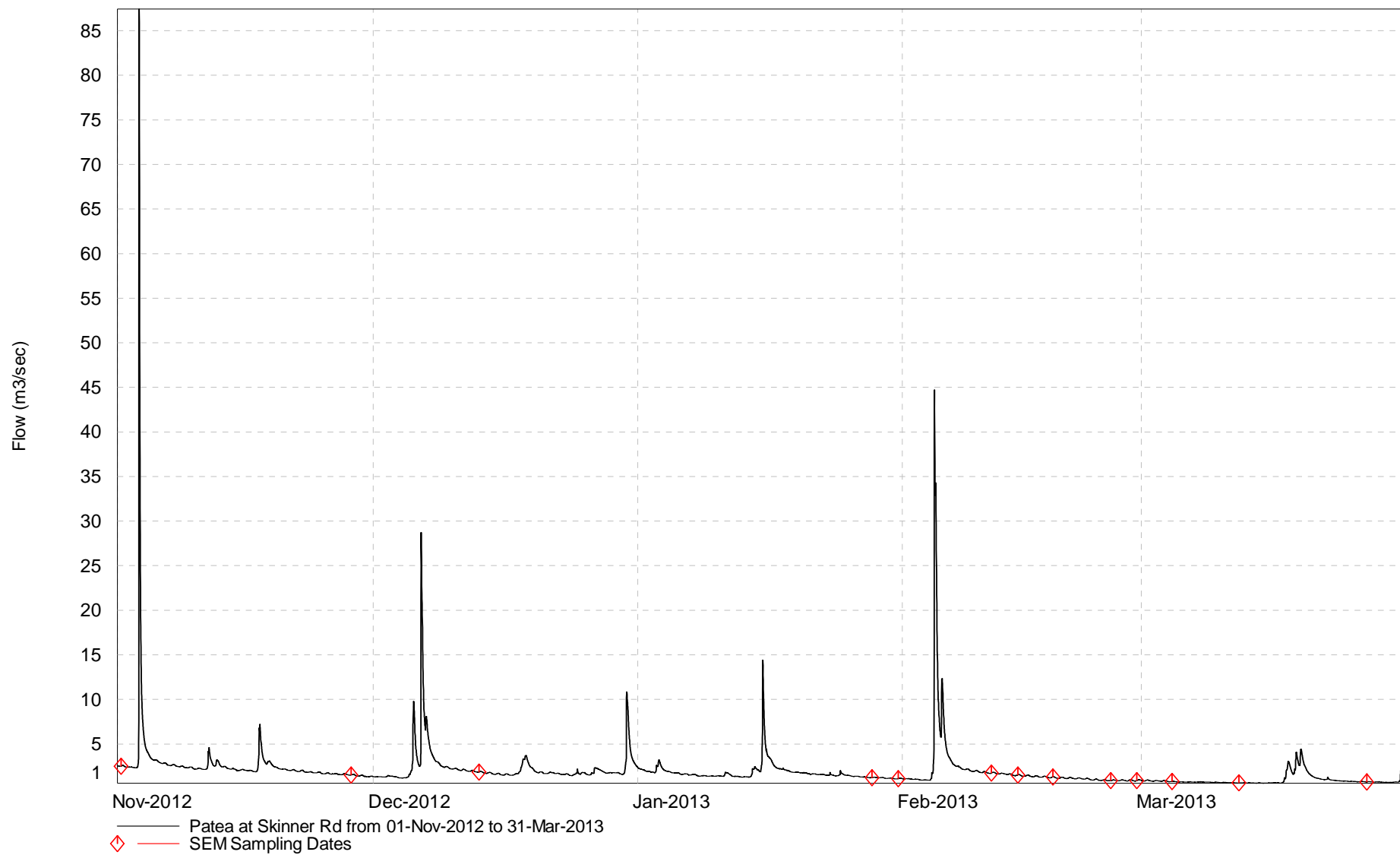


Figure 18 Flow in the Patea River at Skinner Rd during the survey period

Bacteriological water quality was moderate for the mid reaches of this Taranaki ring plain river draining a predominantly agricultural catchment. Four moderately high counts were recorded during the survey period. These did not necessitate further investigation as regular sampling which followed in mid and late February 2013, found lower counts. This was a considerable improvement over a number of previous seasons' surveys when it had been necessary to re-inspect a number of dairy farms' disposal systems in smaller upstream catchments and on several occasions issue abatement notices for non-compliance with consented disposal requirements. Four counts entered the 'Alert' level (in late summer-early autumn during very low flow conditions) but these incidents did not warrant the placement of appropriate signage at the site by the Stratford District Council.

Annual dairy farms inspections in this area of the upper Patea catchment will continue to be timed to ensure compliance with consent conditions prior to the start at the contact recreation period.

3.2.5.1 Comparison with guidelines

Comparison with the 2003 guidelines for freshwater contact usage is summarised in Table 28.

Table 28 Bacterial guidelines performance at the Patea River at King Edward Park, Stratford site [% of 13 samples]

Parameter	Number of exceedances of <i>E. coli</i> guidelines	
	ALERT Single sample 261-550/100ml	ACTION Single sample >550/100 ml
<i>E. coli</i>	4 [31]	0 [0]

(Designation: freshwater contact recreational area)

No single samples fell within the 'Action' mode, but four samples fell in the 'Alert' mode. Three counts occurred in early to mid February 2013 but follow-up sampling found much lower counts until one elevated count in early March, 2013. In terms of the guidelines for contact recreational usage, bacteriological water quality at this site was compliant with the acceptable level for most of the period, with no incursions into the 'Action' level.

3.2.5.2 Comparison with previous summers' surveys

A statistical comparison of each of the seventeen summers' survey data is presented graphically in Appendix V for all sites. A shorter data period (twelve years) exists for the Patea River (at King Edward Park, Stratford) site which was added in 2001-2002. These summer data for the Patea River at King Edward Park, Stratford site are summarised in Table 29 and illustrated in Figure 19.

Table 29 Summary *E. coli* bacteriological water quality data (nos/100 ml) all summer surveys in the Patea River at King Edward Park, Stratford

Summer	01/02	02/03	03/04	04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13
Minimum	46	120	48	96	100	28	46	51	51	54	63	37
Maximum	640	780	580	760	840	1000	690	570	7400	610	440	330
Median	250	190	110	300	310	200	290	200	250	160	150	180

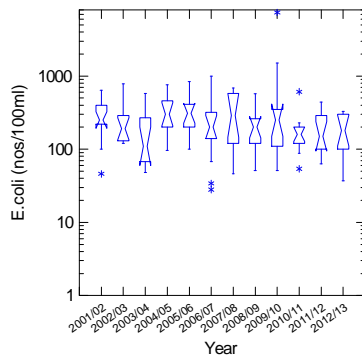
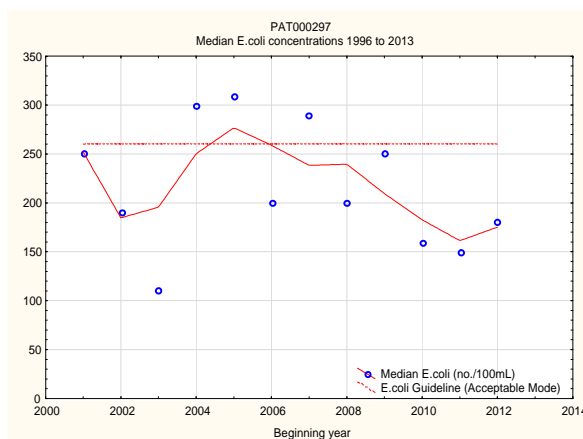


Figure 19 Box & whisker plots for all summer surveys of *E. coli* bacterial numbers for the Patea River at King Edward Park, Stratford

An improvement was indicated as the median *E. coli* bacterial count recorded for the 2012-2013 season was amongst the lower historical median counts over the monitoring seasons. The 2012-2013 season recorded a narrower range of counts for this site due to the lowest maximum count compared with all of the twelve monitoring seasons to date.

Trend analysis of these median *E. coli* numbers has been performed for the twelve seasons of data by first applying LOWESS fit (tension 0.4) to a time scatterplot of the median numbers (Figure 20) and testing the significance of any trend using the Mann-Kendall test at the 5% level followed by Benjamini-Hochberg False Discovery Rate (FDR) analysis.



N = 12
Kendall tau = -0.246
p level = 0.265 [>FDR, p = 0.493]
N/S at p < 0.05

Figure 20 LOWESS trend plot of median *E. coli* numbers (per 100ml) at the Patea River, King Edward Park site, for the 2000-2013 period

A statistically insignificant temporal trend of decreasing median *E. coli* numbers has been found over the twelve monitoring seasons. Three of these seasonal medians exceeded the 'Alert' mode (prior to 2008) but none have exceeded the 'Action' mode.

3.2.6 Patea River at the boatramp, Patea

Bathing usage of this river site was recorded only once at the time of sampling surveys, all but one of which were in the morning. Boating, fishing, and walking were noted from time to time at this site with boating as the main activity as this is a popular launching site for fishermen, judging by the number of boat trailers often in the parking area and the recent provision of a boat jetty. During the 2011-2012 period Taranaki Regional Council undertook microbial source tracking (MST) using DNA marker techniques (see Section 3.2.3) at this site and an upstream site at SH3 bridge

on two occasions (high and low tides). Faecal coliform bacteria were sourced predominantly from cattle on both occasions at the two sites while gulls contributed to populations at the boat ramp site under both tidal conditions and a faint trace of human source derivation was found (downstream of the Patea WWTP treated discharge) at the boatramp site, but only under low tidal flow conditions.

Data from the site are presented in Table 30 and illustrated in Figure 21, with a statistical summary provided in Table 31.

Table 30 Analytical results for the Patea River at the boatramp, Patea

Date	Time	Conductivity @ 20° C	Bacteria			Temperature	Turbidity
	(NZST)	(mS/m)	E. coli (nos/100ml)	Enterococci (nos/100ml)	Faecal coliforms (nos/100ml)	(°C)	(NTU)
01.11.12	1000	4660	3	9	3	16.2	11
28.11.12	1020	4670	16	8	16	16.9	6.4
13.12.12	0905	4680	1	<1	1	17.8	6.1
28.01.13	0945	4710	1	<1	1	21.0	4.4
31.01.13	1125	4720	<1	<1	<1	21.8	3.1
11.02.13	0935	4700	12	12	12	20.2	27
14.02.13	1125	4720	7	4	7	20.2	22
18.02.13	1425	4710	<1	1	<1	21.4	10
25.02.13	0905	4710	1	<1	1	18.9	14
28.02.13	1030	4720	8	5	8	20.2	7.2
04.03.13	1325	4760	1	1	1	20.2	8.4
12.03.13	0900	4720	7	<1	7	18.3	17
27.03.13	0915	4720	84	20	84	19.2	22

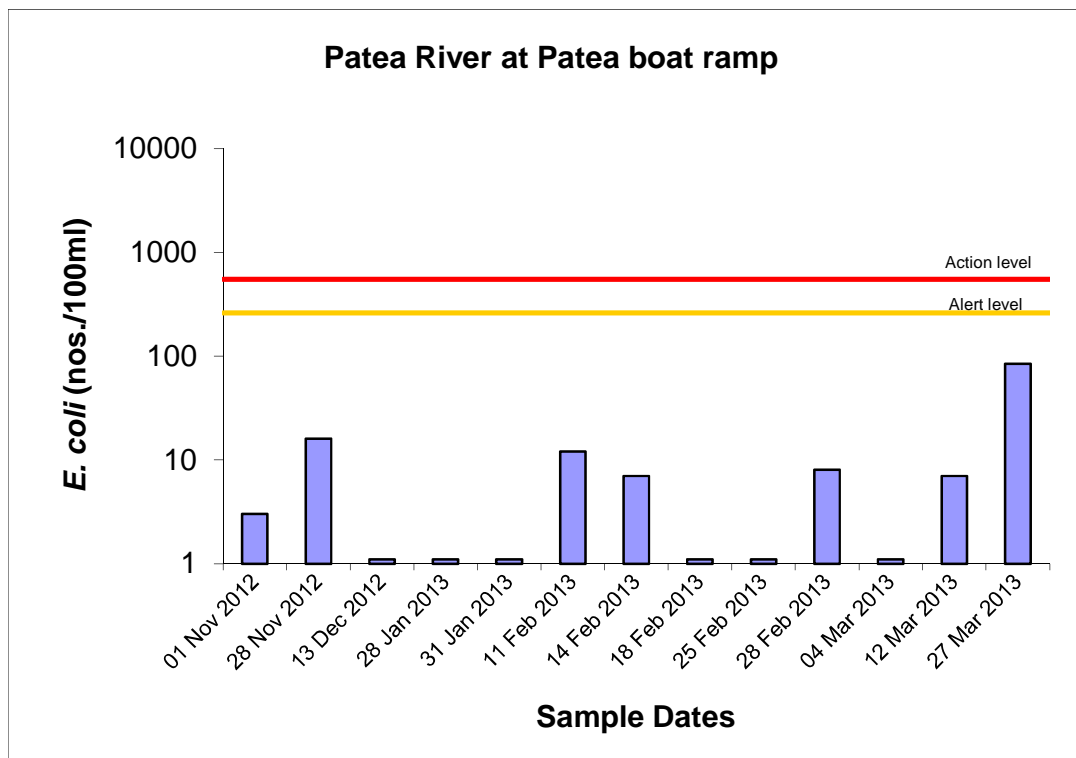


Figure 21 *E. coli* numbers for the Patea River at the boatramp, Patea during the survey season

Table 31 Statistical results summary for the Patea River at the boatramp, Patea

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	4660	4760	4710
<i>E. coli</i>	nos/100ml	13	1	84	3
Enterococci	nos/100ml	13	1	20	1
Faecal coliforms	nos/100ml	13	1	84	3
Temperature	°C	13	16.2	21.8	20.2
Turbidity	NTU	13	3	27	10

This ring plain river drains an extensively developed agricultural catchment. The survey site is situated some 45km downstream of the Patea HEP dam and 300 metres upstream of the river mouth. Flows in the lower river are regulated by operational requirements of the HEP station and associated consent conditions. There are consented dairy ponds' treated wastes discharges in the catchment upstream of the site and the consented upgraded Patea Wastewater Treatment Plant discharge 0.7km upstream of the boatramp.

River water was usually slightly turbid and green-brownish in appearance with high conductivity levels typical of seawater ingress at high tide on all occasions. Water temperatures had a moderate range of 5.6°C, a slightly narrower than expected range despite the coastal seawater influence, with a maximum of 21.8°C recorded in late morning in late January 2013 when the river was in very low flow. All of the samples were collected before 1325 hours and therefore maximum river temperatures (which could be anticipated to occur later in the afternoon) were not sampled.

Bacteriological water quality was very good for the lower reaches of this Taranaki ring plain river (median: 3 *E.coli* per 100mls and 1 enterococci per 100mls) draining a predominantly agricultural catchment as a result of the coastal seawater influence under high tide conditions and to a lesser extent, the high bacteriological quality of the lake waters released from the hydro dam. The existing recreational sampling programme was performed around higher tidal conditions for SEM trend purposes (due to its incorporation within the coastal sites programme) at times when public usage is likely to be more predominant at this site. Poorer bacteriological water quality could be expected under outflowing low tide conditions as emphasised by a consent monitoring programme undertaken at low tide at this site over the same recreational period when a median *E. coli* bacterial number of 69 per 100mls (with counts ranging from 26 to 99 per 100mls) was found with numbers tending to be higher when seawater intrusion was less apparent.

3.2.6.1 Comparison with guidelines

Comparison with the 2003 guidelines for freshwater contact usage is summarised in Table 32.

Table 32 Bacterial guidelines performance at the Patea River at the boatramp, Patea site [% of 13 samples]

Parameter	Number of exceedances of <i>E. coli</i> guidelines	
	ALERT Single sample 261-550/100ml	ACTION Single sample >550/100 ml
<i>E. coli</i>	0 [0]	0 [0]

(Designation: freshwater contact recreational area)

No single sample fell within the 'Alert' or 'Action' modes at any time during the monitoring period.

The bacteriological water quality at this site was within the acceptable guideline for contact recreational usage throughout the season recognising that all sampling occasions coincided with high tides and therefore a predominance of higher quality saline water mixing with poorer quality river water at this estuarine site. This was consistent with data for the nearby 'Mana' Bay coastal site adjacent to the river mouth monitored in the current season [median *E.coli*: 13 per 100 mls; range *E.coli*: 1-81 per 100 mls] for consent and SEM purposes.

3.2.6.2 Comparison with previous summers' surveys

Five previous SEM sampling seasons have been surveyed at this site. Otherwise prior sampling has been confined to consent monitoring surveys (TRC 2012a). A statistical comparison of each of the six summers' survey data is presented graphically in Appendix V for all sites. A much shorter data period exists for the Patea River (at Patea boat ramp) site which was added in 2007-2008. These data are summarised in Table 33 and illustrated in Figure 22.

Table 33 Summary *E. coli* bacteriological water quality data (nos/100 ml) all summer surveys in the Patea River at the boat ramp, Patea

Summer	07/08	08/09	09/10	10/11	11/12	12/13
Minimum	1	1	1	<1	1	1
Maximum	190	87	82	33	260	84
Median	5	9	11	4	16	3

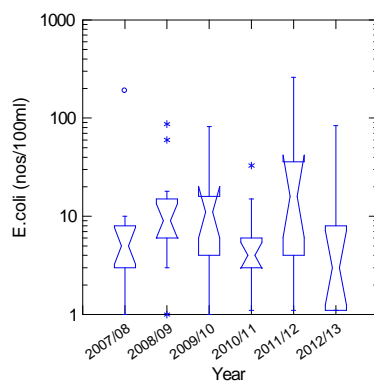


Figure 22 Box & whisker plots for all summer surveys of *E. coli* bacterial numbers for the Patea River at the boat ramp, Patea

Relatively similar (very low) median *E. coli* numbers have been found by these six seasons' surveys with a moderate range of counts due to the maximum values found to date remaining below the 'Alert' level. The recent season's range of counts was very similar to the narrow ranges found in two of the previous seasons. Trend analysis of median *E. coli* numbers will not be performed until the sampling period has encompassed ten seasons of data collection at this site.

3.2.7 Waingongoro River at Eltham camp

No bathing usage of this river site was recorded at the time of sampling surveys but camp activities were recorded as the camp was occupied on several occasions. The site is used as part of the camp's activities.

Sheep and/or horses were present in the paddock adjacent to this unfenced site on occasions and horses were seen at the river's edge on one occasion. Data from the site are presented in Table 34 and illustrated in Figure 23 with a statistical summary provided in Table 35. River flow records are illustrated in Figure 24.

Table 34 Analytical results for the Waingongoro River at Eltham camp

Date	Time	Conductivity @ 20°C	Bacteria			Temperature	Turbidity
	(NZST)	(mS/m)	E. coli (nos/100ml)	Enterococci (nos/100ml)	Faecal coliforms (nos/100ml)	(°C)	(NTU)
01.11.12	1320	11.5	140	35	140	17.0	2.0
28.11.12	1410	11.4	74	54	74	19.3	1.8
13.12.12	1225	11.2	88	21	88	17.1	1.4
28.01.13	1305	11.8	84	19	84	22.1	1.2
31.01.13	0855	11.8	200	120	210	18.4	1.1
11.02.13	0830	10.2	240	370	280	16.1	0.8
14.02.13	0900	11.1	430	570	450	15.2	1.0
18.02.13	1330	10.8	100	80	110	20.6	0.8
25.02.13	1230	11.2	160	40	160	18.9	1.0
28.02.13	1405	11.7	120	48	140	20.1	1.0
04.03.13	1030	11.9	310	280	310	16.9	1.0
12.03.13	1230	12.6	200	120	200	18.1	0.9
27.03.13	0820	12.0	310	420	310	14.4	0.9

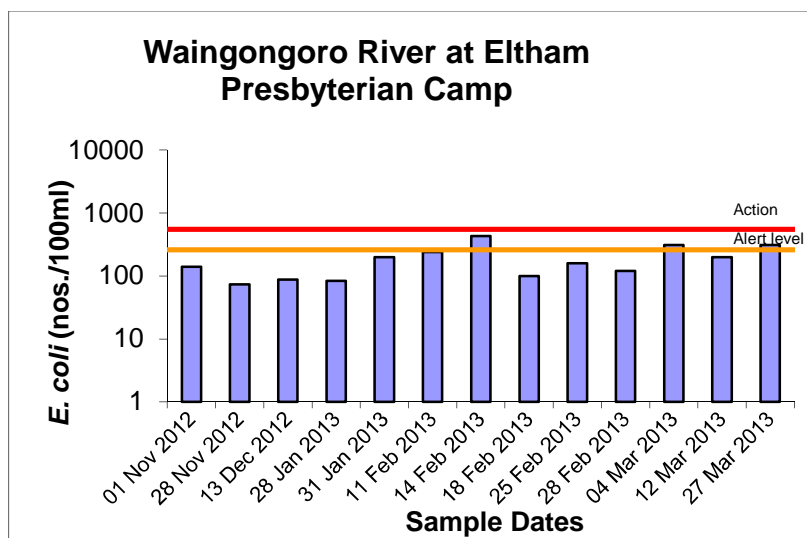


Figure 23 *E. coli* numbers for the Waingongoro River at Eltham Camp during the survey season

Table 35 Statistical results summary for the Waingongoro River at Eltham camp

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	10.2	12.6	11.5
E. coli	nos/100ml	13	74	430	160
Enterococci	nos/100ml	13	19	570	80
Faecal coliforms	nos/100ml	13	74	450	160
Temperature	°C	13	14.4	22.1	18.1
Turbidity	NTU	13	0.8	2.0	1.0

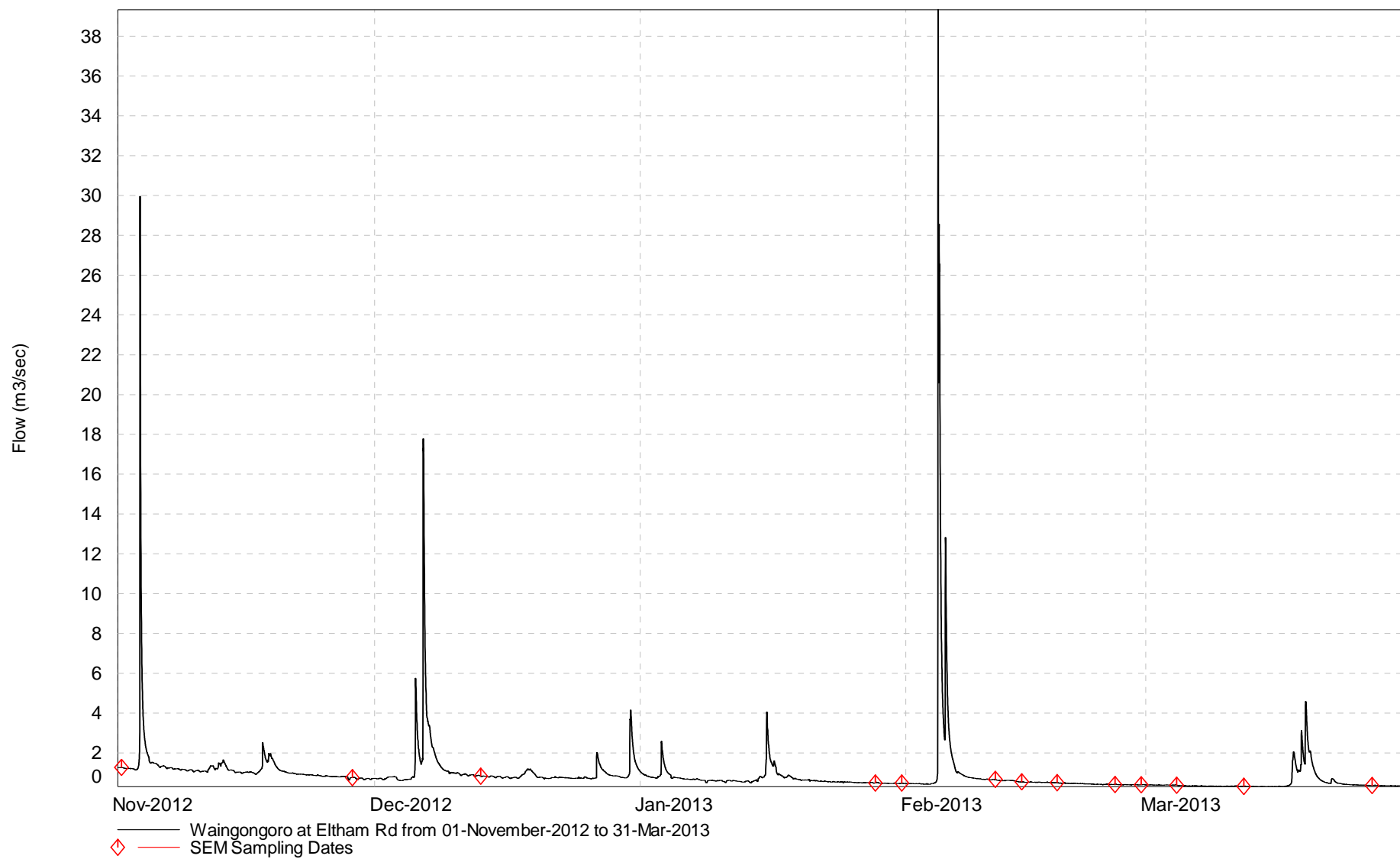


Figure 24 Flow in the Waingongoro River at Eltham during the survey period

This ring plain river drains an extensively developed agricultural catchment, with the survey site situated in Eltham some 21km below the National Park boundary. River water was relatively clear to slightly turbid in appearance with moderate conductivity levels. Water temperatures were within a moderate range of 6.7 °C with a maximum of 22.1 °C recorded at 1305 hours in late January 2013. All samples were collected before 1415 hours and therefore higher river temperatures (which tend to occur later in the afternoon) were not recorded.

Bacteriological water quality was in the range typical of the mid reaches of the Taranaki ring plain river draining a predominantly agricultural catchment. This was also apparent in comparison with the nearby Eltham Road (state of the environment physicochemical monitoring) site where a median *E.coli* count of 160 per 100mls (range: 6 to 59000 per 100mls) has been recorded by monthly sampling since 1995. The highest count in the current survey (which entered the 'Alert' mode) occurred in mid February under low flow conditions with two subsequent samples in the 'Alert' mode late in the period (Figures 23 and 24).

3.2.7.1 Comparison with guidelines

Comparison with the 2003 guidelines for freshwater contact usage is summarised in Table 36.

Table 36 Bacterial guidelines performance at the Waingongoro River, Eltham Camp [% of 13 samples]

Parameter	Number of exceedances of <i>E. coli</i> guidelines	
	ALERT Single sample 261-550/100ml	ACTION Single sample >550/100 ml
<i>E. coli</i>	3 [23]	0 [0]

(Designation: freshwater contact recreational area)

Three single samples fell within the 'Alert' mode and no samples reached the 'Action' mode. The highest sample count (in the 'Alert' mode) occurred in mid February 2013 about nine days after the most recent river fresh. The count dropped below the 'Alert' mode some four days later. Two 'Alert' level results were recorded in March 2013 under very low flow conditions. In general these results were typical of bacteriological counts obtained at the site just downstream at Eltham Road (by the longer term physicochemical SEM programme), although the latter programme samples throughout the year under more variable river flows and climatological conditions.

In terms of contact recreational usage guidelines, bacteriological water quality at this site was within the acceptable level for most of the period and no warning signage was required during the period.

3.2.7.2 Comparison with previous summers' surveys

A statistical comparison of each of the seventeen summer's survey data is presented graphically in Appendix V for all sites. A shorter data period exists for the Waingongoro River (at Eltham camp) site as this site was added to the programme in 2001-2002. These data are summarised in Table 37 and illustrated in Figure 25.

Table 37 Summary of *E. coli* bacteriological water quality data (nos/100 ml) for all summer surveys in the Waingongoro River at Eltham camp to date

Summer	01/02	02/03	03/04	04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13
Minimum	31	63	23	51	54	23	57	77	57	32	68	74
Maximum	870	550	360	1700	430	290	420	500	270	490	330	430
Median	230	230	100	170	130	110	160	130	160	140	150	160

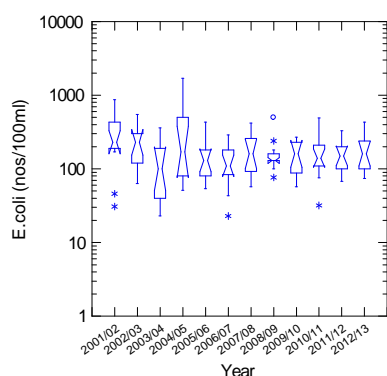
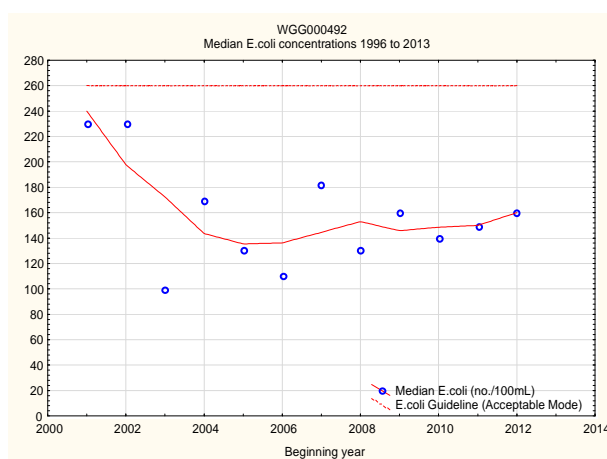


Figure 25 Box and whisker plots for all summer surveys of *E. coli* bacterial numbers for the Waingongoro River at Eltham Camp

Similar *E. coli* bacterial water quality was indicated by a median count within the mid range of those recorded by the eleven preceding seasons (Figure 25). There was a moderate range of counts over the 2012-2013 season typical of many ranges in the eleven other seasons monitored previously.

Trend analysis of these median *E. coli* numbers has been performed for the eleven seasons of data by first applying a LOWESS fit (tension 0.4) to a time scatterplot of the median numbers (Figure 26) and testing the significance of any trend using the Mann-Kendall test at the 5% level followed by Benjamini-Hochberg False Discovery Rate (FDR) analysis.



N = 12
Kendall tau = - 0.109
p level = 0.623 [>FDR, p = 0.967]
N/S at p < 0.05

Figure 26 LOWESS trend plot of median *E. coli* numbers (per 100ml) at the Waingongoro River, Eltham camp for the 2000 to 2013 period

A statistically insignificant temporal trend of decreasing median *E. coli* numbers was found over the twelve seasons of monitoring. None of these seasonal medians exceeded the 'Alert' or 'Action' modes although those of the first two seasons were relatively high.

3.2.8 Waingongoro River at Ohawe Beach

Limited bathing usage of this site was recorded with the site used more frequently for whitebaiting (in season), fishing, and picnicking. Occasionally stock were present in the paddock upstream of the site but were not noted at the river's edge or in the river as had been the case on occasions in the past (TRC, 2010). A few ducks and dogs were also noted on occasions. The data for this site are presented in Table 38 and illustrated in Figure 27, with a statistical summary provided in Table 39. River flow records are illustrated in Figure 28.

Table 38 Analytical results for the Waingongoro River at Ohawe Beach

Date	Time	Conductivity @ 20°C (mS/m)	Bacteria			Temperature (°C)	Turbidity (NTU)
	(NZST)		<i>E. coli</i> (nos/100ml)	Enterococci (nos/100ml)	Faecal coliforms (nos/100ml)		
01.11.12	1110	17.6	110	31	110	16.6	2.4
28.11.12	0940	18.1	120	44	120	17.8	2.6
13.12.12	0820	17.1	200	220	200	18.0	2.5
28.01.13	1055	18.4	100	74	100	22.9	1.4
31.01.13	1235	18.4	46	94	48	23.8	1.6
11.02.13	1045	15.9	2300	750	2300	20.2	1.9
14.02.13	1240	16.6	77	540	80	20.5	1.3
18.02.13	1550	17.4	71	76	71	23.4	1.1
25.02.13	1020	19.0	92	340	96	18.9	1.5
28.02.13	1145	18.0	320	220	340	20.5	1.6
04.03.13	1435	18.6	51	100	51	21.3	1.2
12.03.13	1005	19.7	220	1500	220	19.3	1.7
27.03.13	1030	19.7	760	630	770	17.4	1.5

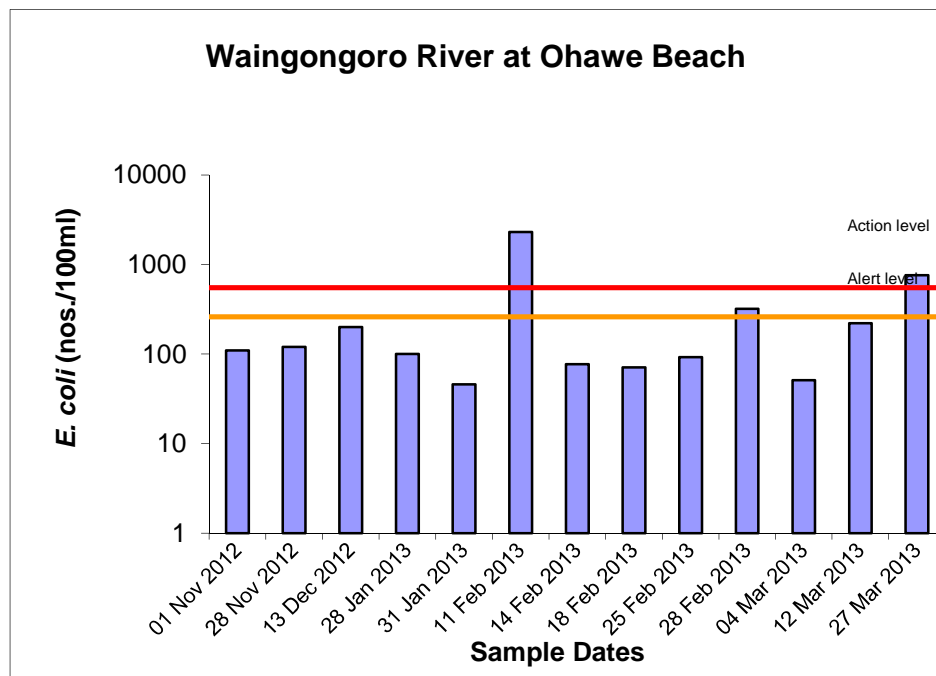


Figure 27 *E. coli* numbers for the Waingongoro River at Ohawe Beach during the survey season

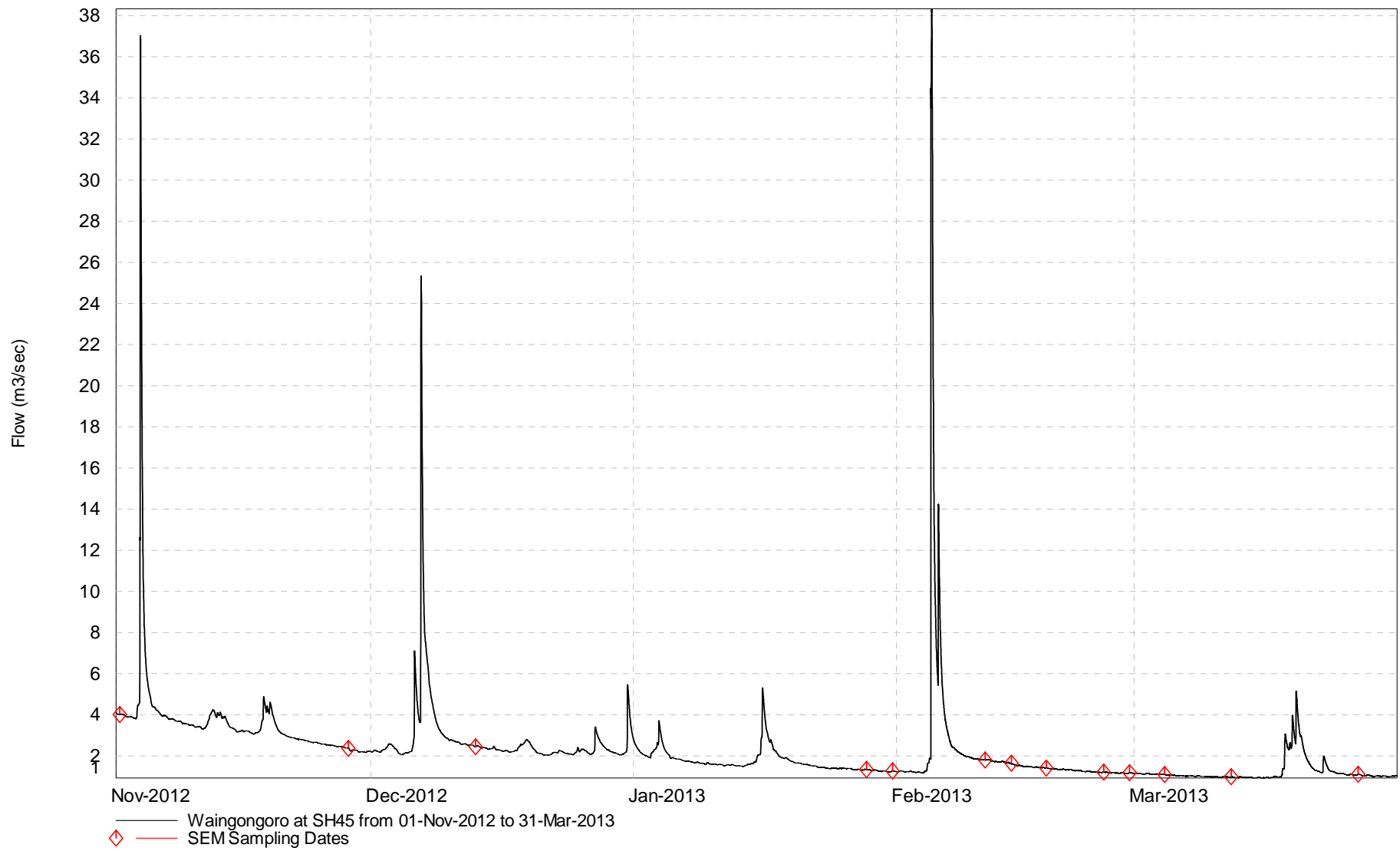


Figure 28 River flow in the Waingongoro River at SH45 during the survey period

Table 39 Statistical results summary for the Waingongoro River at Ohawe Beach

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	15.9	19.7	18.1
<i>E. coli</i>	nos/100ml	13	46	2300	110
Enterococci	nos/100ml	13	31	1500	220
Faecal coliforms	nos/100ml	13	48	2300	110
Temperature	°C	13	16.6	23.8	20.2
Turbidity	NTU	13	1.1	2.6	1.6

This river drains an extensively farmed catchment and receives point source industrial wastes (in its mid-reaches) and dairy pond wastes (more than 100 treatment systems) discharges. These industrial (meatworks) wastes are predominantly diverted out of the river (to land irrigation) during summer months while the Eltham WWTP municipal and industrial wastes discharge was diverted permanently out of the catchment in winter 2010. The site is in the lower reaches of the river immediately upstream of the mouth, but is generally not tidal, although occasional upstream surging in the ponded area has been noted during low river flow and high tidal conditions during late summer. These conditions were more prevalent during the 2012-2013 season.

The range of water temperatures was moderate (7.2°C) with a typical maximum (23.8°C) recorded in very early afternoon in late January 2013. However, as sampling was seldom performed after 1430 hrs at this site, this maximum might be expected to have been exceeded later in the day from time-to-time during the period of the survey. Conductivity values were typical of the lower reaches of a Taranaki ring plain and showed minimal salt water influence on any occasion despite sampling low flow conditions coincident with higher tides and observing frequent upstream surging (Appendix III). Turbidity values were indicative of slightly turbid water on most occasions, consistent with the presence of some fine colloidal material in suspension (ie: 1.5 to 3 NTU on most occasions), typical of the lower reaches of a ring plain river.

Bacteriological water quality (Figure 27) was relatively good for the lower reaches of a Taranaki ring plain river receiving agricultural run-off and point source discharges in the catchment. This was also apparent in comparison with the nearby (state of the environment physicochemical monitoring) site at SH45 where monthly sampling since mid 1998 has recorded a median *E. coli* count of 215 per 100 mls. Uncontrolled stock access to the river immediately upstream of this site near the mouth, particularly during low flow periods, was not as apparent during the current season as it had been historically.

Samples from two separate fine weather, low tide, very low flow conditions (mid to late summer) surveys at sites upstream of the township and near mouth were forwarded to Cawthron Institute, Nelson for faecal source DNA tracking marker analyses (Appendix VIII). Both series of samples found low *E.coli* counts (ranging from 51 to 92 nos/100 ml upstream and 43 to 60 nos/100 ml downstream of the township) which comprised bacteria of only ruminant and wildfowl origins, typical for the lower reaches of ringplain streams and not indicative of septic tank waste disposal issues.

3.2.8.1 Comparison with guidelines

Comparison with the 2003 guidelines for freshwater contact usage is summarised in Table 40.

Table 40 Bacterial guidelines performance at the Waingongoro River, Ohawe Beach [% of 13 samples]

Parameter	Number of exceedances of <i>E. coli</i> guidelines	
	ALERT Single sample 261-550/100ml	ACTION Single sample >550/100 ml
<i>E. coli</i>	1 [8]	2 [15]

(Designation: freshwater contact recreational area)

One single sample was recorded in the 'Alert' category but two samples were found in the 'Action' mode in mid February 2013 (five days after the first significant river fresh since spring) and at the end of March 2013 under very low flow conditions (see Appendix VII). No reasons were found for these isolated exceedances of the guidelines and follow-up regular sampling at this site a few days later in mid February found a return to a typical low level. Counts were often between 45 and 110 *E.coli* per 100 mls under late summer- autumn lower flow conditions.

Bacteriological water quality at this site was within the acceptable guidelines for contact recreational usage for most of the survey period coincident with the diversion of the Eltham WWTP discharge out of the catchment and land irrigation of Riverlands meatworks wastes for most of the season.

3.2.8.2 Comparison with previous summers' surveys

A statistical comparison of each of the seventeen summer's survey data is presented graphically in Appendix V for all sites. These summer data for the Waingongoro River site at Ohawe Beach are summarised in Table 41 and illustrated in Figure 29.

Table 41 Summary of *E. coli* bacteriological water quality data (nos/100 ml) for all summer surveys in the Waingongoro River at Ohawe Beach to date

Summer	96/97	97/98	98/99	99/00	00/01	01/02	02/03	03/04	04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13
Minimum	88	43	17	34	38	46	31	43	54	31	31	9	31	26	8	43	46
Maximum	310	650	300	240	850	660	14000	280	940	380	410	5000	870	1000	180	2800	2300
Median	185	130	80	180	170	160	110	110	130	96	100	100	120	96	100	96	110

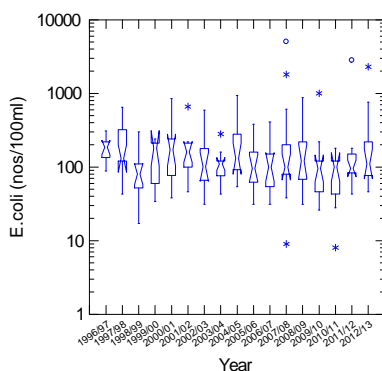
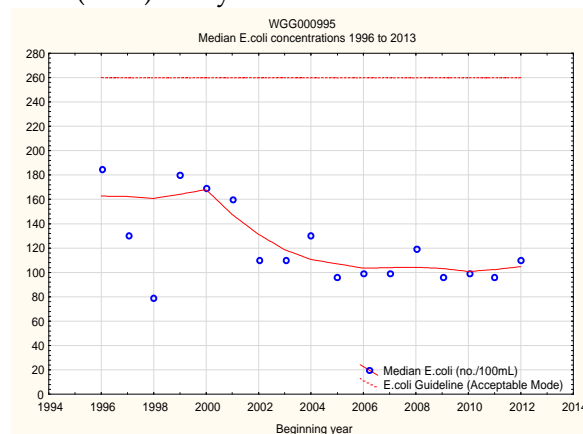


Figure 29 Box and whisker plots for all summer surveys of *E. coli* bacterial numbers in the Waingongoro River at Ohawe Beach

Median *E. coli* bacteria number for the 2012-2013 period was very similar to those found in the previous ten seasons, maintaining the general trend of improvement in bacterial water quality recorded over the last eleven seasons (Figure 29).

A relatively wide range of *E. coli* numbers was recorded in the recent 2012-2013 period in comparison with a majority of past seasons' ranges, as a result of the one high count.

Trend analysis of these median *E. coli* numbers has been performed for the seventeen seasons of data by first applying a LOWESS fit (tension 0.4) to a time scatterplot of the median numbers (Figure 30) and testing the significance of any trend using the Mann-Kendall test at the 5% level followed by Benjamini-Hochberg False Discovery Rate (FDR) analysis.



N = 17
 Kendall tau = - 0.443
 p level = 0.013 [$>$ FDR, $p = 0.042$]
 Significant at $p < 0.05$,
 not significant at $p < 0.01$ after FDR.

Figure 30 LOWESS trend plot of median *E. coli* numbers (per 100ml) for the 1996 to 2013 period at the Waingongoro River Ohawe beach site

A strongly decreasing trend in median *E. coli* number was found over the seventeen seasons of monitoring and the decrease has been particularly apparent over the past eleven seasons. The trend was statistically significant at the $p < 0.05$ level and after FDR but not significant at $p < 0.01$ after FDR application. None of these seasonal medians exceeded the 'Alert' or 'Action' modes.

3.2.9 Kaupokonui River at Beach Domain

Minor usage at this site by bathers was recorded at the time of the sampling surveys but other recreational usage (mainly fishing (whitebaiting was common in early season) and picnicking) was occurring on the majority of survey occasions at this popular site where the camping ground was consistently in use. The site was characterised by the tidal ponded nature of this reach of the river on all but three occasions, particularly under very high tide and low river flow conditions. No stock access was noted near the river's edge upstream of the domain during the current season. River flow records are provided in Figure 31. Data from this site are presented in Table 42 and illustrated in Figure 32, with a statistical summary provided in Table 43.

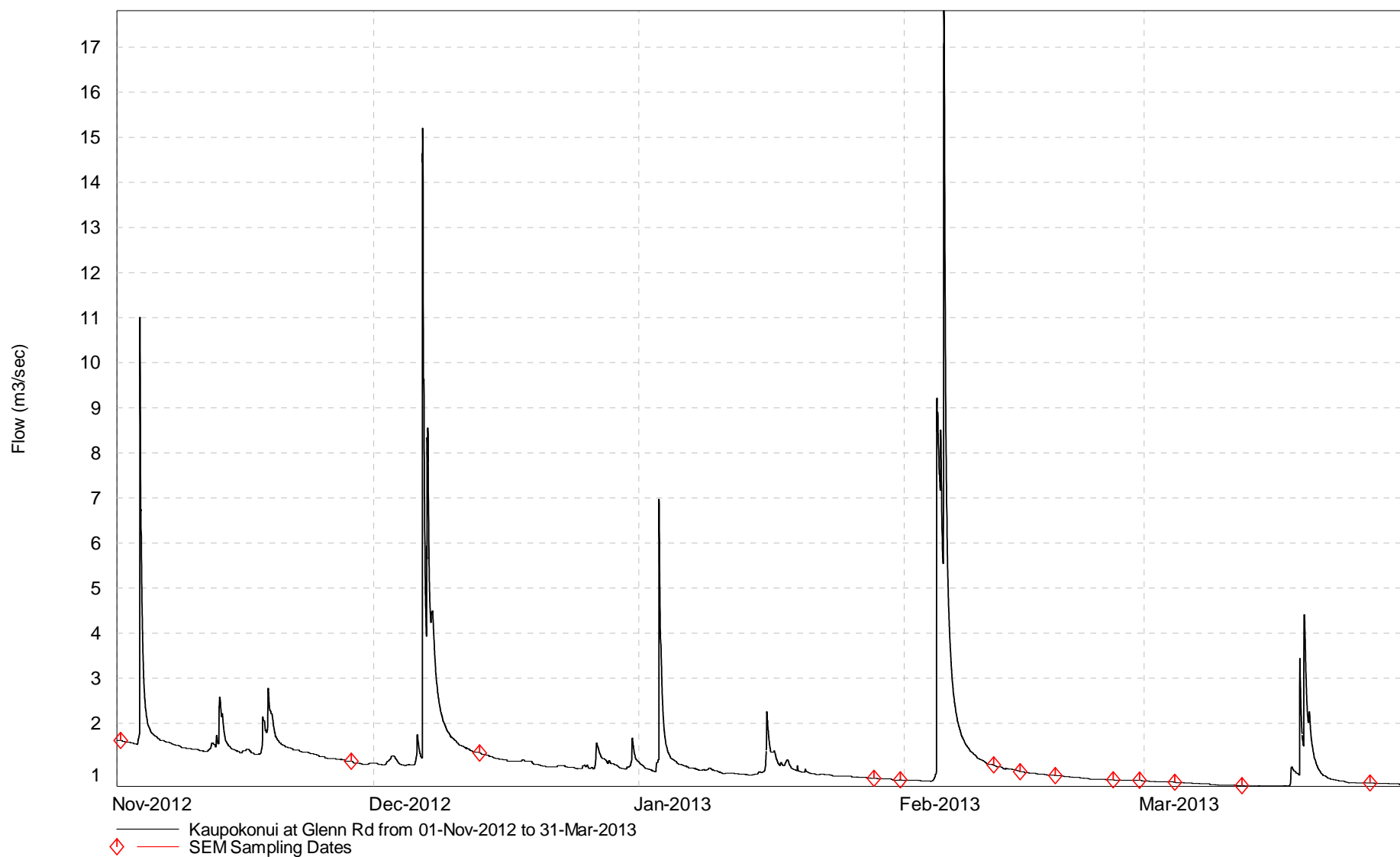
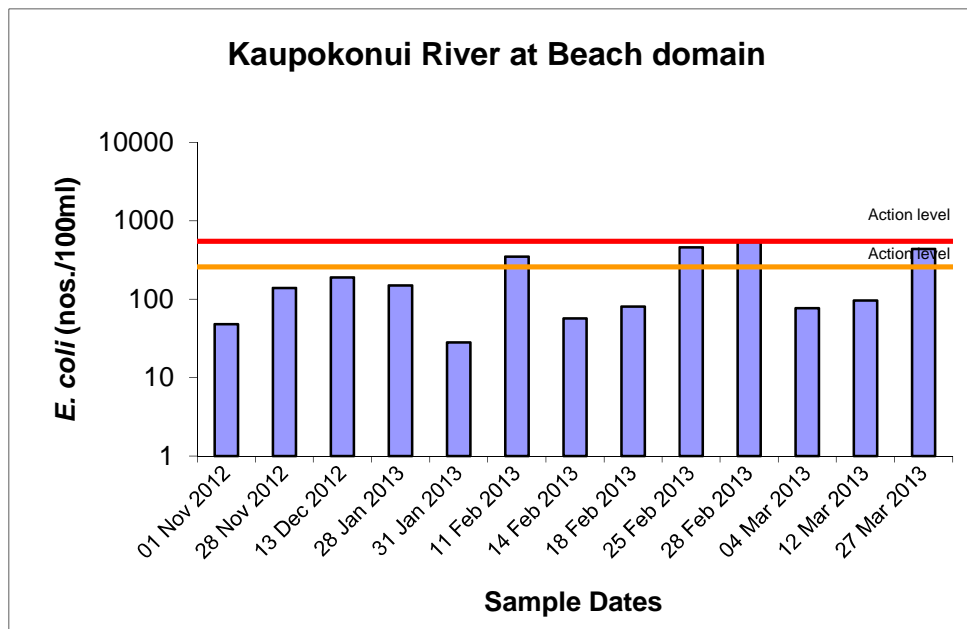


Figure 31 River flow in the Kaupokonui River at Glenn Rd during the survey period

Table 42 Analytical results for the Kaupokonui River at the beach domain

Date	Time	Conductivity @ 20°C	Bacteria			Temperature	Turbidity
	(NZST)	(mS/m)	<i>E. coli</i> (nos/100ml)	Enterococci (nos/100ml)	Faecal coliforms (nos/100ml)	(°C)	(NTU)
01.11.12	1135	16.3	48	50	48	17.0	1.8
28.11.12	0900	16.3	140	88	140	17.5	2.0
13.12.12	0945	14.8	190	590	190	19.8	2.6
28.01.13	1125	16.2	150	84	150	23.5	1.1
31.01.13	1300	59.8	28	24	28	25.0	1.2
11.02.13	1115	864	350	390	550	20.3	8.6
14.02.13	1315	211	57	66	60	20.9	1.3
18.02.13	1615	20.6	80	92	80	23.5	1.0
25.02.13	1045	85.9	460	370	470	19.0	1.3
28.02.13	1215	274	540	260	540	21.7	1.1
04.03.13	1510	16.3	77	150	77	21.9	1.4
12.03.13	1035	168	96	62	100	18.6	1.3
27.03.13	1110	24.9	440	440	440	18.1	2.2

**Figure 32** *E. coli* numbers for the Kaupokonui River at the beach domain during the survey season**Table 43** Statistical results summary for the Kaupokonui River at the beach domain

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	14.8	864	24.9
<i>E. coli</i>	nos/100ml	13	28	540	140
Enterococci	nos/100ml	13	24	590	92
Faecal coliforms	nos/100ml	13	28	550	140
Temperature	°C	13	17.0	25.0	20.3
Turbidity	NTU	13	1.0	8.6	1.3

This river also drains an extensively farmed catchment and receives point source wastes discharges from dairy pond wastes treatment systems, and in its mid-reaches from Fonterra Kapuni Company (cooling waters) and the Kaponga township municipal upgraded wastewater treatment system.

The site is located in the lower reach of the river near the mouth and on ten occasions was noted as tidal (incoming surges or ponded) in terms of flow conditions. Elevated conductivity levels indicating some seawater influence were recorded on six occasions near high tide and under very low flow conditions particularly during late summer (e.g. mid to late February 2013). Otherwise these levels were relatively stable (14.8 to 20.6 mS/m at 20°C) and more typical of the lower reaches of a Taranaki ring plain river.

Turbidity levels were typical of lower ring plain river reaches throughout the period (with one exception in mid February 2013 under more saline conditions) with minimal impacts of suspended algal matter, unlike in many previous survey periods. Foaming was seldom noticeable in the ponded reach of the river and toward the edges, unlike in previous periods when foaming and suspended algal matter reduced the aesthetic quality of this reach from time to time. Water temperatures varied over a moderate range of 8.0°C with a maximum of 25.0°C recorded in late January 2013. This temperature was recorded in early afternoon and would be expected to have been exceeded later in the day, particularly as most of the surveys were performed before 1515 hrs at this site.

Bacteriological water quality was relatively good and similar to that recorded in the lower reaches of the nearby Waingongoro River (see section 3.2.8), and better than often found in the lower reaches of a Taranaki ring plain river draining a predominantly agricultural catchment.

Previous surveys have noted that bacteriological water quality deteriorated in this tidal pool reach of the river probably as a result of the ponding of the flow and 'accumulation' of slugs of poorer quality downstream flow. This may have been in response to upstream stock access, point source dairy effluent discharges and/or various other non-point source runoff, emphasising the importance of control and surveillance of dairy shed wastewater disposal practices, particularly in lower reaches of ring plain catchments utilised for bathing and recreational purposes. It has also been noted that lower faecal coliform to enterococci ratios than usual have been recorded at this (and other) tidal ponded sites, possibly as a result of vegetative enterococcal sources and/or better enterococci survival in tidal pool environments, particularly sites characterised by ebbing and flowing within the ponded river mouth reach. This again was apparent later in summer (Table 43) when enterococci numbers were in excess of *E. coli* numbers on several occasions.

Four 'Alert' levels were recorded, between mid February 2013 and the end of the season, but much lower counts were recorded by the following surveys up to seven days later on three of these occasions. Previously, many flocks of ducks have been recorded in reaches of the river upstream of this site.

Relatively poor aesthetic water quality has been noted from time-to-time at this site, mainly in the form of surface froth (particularly toward the river margins) and fragments of periphyton suspended in the water column. These aspects of physical water quality were not as apparent during the 2012-2013 season.

Additional five weather samples were collected on two separate low tide, very low flow conditions (mid summer and end of the season) at this site and analysed (by Cawthron Institute, Nelson) for faecal source DNA tacking markers (Appendix VIII).

Low *E.coli* counts (26 and 17 nos/100 ml) were found to be coincident with bacteria of only ruminant and wildfowl origin indicative of no septic tank wastes disposal issues at the beach, and typical of the lower reaches of ringplain streams.

3.2.9.1 Comparison with guidelines

Comparison with the 2003 guidelines for freshwater contact usage is summarised in Table 44.

Table 44 Bacterial guidelines performance at the Kaipokonui River beach domain site [% of 13 samples]

Parameter	Number of exceedances of <i>E. coli</i> guidelines	
	ALERT Single sample 261-550/100ml	ACTION Single sample >550/100 ml
<i>E. coli</i>	4 [31]	0 [0]

(Designation: freshwater contact recreational area)

Four individual samples were recorded in the 'Alert' mode during the season but no samples entered the 'Action' mode. Minimal rainfall immediately preceded any of these counts with numbers returning to typical levels within four to seven days on all but the final sampling occasion (which was followed by spells of wet weather).

In summary, bacteriological water quality at this ponded lower river site was within guidelines for contact recreational usage for the majority of the survey period.

3.2.9.2 Comparison with previous summers' surveys

A statistical comparison of each of the seventeen summer's survey data is presented graphically in Appendix V for all sites. These summer data for the Kaipokonui River site at the Beach Domain are summarised in Table 45 and illustrated in Figure 33.

Table 45 Summary of *E. coli* bacteriological water quality data (nos/100ml) for all summer surveys in the Kaipokonui River at the Beach Domain

Summer	96/97	97/98	98/99	99/00	00/01	01/02	02/03	03/04	04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13
Minimum	26	31	3	7	17	46	46	<8	40	14	26	15	29	20	20	17	28
Maximum	360	2100	580	780	2000	400	630	200	880	280	2500	850	890	440	340	290	540
Median	110	360	130	80	120	110	130	77	92	160	140	77	210	100	76	120	140

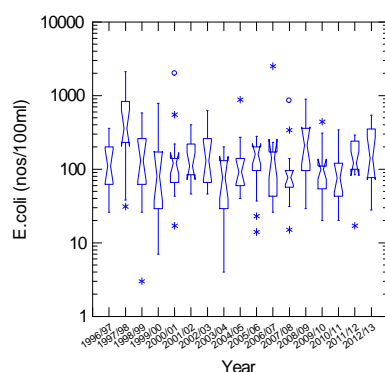


Figure 33

Box and whisker plots for all summer surveys of *E. coli* bacterial numbers in the Kaipokonui River at the Beach Domain

Typical *E. coli* bacterial water quality in terms of median number and a moderate range compared with the previous sixteen survey seasons, were recorded over the 2012-2013 season (Figure 33). The median *E. coli* count was in the mid-range of all other seasons' medians to date (Table 46), as was the seasonal maximum for the 17 years of record.

Trend analysis of these median *E. coli* numbers has been performed for the seventeen seasons of data by first applying a LOWESS fit (tension 0.4) to a time scatterplot of the median numbers (Figure 34) and testing the significance of any trend using the Mann-Kendall test at the 5% level followed by Benjamini-Hochberg False Discovery Rate (FDR) analysis.

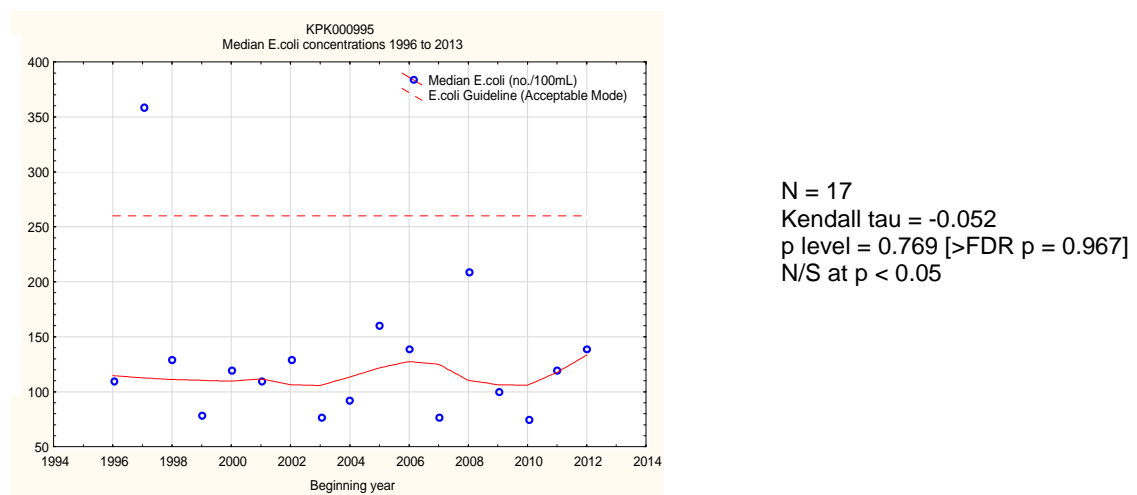


Figure 34 LOWESS trend plot of median *E. coli* numbers (per 100ml) at the Kaupokonui River beach domain site for the 1996 to 2013 period

A very slight and statistically insignificant, decreasing trend in median *E. coli* counts was found over the seventeen seasons of monitoring. One of these seasonal medians (1997-1998 season) exceeded the 'Alert' mode but none have exceeded the 'Action' mode, nor have any approached the 'Alert' mode since 1997-1998.

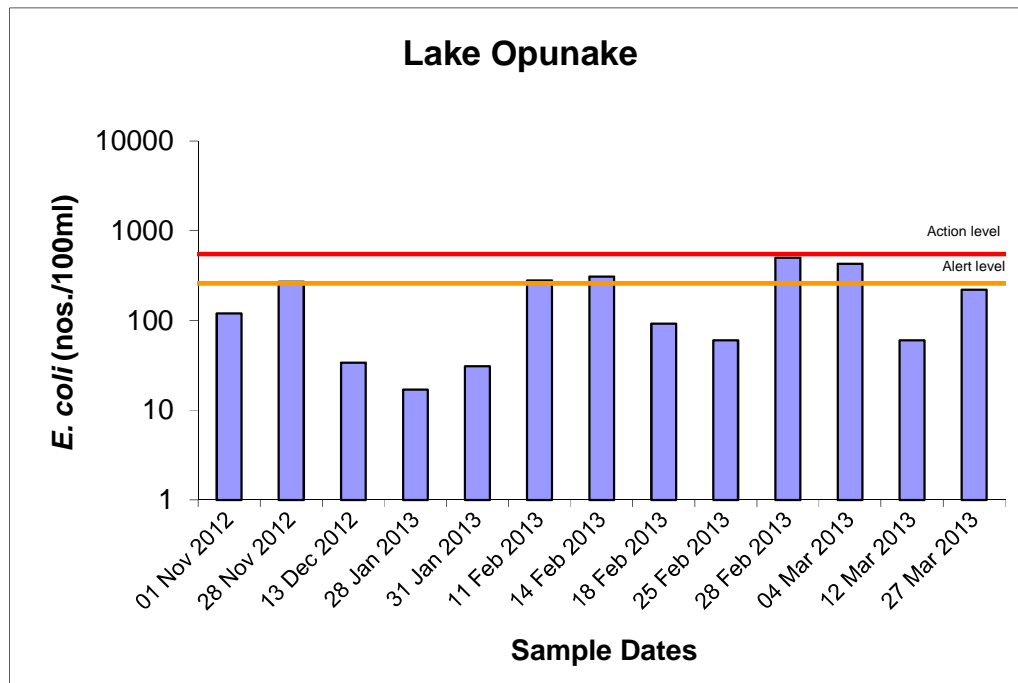
3.2.10 Lake Opunake

No bathing or boating usage of the lake was noted on any occasion, but picnicking activities were recorded occasionally at the time of sampling surveys. Ducks were also noted regularly on the lake or in the vicinity of the lake edge and numbers were high on most occasions. Large numbers of these wildfowl were present frequently on the picnic area grass verge adjacent to the lake edge, attracted from time to time by food provided by picnickers. There was no repeat of the thick unsightly, algal scum prevalent on the lake surface for several weeks during mid to late summer in the 2010-2011 season (TRC, 2011b) although some weed was noted near the shore and some floating algae was recorded on occasions.

Data from this site are presented in Table 46 and illustrated in Figure 35, with a statistical summary provided in Table 47.

Table 46 Analytical results for Lake Opunake

Date	Time	Conductivity @ 20°C	Bacteria			Temperature	Turbidity
	(NZST)	(mS/m)	<i>E. coli</i> (nos/100ml)	Enterococci (nos/100ml)	Faecal coliforms (nos/100ml)	(°C)	(NTU)
01.11.12	1240	13.7	120	20	120	16.6	1.3
28.11.12	0805	14.1	270	60	270	17.1	1.6
13.12.12	1035	13.4	34	28	34	20.0	1.3
28.01.13	1155	14.3	17	210	17	24.0	0.8
31.01.13	1330	14.5	31	440	31	22.9	1.2
11.02.13	1140	13.2	280	2200	280	22.5	0.9
14.02.13	0935	14.6	310	140	310	20.7	1.2
18.02.13	1645	14.3	92	52	92	23.3	0.9
25.02.13	1150	15.5	60	1300	63	20.3	1.0
28.02.13	1245	14.5	500	800	500	21.8	1.6
04.03.13	1540	15.1	430	1900	430	21.3	1.4
12.03.13	1110	14.9	60	2500	71	19.5	1.3
27.03.13	0900	14.4	220	2300	220	17.3	1.2

**Figure 35** *E. coli* numbers for Lake Opunake during the survey season**Table 47** Statistical results summary for Lake Opunake

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	13.2	15.5	14.4
<i>E. coli</i>	nos/100ml	13	17	500	120
Enterococci	nos/100ml	13	20	2500	440
Faecal coliforms	nos/100ml	13	17	500	120
Temperature	°C	13	16.6	24.0	20.7
Turbidity	NTU	13	0.8	1.6	1.2

The lake is formed by the diversion of water from the nearby Waiaua River (as a component of the Waiaua HEP scheme) and is close to the coast.

Water clarity was good (median turbidity: 1.2 NTU; range of turbidity: 0.8 NTU) with a very narrow range, as a result of minimal sediment disturbance or suspended algae in the water column. Generally good water quality was due, in part, to the lake's short residence time, with regular replenishment as a result of local hydroelectric power scheme usage. Water temperatures were relatively high (above 20.5°C) for half of the period with a maximum of 24.0°C (in mid February 2013) and a moderate range of 7.4°C. Conductivity varied over a narrow range (2.3 mS/m @ 20°C) reflecting river flow conditions.

Generally bacteriological quality was moderate, influenced in part by the inflow to the lake originating from the lower reaches of a river draining a developed catchment but more so by the local wildfowl population. Elevated numbers, above 200 *E. coli* per 100 mls, were found from time to time but more so in the latter half of the season co-incidental with higher wildfowl numbers in the immediate vicinity of the site. Marked fluctuations in counts were most likely associated with this bird population, particularly in instances where ducks had been attracted to the monitoring site by picnickers feeding the birds.

3.2.10.1 Comparison with guidelines

Compliance with the 2003 guidelines for freshwater contact usage is summarised in Table 48.

Table 48 Bacterial guidelines performance at Lake Opunake [% of 13 samples]

Parameter	Number of exceedances of <i>E. coli</i> guidelines	
	ALERT Single sample 261-550/100ml	ACTION Single sample >550/100 ml
<i>E. coli</i>	5 [38]	0 [0]

(Designation: freshwater contact recreational area)

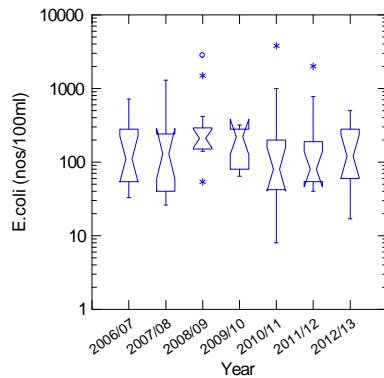
No single sample exceedances of the 'Action' mode occurred during the period but five single samples were recorded within the 'Alert' mode. Sampling subsequent to the 'Alert' levels showed much lower *E. coli* numbers within 14 days of exceedances. There was no immediate requirement for the installation of 'health warning' signage by STDC but publicity was given to the state of the lake on both relevant websites. The last exceedance occurred at the time of the final survey, coincident with the presence of a very large number of ducks immediately adjacent to the sampling site.

3.2.10.2 Comparison with previous summers' surveys

A statistical comparison of all of the summers' *E. coli* survey data is presented graphically in Appendix V for all sites. The seven summers of data collection for the Lake Opunake site are summarised in Table 49 and illustrated in Figure 36.

Table 49 Summary of *E. coli* bacteriological water quality data to date (nos/100 ml) for all summer surveys at Lake Opunake to date

Summer	06/07	07/08	08/09	09/10	10/11	11/12	12/13
Minimum	33	26	54	64	8	40	17
Maximum	720	1300	2800	320	3800	2000	500
Median	110	130	210	220	80	80	120

**Figure 36**

Box and whisker plots for the summer SEM survey of *E. coli* bacteria numbers at Lake Opunake

A median *E. coli* number in the mid range of the six previous seasons' surveys was found in the latest season but a relatively narrow range of counts was found during the latest season (Figure 36), and only the second occasion in which no 'Action' levels were recorded during the season.

Trend analysis of median *E. coli* numbers will not be performed for this site until ten seasons' data are available.

3.2.10.3 Cyanobacteria

Microscopic scans of seven samples were performed for the presence and enumeration of cyanobacteria during the season. The results of these analyses are presented in Table 50.

Table 50 Cyanobacteria counts (cells/ml) for Lake Opunake
[Health warning: >15,000 cells/ml]

Date	Cyanobacteria total cell count (cells/ml)
06.11.12	nil
19.12.12	nil
07.01.13	nil
22.01.13	nil
07.02.13	nil
21.02.13	nil
22.03.13	nil

No cyanobacteria were detected in any of these samples. No cyanobacteria had been found in this lake during the 2006-2007, 2008-2009, 2009-2010, 2010-2011, or 2011-2012 seasons, but their presence (in low numbers) on three occasions in the latter part of the 2007-2008 season followed a lengthy, extremely low flow period. However, these numbers did not reach levels requiring the issue of 'health warnings' during that season. The relatively short lake water residence time (due to hydroelectric power generation usage) may be a controlling factor for these populations.

3.2.11 Timaru Stream at Weld Road (near mouth)

Bathing usage was noted at this site on only two sampling occasions while some picnicking and fishing (including whitebaiting in season) usage was recorded at the times of sampling surveys during the season. The site had been a popular camping area (until the camp was closed by NPDC during early 2005) and access point to the

sea coast but camping occurred from time to time across on the true left bank. The site, to a certain extent tidal, showed varying degrees of saltwater penetration, particularly in the period after New Year under low flow recession conditions. Some gulls were present on many occasions with dogs and a horse in the water from time to time.

Data from this site are presented in Table 51 and illustrated in Figure 37, with a statistical summary provided in Table 52.

Table 51 Analytical results for the Timaru Stream at Weld Road

Date	Time	Conductivity @ 20° C	Bacteria			Temperature	Turbidity
	(NZST)	(mS/m)	<i>E. coli</i> (nos/100ml)	Enterococci (nos/100ml)	Faecal coliforms (nos/100ml)	(°C)	(NTU)
01.11.12	0905	9.2	340	36	350	13.6	0.4
28.11.12	0825	10.4	220	160	220	15.9	0.5
13.12.12	0805	25.4	260	100	270	17.9	0.5
28.01.13	0800	20.4	260	300	260	18.6	0.3
31.01.13	1215	160	26	79	26	21.6	0.6
11.02.13	1100	911	270	630	270	19.5	1.0
14.02.13	1345	305	54	220	54	19.1	0.8
18.02.13	1635	46.1	60	210	60	23.4	0.5
25.02.13	0800	34.0	250	400	260	17.3	0.4
28.02.13	0920	137	230	200	240	19.1	0.6
04.03.13	1230	209	200	190	210	18.9	0.7
12.03.13	0800	199	500	700	520	17.4	0.5
27.03.13	0800	121	550	440	560	15.9	0.5

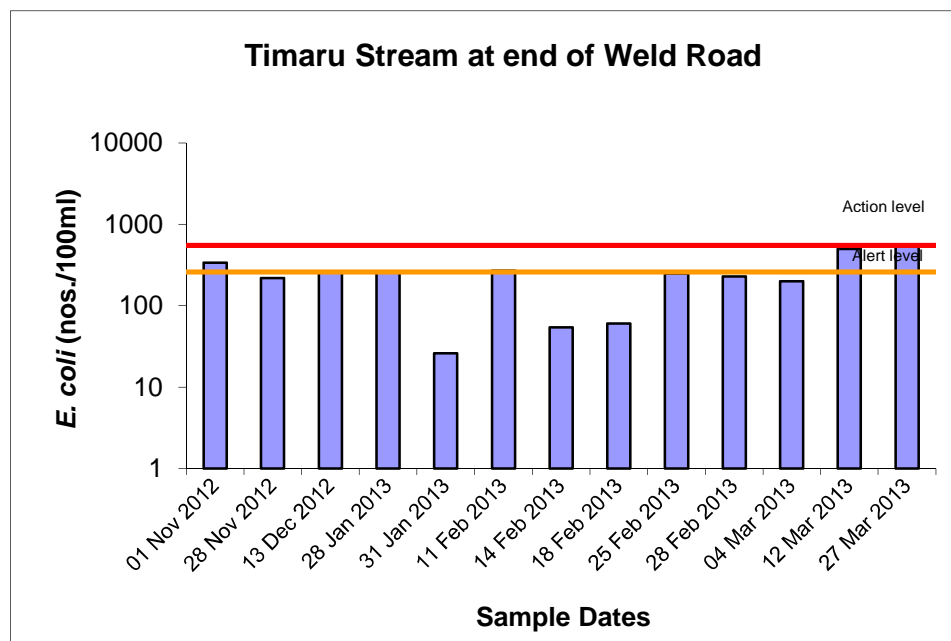


Figure 37 *E. coli* numbers for the Timaru Stream at Weld Road during the survey season

Table 52 Statistical results summary for the Timaru Stream at Weld Road

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	9.2	911	121
<i>E. coli</i>	nos/100ml	13	26	550	250
Enterococci	nos/100ml	13	36	700	210
Faecal coliforms	nos/100ml	13	26	560	260
Temperature	°C	13	13.6	23.4	18.6
Turbidity	NTU	13	0.3	1.0	0.5

This river drains a moderately farmed catchment (five consented dairy farm discharges) receiving point and non-point source discharges from these dairy farms, although it is relatively short in length, rising partly in the nearby Kaitake range and the north-western area of Egmont National Park. Conductivity levels varied markedly in response to saltwater penetration at this site and were elevated on several occasions during the season and particularly in mid to late summer-autumn under very low stream flow conditions. Turbidity levels were very low throughout the season consistent with the clear appearance of the river. Minimal algal cover was noted in association with the good aesthetic appearance of the river due to the sandy substrate at this deeper, ponded site. Water temperature varied over a relatively wide range of 9.8°C with a maximum water temperature of 23.4°C recorded in late afternoon in mid February 2013. This maximum could have been expected to have been approached on other occasions during summer as all other sampling was undertaken before 1350 hrs and the majority in the mornings.

Bacteriological water quality at this site was generally below average and probably poorer than typical of the lower reaches of other Taranaki ring plain streams draining agricultural catchments. Elevated counts occurred sporadically, more particularly under low flow conditions in the mid to latter part of the sampling period. However, there was no installation of 'health warning' signage at the site by NPDC as there was no exceedance of the 'Action' level on any occasion. Stock access to the lower stream (which was crossed to reach adjacent farmland at times) during the prolonged dry period of the 2007-2008 seasons (requiring remedial action after incidents were reported by the general public) was not repeated or recorded in the 2009-2010, 2010-2011, or 2011-2012 seasons nor in the current season. Surveys in other rivers with tidal pool reaches have found that bacteriological water quality may deteriorate probably as a result of ponding of the flow and 'accumulation' of slugs of poorer quality downstream flow, and several high *E. coli* counts were coincidental with more ponded conditions (during elevated conductivity events). It has also been noted at these tidal river pool sites that lower faecal coliform to enterococci ratios than usual have been recorded possibly due to vegetative sources and/or better enterococci survival in pool environments characterised by the ebb and flow in the ponded river/stream mouth.

Analyses for faecal source DNA tracking markers (by Cawthron Institute, Nelson) were undertaken on two fine weather, low tide, samples collected under very low flow conditions in January and early April 2013 (Appendix VIII). Low *E. coli* counts (80 and 40 per 100 mls) were found to be coincident with bacteria of ruminant and wildfowl origin, typical of sites in the lower reaches of streams and rivers elsewhere on the ringplain.

3.2.11.1 Comparison with guidelines

Compliance with the 2003 guidelines for freshwater contact usage is summarised in Table 53.

Table 53 Bacterial guidelines performance at the Timaru Stream, Weld Road site [% of 13 samples]

Parameter	Number of exceedances of <i>E. coli</i> guidelines	
	ALERT Single sample 261-550/100ml	ACTION Single sample >550/100 ml
<i>E. coli</i>	4 [31]	0 [0]

(Designation: freshwater contact recreational area)

Four single samples were recorded in the 'Alert' mode, but none were recorded in the 'Action' mode during the period. Poorer bacteriological water quality tended to coincide with dry weather, prolonged very low stream flow toward the end of the season and moderate seawater intrusion causing ponding at the site. Wet weather subsequent to the relatively high count at the end of the season prevented timely follow-up sampling from being performed but overall the erection of health warning signage was not required as no single samples entered the 'Action' mode and public advice was provided on both web sites.

In terms of the 2003 contact recreation guidelines, the bacteriological water quality at the site was moderately good, although partly affected by the ponding caused by the site's proximity to the sea coast.

3.2.11.2 Comparison with previous summers' surveys

A statistical comparison of each of the summers' survey data is presented graphically in Appendix V for all sites. These summer data for the Timaru Stream site at the end of Weld Road (which has been monitored for thirteen summers) are summarised in Table 54 and illustrated in Figure 38.

Table 54 Summary of *E. coli* bacteriological water quality data to date (nos/100ml) for all summer surveys in the Timaru Stream at lower Weld Road

Summer	97/98	98/99	99/00	00/01	01/02	02/03	03/04	04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13
Minimum	40	23	31	77	31	140	77	84	38	43	46	92	46	28	34	26
Maximum	410	710	1400	540	660	1000	410	1000	460	480	930	440	560	410	440	550
Median	280	210	160	180	180	260	220	260	220	200	180	230	290	180	160	250

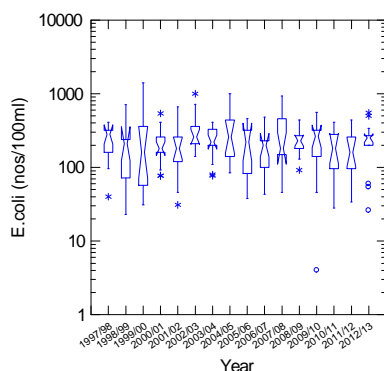
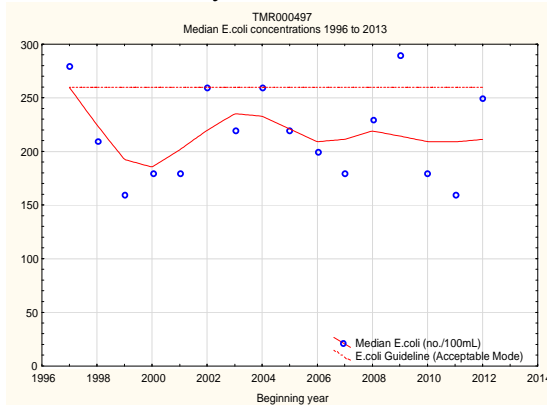


Figure 38

Box and whisker plots for all summer surveys of *E. coli* bacterial numbers in the Timaru Stream at lower Weld Road

The median *E. coli* count for the 2012-2013 season indicated some deterioration in bacterial water quality (Table 54) in comparison with recent seasons but was within the range of previous seasons' counts. Counts over the 2012-2013 season had a moderate range (Figure 38), with no counts reaching the 'Action' mode, and a seasonal maximum in the mid range of those found over the 17 years of monitoring.

Trend analysis of these median *E. coli* numbers has been performed for the sixteen seasons of data by first applying a LOWESS fit (tension 0.4) to a time scatterplot of the median numbers (Figure 39) and testing the significance of any trend using the Mann-Kendall test at the 5% level followed by Benjamini-Hockberg False Discovery Rate (FDR) analysis.



N = 16
Kendall tau = -0.009
p level = 0.962 [$>$ FDR, $p = 0.967$]
N/S at $p < 0.05$

Figure 39 LOWESS trend plot of median *E. coli* numbers (per 100ml) at Timaru Stream, lower Weld Road site for the 1997 to 2013 period

An overall very slight decreasing trend in median *E. coli* numbers has been found over the sixteen seasons of monitoring which has not been statistically significant. None of these seasonal medians exceeded the 'Action' mode, although the medians for the initial and 2008-2009 seasons entered the 'Alert' mode and three others have been very close to the 'Alert' mode from time to time at this site.

3.2.12 Oakura River below SH45

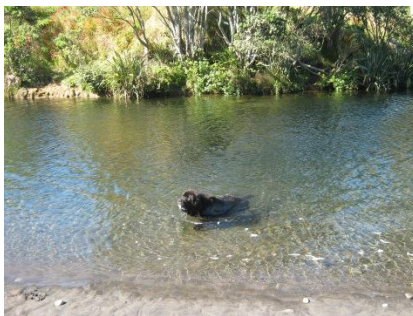


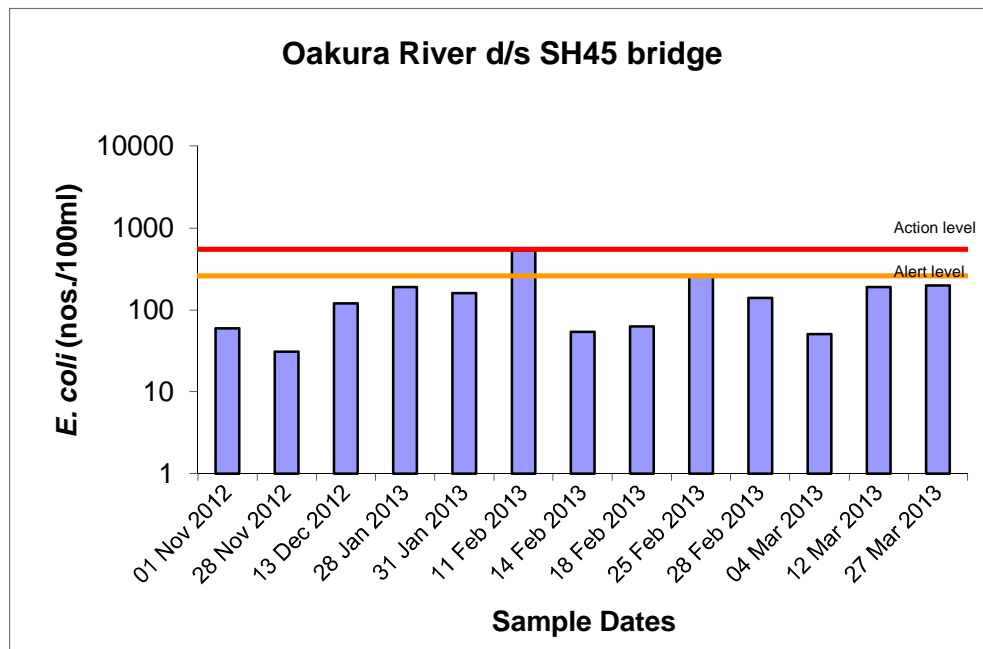
Photo 3 The occasional pooch joins in recreational contact activities - Oakura River, January 2013

Bathing usage was recorded on occasions at this site where people were often present (occasionally fishing (including whitebaiting in season)) on the riverbank at this very accessible tidal site. Ponding and upstream surging frequently occurred under high tide conditions and gulls and dogs were recorded on or in the river (Photo 3).

Data from the site are presented in Table 55 and illustrated in Figure 40, with a statistical summary provided in Table 56.

Table 55 Analytical results for the Oakura River below SH45

Date	Time	Conductivity @ 20°C	Bacteria			Temperature	Turbidity
	(NZST)	(mS/m)	<i>E. coli</i> (nos/100ml)	Enterococci (nos/100ml)	Faecal coliforms (nos/100ml)	(°C)	(NTU)
01.11.12	1005	8.1	60	17	60	14.2	0.6
28.11.12	0915	9.0	31	75	34	17.2	0.4
13.12.12	0845	9.2	120	65	130	17.7	0.7
28.01.13	0900	8.9	190	240	200	18.8	0.6
31.01.13	1125	129	160	150	160	21.8	1.1
11.02.13	1005	424	530	230	530	18.4	0.2
14.02.13	1245	146	54	100	57	19.1	0.4
18.02.13	1545	11.1	63	87	63	23.5	0.4
25.02.13	0850	19.0	260	240	280	17.4	0.3
28.02.13	1010	260	140	160	140	18.8	0.5
04.03.13	1320	28.3	51	160	54	19.6	0.3
12.03.13	0900	47.4	190	230	190	17.6	0.3
27.03.13	0850	549	200	210	200	16.2	0.4

**Figure 40** *E. coli* numbers for the Oakura River below SH45 during the survey season**Table 56** Statistical results summary for the Oakura River below SH45

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	8.1	549	28.3
<i>E. coli</i>	nos/100ml	13	31	530	140
Enterococci	nos/100ml	13	17	240	160
Faecal coliforms	nos/100ml	13	34	530	140
Temperature	°C	13	14.2	23.5	18.4
Turbidity	NTU	13	0.2	1.1	0.4

This river drains a mainly agricultural catchment (three consented dairy farm discharges to surface water) with the survey site established in the short tidal reach between SH45 and the mouth of the river. The river was noted as tidal with ponding or inflowing obvious on seven sampling occasions. Conductivity levels indicated a variable influence of saltwater intrusion on at least six sampling occasions during the

season. The more significant intrusions occurred during very low flow conditions during the latter part of this season. On all occasions the river was clear in appearance with no algal substrate cover due to the sandy nature of much of the substrate. Water temperatures varied over a moderate range (9.3°C) during the period reaching a maximum of 23.5°C in mid afternoon in mid February 2013, but below the maximum water temperature which might be anticipated later in the day as most sampling at this site occurred before 1325 hrs.

Bacteriological water quality was average, with the majority of *E. coli* counts below 195 per 100 mls. Bacteriological water quality was not dissimilar to that found elsewhere in ponded tidal reaches of ringplain rivers and streams, probably as a result of the occasional 'accumulation' of slugs of poorer quality downstream flow. This may have resulted from upstream stock access, agricultural non-point source runoff and/or point source discharges. Lower faecal coliform to enterococci ratios (than normally found at flowing river sites) were occasionally recorded possibly as a result of vegetative sources of enterococci and/or better survival rates in tidal pool environments; sites which are characterised by ebbing and flowing within the ponded stream mouth reach. The elevated count in mid February 2013 was coincident with significant saltwater intrusion under very low flow conditions and regular sampling, three days after this elevated count, found a much lower *E. coli* count (54 per 100mls).

Faecal source DNA tracking markers analyses (by Cawthron Institute, Nelson) were performed on two low tide, fine weather samples collected in mid January and early April 2013 under very low flow conditions upstream of Oakura township as well as the usual site (see Appendix VIII). *E. coli* counts were low (80 and 23 per 100 mls upstream and 100 and 20 per 100 ml downstream) and found to be coincident with bacteria of ruminant and wildfowl origin only, similar to the lower reaches of ringplain rivers and streams elsewhere.

3.2.12.1 Comparison with guidelines

Comparison with the 2003 guidelines for freshwater contact usage is summarised in Table 57.

Table 57 Bacterial guidelines performance at the Oakura River SH45 bridge site [% of 13 samples]

Parameter	Number of exceedances of <i>E. coli</i> guidelines	
	ALERT Single sample 261-550/100ml	ACTION Single sample >550/100 ml
<i>E. coli</i>	1 [8]	0 [0]

(Designation: freshwater contact recreational area)

Only one single sample fell within the 'Alert' mode and no samples entered the 'Action' mode. This occurrence coincided with low flow conditions with subsequent sampling showing a return to a low level, well below the 'Alert' mode, three days after the occurrence. No health warning signage was required to be displayed at this site by NPDC following the 'Alert' level exceedance.

However, generally bacteriological water quality was typical for the lower reaches of a Taranaki ringplain stream, and within the acceptable single sample guidelines for contact recreational usage for the majority of the sampling occasions.

3.2.12.2 Comparison with previous summers' surveys

A statistical comparison of each of the seventeen summers' survey data is presented graphically in Appendix V for all sites. These summer data for the Oakura River site below the SH45 bridge are summarised in Table 58 and illustrated in Figure 41.

Table 58 Summary of *E. coli* bacteriological water quality data (nos/100ml) for all summer surveys in the Oakura River downstream of SH45

Summer	96/97	97/98	98/99	99/00	00/01	01/02	02/03	03/04	04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13
Minimum	7	28	42	24	23	31	26	43	11	46	23	31	34	60	19	11	31
Maximum	260	1100	240	540	310	580	420	1200	820	380	330	2400	450	2500	290	440	530
Median	34	110	100	77	80	120	120	120	140	160	220	140	180	150	100	140	140

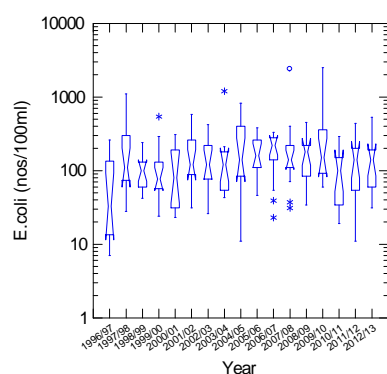


Figure 41 Box and whisker plots for all summer surveys of *E. coli* bacteria numbers in the Oakura River downstream of SH45

The median *E. coli* count was toward the middle of the range of past seasons' results (Figure 41). A relatively narrow range of *E. coli* counts was recorded due to the absence of any very high counts. No median *E. coli* counts have exceeded the 2003 guidelines for contact recreational usage over the seventeen seasons of monitoring.

Trend analysis of these median *E. coli* numbers has been performed for the seventeen seasons of data by first applying a LOWESS fit (tension 0.4) to a time scatterplot of the median numbers (Figure 42) and testing the significance of any trend using the Mann-Kendall test at 5% level followed by Benjamini-Hockberg False Discovery Rate (FDR) analysis.

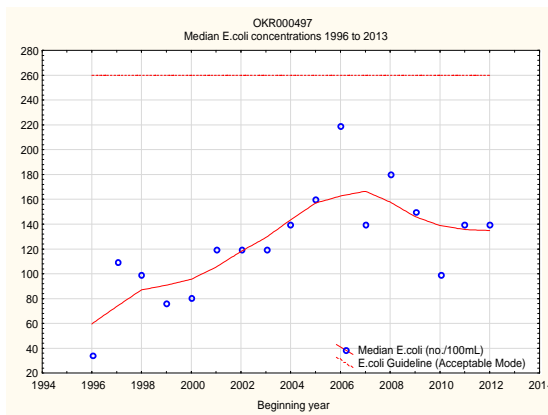


Figure 42 LOWESS trend plot of median *E. coli* numbers (per 100ml) at the Oakura River, SH 45 site for the 1996 to 2013 period

N = 17
Kendall tau = + 0.519
p level = 0.0036 [$>$ FDR, p = 0.023]
Significant at p < 0.05; not significant at p < 0.01 after FDR.

A strong increasing trend in median *E. coli* counts has been found over the seventeen seasons of monitoring. Although statistically significant at the p < 0.05 level, it was not significant at p < 0.01 after FDR application. However, none of these seasonal medians exceeded the 'Alert' or 'Action' modes. This increasing trend may warrant further investigation if it continues although it should be noted that there has been a slightly improving trend (decrease) in median *E. coli* counts over the past six year period.

3.2.13 Waitara River at the town wharf, Waitara

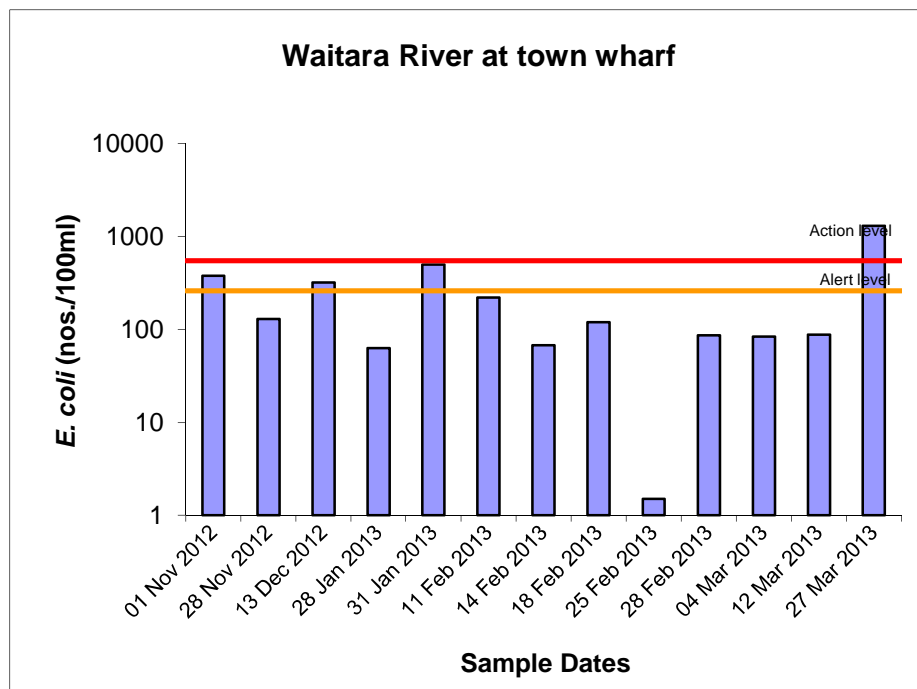
Minor bathing usage of this river site at the new town wharf was recorded at the time of sampling surveys, the majority of which were prior to mid-afternoon. Fishing (limiting whitebaiting in season) was noted from time-to-time at this site with walking and boating as additional activities. Ducks and gulls were present on occasions. The permanent signage installed by NPDC did not survive beyond mid-season (see 3.2.13.1 (below)).

Concerns relating to the source of faecal bacteria found at this site by past monitoring, led TRC to undertake additional microbial source tracing (MST) using DNA marker techniques (see Section 3.2.10) at four sites in the lower Waitara River during the 2010-2011 season (TRC, 2011b). In summary, faecal bacteria found at this Town Wharf site were sourced predominantly from cattle (under all tidal and flow conditions) with some indication of bacteria of human origin under high tide and flood conditions. Upstream (Bertrand Road site) faecal bacteria were totally of cattle origin whilst downstream (on both sides of the river mouth), faecal bacteria of cattle (all occasions), wildfowl and human (occasional) derivation were found.

Regular sampling data from the site are presented in Table 59 and illustrated in Figure 43 with a statistical summary provided in Table 60. River flow information is illustrated in Figure 44.

Table 59 Analytical results for the Waitara River at the town wharf, Waitara

Date	Time	Conductivity @ 20° C	Bacteria			Temperature	Turbidity
	(NZST)	(mS/m)	E. coli (nos/100ml)	Enterococci (nos/100ml)	Faecal coliforms (nos/100ml)	(°C)	(NTU)
01.11.12	1045	513	380	17	400	17.2	33
28.11.12	0935	477	130	52	150	18.7	2.2
13.12.12	0930	642	320	27	320	19.0	6.6
28.01.13	1130	678	63	48	63	22.2	1.9
31.01.13	1140	1130	500	95	530	23.1	2.2
11.02.13	0935	972	220	100	220	19.7	13
14.02.13	1130	1270	68	40	74	20.6	5.1
18.02.13	1410	1110	120	21	120	23.0	4.3
25.02.13	1005	4460	<3	24	<3	18.2	3.3
28.02.13	1030	2720	87	40	87	20.0	3.8
04.03.13	1325	2170	84	140	92	21.2	2.6
12.03.13	1045	2660	88	42	88	19.0	3.3
27.03.13	0915	1340	1300	91	1300	18.1	3.1

**Figure 43** *E. coli* numbers for the Waitara River at the town wharf, Waitara during the survey season**Table 60** Statistical results summary for the Waitara River at the town wharf, Waitara

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20° C	mS/m	13	477	4460	1130
<i>E. coli</i>	nos/100ml	13	3	1300	120
Enterococci	nos/100ml	13	17	140	42
Faecal coliforms	nos/100ml	13	3	1300	120
Temperature	°C	13	17.2	23.1	19.7
Turbidity	NTU	13	1.9	33	3.3

This ring plain and eastern hill country river drains an extensively developed agricultural catchment. The survey site is situated in the lower tidal reaches of this

large river, some 2km upstream of the river mouth. There are consented dairy ponds treated wastes discharges in the catchment upstream of the site particularly in the Manganui River sub catchment (see 3.2.14). River water was generally slightly turbid, brown-green and occasionally turbid, brown in appearance with elevated conductivity levels typical of seawater ingress near high tide on all sampling occasions and occasionally coincidental with ponded or upstream flow conditions.

Water temperatures had a moderate range of 5.9°C partly due to the coastal seawater influence, with a maximum of 23.1°C recorded at 1140 hrs in late January 2013. All of the samples were collected before 1415 hrs and therefore maximum river temperatures (which tend to occur later in the afternoon) were not sampled.

Bacteriological water quality was moderate and typical of the lower reaches of this large Taranaki eastern hill country and ring plain river draining a predominantly agricultural catchment despite some coastal seawater influence under high tide conditions (median 120 *E.coli* per 100mls and 42 enterococci per 100mls). The existing recreational sampling programme was performed around higher tidal conditions for SEM trend purposes (due to its incorporation within the coastal sites programme) at times when public usage is often more predominant at this site. Poorer bacteriological water quality might be expected under outflowing low tide conditions although monitoring undertaken 6km further upstream (at the flow recorder site at Bertrand Road) over the same recreational period and base flow conditions found a lower median *E.coli* bacterial number of 46 per 100mls and a narrower range of *E. coli* numbers (11 to 500 per 100mls).

3.2.13.1 Comparison with guidelines

Comparison with the 2003 guidelines for freshwater contact usage is summarised in Table 61.

Table 61 Bacterial guidelines performance at the Waitara River at the town wharf, Waitara [% of 13 samples]

Parameter	Number of exceedances of <i>E. coli</i> guidelines	
	ALERT Single sample 261-550/100ml	ACTION Single sample >550/100 ml
<i>E. coli</i>	3 [22]	1 [8]

(Designation: freshwater contact recreational area)

Three single samples fell within the 'Alert' mode and one within the 'Action' mode during the monitoring period. Two of the 'Alert' exceedances occurred within five days following river freshes (Figure 44), coincident with more turbid, brown river appearance indicative of the lag effects of rainfall run-off within this large catchment. It has been noted that the three-day post rainfall sampling protocols followed by the SEM programme for the other (ringplain) catchment sites are therefore not necessarily appropriate for baseline assessments of bacteriological water quality this site near the mouth of this large predominantly eastern hill country catchment river.

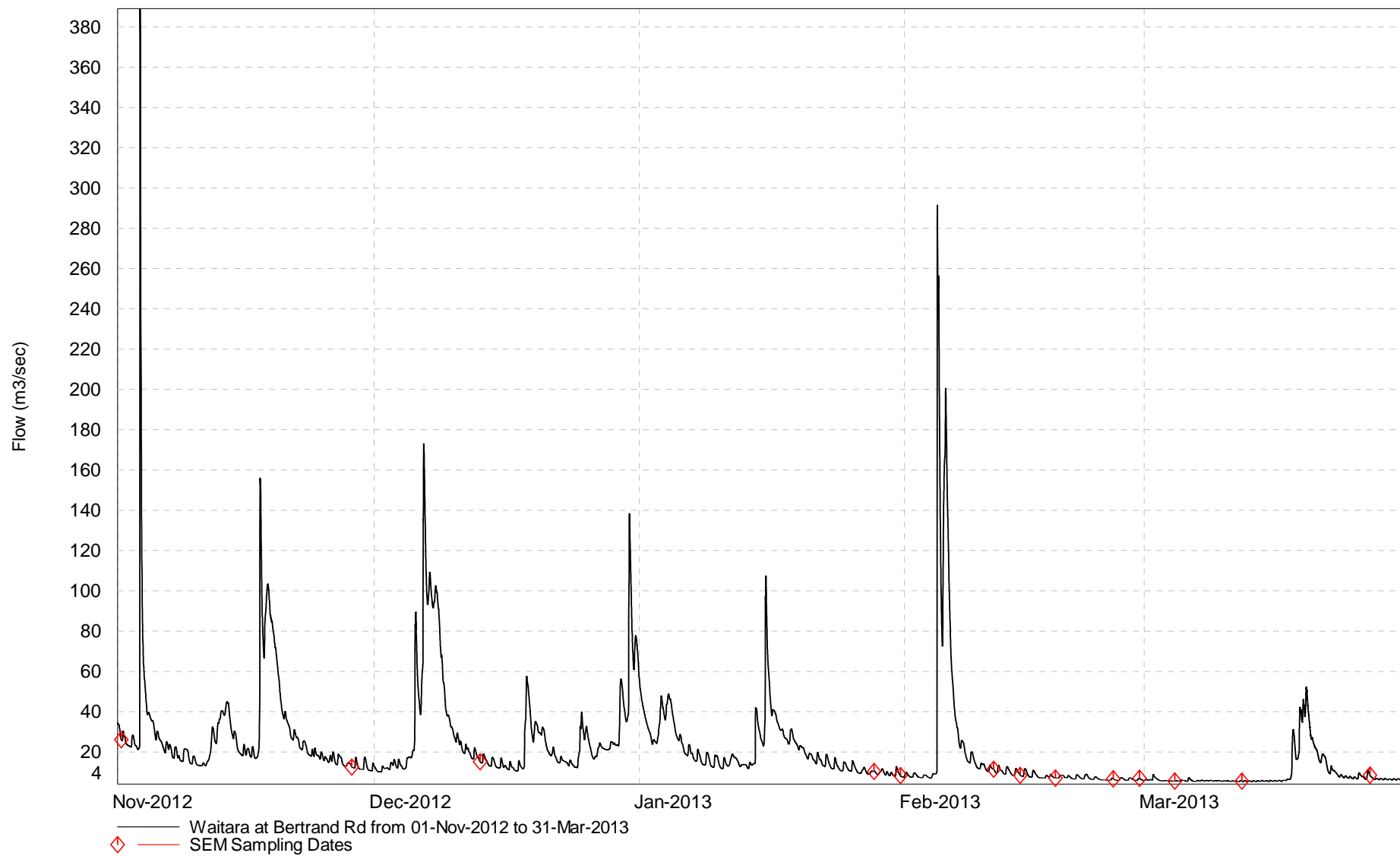


Figure 44 Flow in the Waitara River at Bertrand Road during the survey period

These issues have been discussed with the Area Health Board and NPDC staff and appropriately worded health warning signage was permanently installed at the town wharf prior to the 2010-2011 season. However, the permanency of this signage has been problematical due in part to vandalism. Subsequent sampling indicated that *E.coli* numbers had fallen below the 'Alert' level. The 'Action' level incident in late March 2013 (see Appendix VII) was considered a result of the lag effects of the first freshes (for seven weeks) which were recorded in the catchment some 6 to 8 days earlier. No appropriate follow-up sampling was possible in the fortnight following this survey.

Generally, *E. coli* numbers were moderate (i.e. < 225 per 100mls) for the majority of the sampling period and no exceedances of the guidelines were recorded during lengthier recession flow, dry weather conditions (i.e. 7 days or more after a river fresh).

3.2.13.2 Comparison with previous summers' surveys

Three previous SEM sampling seasons have been monitored at this site. Therefore only a brief statistical comparison can be made with previous data. These data for the Waitara River at the town wharf, Waitara site are summarised in Table 62 and illustrated in Figure 45 for this, the fourth season of monitoring.

Table 62 Summary *E. coli* bacteriological water quality data (nos/100ml) for summer surveys in the Waitara River at the town wharf, Waitara

Summer	09/10	10/11	11/12	12/13
Minimum	92	19	28	3
Maximum	1700	570	550	1300
Median	230	76	150	120

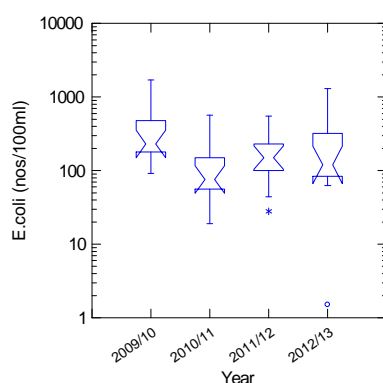


Figure 45 Box and whisker plots for all summer surveys of *E. coli* bacterial numbers for the Waitara River at the town wharf, Waitara

A moderate median *E. coli* number was found by this fourth season's survey with a wider range of counts found during the season due to several delayed effects of preceding freshes in this large, predominantly hill country catchment. Trend analysis of median *E.coli* numbers will not be performed until the sampling period has encompassed ten seasons of data collection at this site.

3.2.14 Urenui River at the estuary

Some bathing usage of this site was noted (on four of the sampling surveys) with some usage apparent for other activities (e.g boating, fishing, and picnicking) at this

tidal site. This is a very popular site during weekends and holiday periods (see TRC, 1999 and TRC, 2008a).

Data from the site are presented in Table 63 and enterococci counts (as the site is predominantly seawater) are illustrated in Figure 46, with a statistical summary provided in Table 64.

Table 63 Analytical results for the Urenui River at the estuary

Date	Time	Conductivity @ 20°C	Bacteria			Temperature	Turbidity
	(NZST)	(mS/m)	E. coli (nos/100ml)	Enterococci (nos/100ml)	Faecal coliforms (nos/100ml)	(°C)	(NTU)
01.11.12	0925	4530	19	1	19	16.1	7.0
28.11.12	1040	4720	1	<1	1	17.5	6.4
13.12.12	1035	4640	32	21	32	19.2	12
28.01.13	0955	4740	<1	<1	<1	20.3	3.1
31.01.13	1040	4720	5	1	5	21.7	8.2
11.02.13	1030	4730	60	100	60	20.9	14
14.02.13	1030	4690	3	<1	3	20.4	11
18.02.13	1330	4550	<1	<1	<1	21.4	4.6
25.02.13	0900	4600	7	40	11	17.5	13
28.02.13	0930	4720	3	3	4	19.8	7.6
04.03.13	1220	4760	8	12	8	20.9	21
12.03.13	0920	4790	<1	5	<1	19.6	6.5
27.03.13	1030	4740	9	8	9	20.3	19

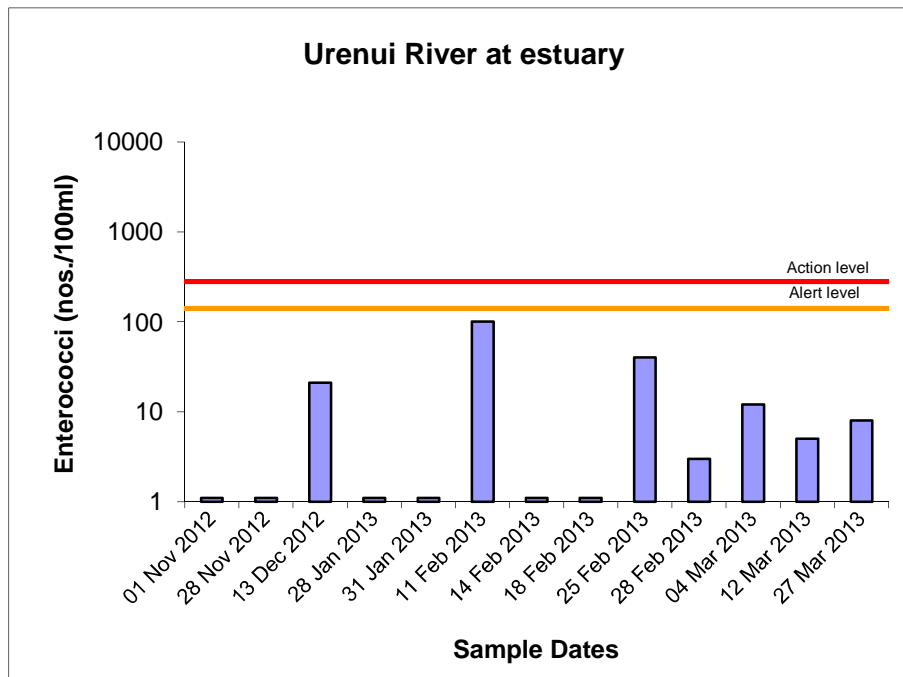


Figure 46 Enterococci numbers for the Urenui River at the estuary during the survey season

Table 64 Statistical results summary for the Urenui River at the estuary

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	4530	4790	4720
<i>E. coli</i>	nos/100ml	13	<1	60	5
Enterococci	nos/100ml	13	<1	100	3
Faecal coliforms	nos/100ml	13	<1	60	5
Temperature	°C	13	16.1	21.7	20.3
Turbidity	NTU	13	3.1	21	8.2

This hill country catchment river typically is turbid under low tide conditions in the tidal lower reaches of the estuary where it is extensively used by visitors and the holiday population based at the Urenui Beach settlement. High tide conditions resulted in aesthetic improvements within the estuary. Under high tide sampling conditions, the minimum (3.1 NTU) and median turbidity (8.2 NTU) levels were indicative of slightly to moderately turbid conditions typical of mixing of the more discoloured river flow with inflowing cleaner seawater. The river at this site was generally described as greenish in appearance and slightly turbid to turbid. Conductivity levels were characteristic of coastal saltwater on all occasions. Relatively high water temperatures (median of 20.3°C), more typical of coastal seawater temperatures, varied over a relatively narrow range of 5.6°C during the sampling period with a maximum of 21.7°C recorded in late morning in late February 2013. All sampling however, was undertaken prior to 1225 hrs when water temperatures could have been expected to have been cooler than later in the day, depending upon the state of the tide.

Bacteriological water quality was generally very good as a result of the seawater tidal intrusion into the estuary. Poorer bacteriological river water quality might be expected under low outflowing tidal conditions as comparative sampling at the semi-tidal upstream SH3 bridge site to date has identified significantly higher numbers of all three bacteriological species (eg medians for *E. coli* [220 per 100 ml] and enterococci [150 per 100 ml]). The existing sampling programme was designed around higher tidal conditions (for SEM trend purposes and due to its incorporation within the coastal sites sampling programme) at times when bathing is more predominant at this site. No very high enterococci counts were recorded during the monitoring period.

3.2.14.1 Comparison with guidelines

Comparison with the 2003 guidelines for contact usage is summarised in Table 65 using the marine guidelines, which are considered to be more appropriate for this estuarine site.

Table 65 Bacterial guidelines performance at the Urenui River estuary site [% of 13 samples]

Parameter	Number of exceedances of enterococci guidelines	
	ALERT Single sample 141-280/100ml	ACTION 2 consecutive single samples >280/100 ml
<i>E. coli</i>	0 [0]	0 [0]

(Designation: coastal contact recreational area)

No single samples fell within the 'Alert' mode or within the 'Action' mode for saline water at any time during the monitoring period. Also, neither mode was exceeded in terms of the freshwater guidelines (for *E. coli*).

The bacteriological water quality at this site was within the acceptable guideline for contact recreational usage throughout the season recognising that all sampling occasions coincided with high tides and therefore a predominance of high quality saline water mixing with poorer quality river water at this estuarine site. This was consistent with data for the nearby Urenui Beach coastal site (median enterococci: 4 per 100mls) monitored over six seasons to date.

3.2.14.2 Comparison with previous summers' surveys

A statistical comparison of each of the seventeen summers' survey data is presented graphically in Appendix V for all sites. These summer enterococci data for the Urenui River site at the estuary are summarised in Table 66 and illustrated in Figure 47.

Table 66 Summary of enterococci bacteriological water quality data (nos/100ml) for all summer surveys in the Urenui River estuary to date

Summer	96/97	97/98	98/99	99/00	00/01	01/02	02/03	03/04	04/05	05-06	06/07	07/08	08/09	09/10	10/11	11/12	12/13
Minimum	<1	<1	<1	1	<1	<1	<1	<1	1	<1	<1	<1	<1	<1	<1	<1	<1
Maximum	40	69	82	220	160	27	19	72	640	30	9	36	120	190	150	36	100
Median	5	7	3	8	14	8	4	4	5	4	1	2	11	7	3	4	3

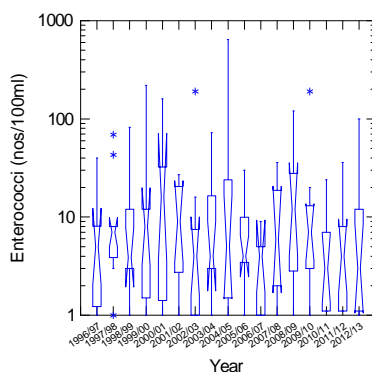


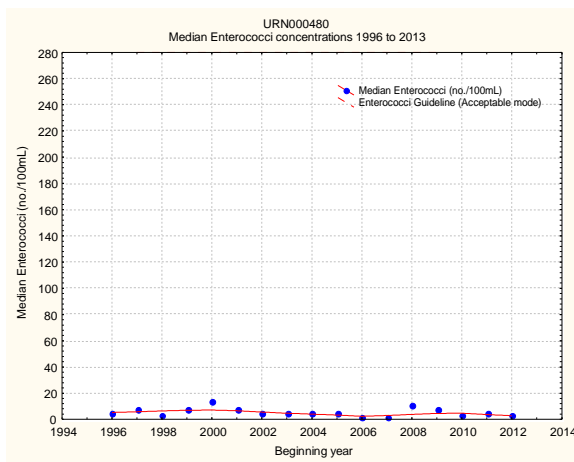
Figure 47 Box and whisker plots for all summer surveys of enterococci bacterial numbers in the Urenui River at the estuary

The high bacteriological water quality of the Urenui River estuary, during high tide conditions, continued during the 2012-2013 season (Figure 47). This was emphasised by all seasonal median enterococci counts being less than 15 enterococci (per 100 mls). The range was relatively narrow for enterococci during the 2012-2013 season as a result of no single sample counts in excess of 100 enterococci per 100 mls during the period.

The high bacteriological quality of the coastal sea water intrusion was the major influence on the bacteriological water quality of the lower quality river water at this estuarine site during preferred recreational usage (ie, higher tide) conditions.

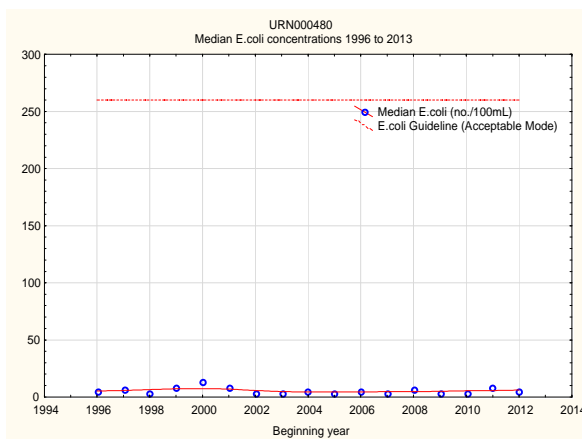
Trend analysis of median enterococci and *E. coli* numbers has been performed for the seventeen seasons of data by first applying a LOWESS fit (tension 0.4) to a time scatterplot of the median numbers (Figures 48 and 49) and testing the significance of

any trend using the Mann-Kendall test at 5% level followed by Benjamini-Hockberg False Discovery Rate (FDR) analysis.



N = 17
Kendall tau = - 0.261
p level = 0.142 [$>$ FDR, p = 0.309]
N/S at p < 0.05

Figure 48 LOWESS trend plot of median enterococci (per 100ml) at the Urenui River, estuary site for the 1996 to 2013 period



N = 17
Kendall tau = - 0.071
p level = 0.689 [$>$ FDR, p = 0.967]
N/S at p < 0.05

Figure 49 LOWESS trend plot of median *E. coli* (per 100ml) at the Urenui River, estuary site for the 1996 to 2013 period

No statistically significant trend in median enterococci or *E. coli* counts has been found over the seventeen seasons of monitoring which have indicated a slight decrease in both bacterial species numbers over this period. None of these medians exceeded the 'Alert' or 'Action' modes for either marine or freshwater contact recreational usage.

3.2.15 Manganui River at Everett Park (downstream of Kurapete Stream)

No bathing or other usage of this river site was noted at the time of sampling occasions during the survey period despite the proximity of the site to a nearby outdoor adventure camp.

Data from the site are presented in Table 67 and illustrated in Figure 50, with a statistical summary provided in Table 68. River flow records are illustrated in Figure 51.

Table 67 Analytical results for the Manganui River at Everett Park (downstream of the Kurapete Stream)

Date	Time	Conductivity @ 20° C	Bacteria			Temperature	Turbidity
	(NZST)	(mS/m)	<i>E. coli</i> (nos/100ml)	Enterococci (nos/100ml)	Faecal coliforms (nos/100ml)	(°C)	(NTU)
01.11.12	0835	9.3	760	28	760	14.9	1.1
28.11.12	1140	9.8	290	3	290	17.8	0.8
13.12.12	1145	9.8	80	17	88	18.5	0.8
28.01.13	0845	10.6	83	120	83	17.8	0.7
31.01.13	0930	10.3	100	100	100	19.1	0.7
11.02.13	1130	9.6	160	190	210	17.4	0.5
14.02.13	0915	9.8	200	200	200	17.2	0.6
18.02.13	1230	9.9	96	110	96	19.3	0.7
25.02.13	1130	10.0	92	130	100	17.4	0.6
28.02.13	0825	10.0	260	140	280	18.1	0.5
04.03.13	1000	10.2	140	99	160	17.4	0.4
12.03.13	0835	10.3	96	160	96	17.1	0.6
27.03.13	1115	10.1	170	160	170	15.2	0.6

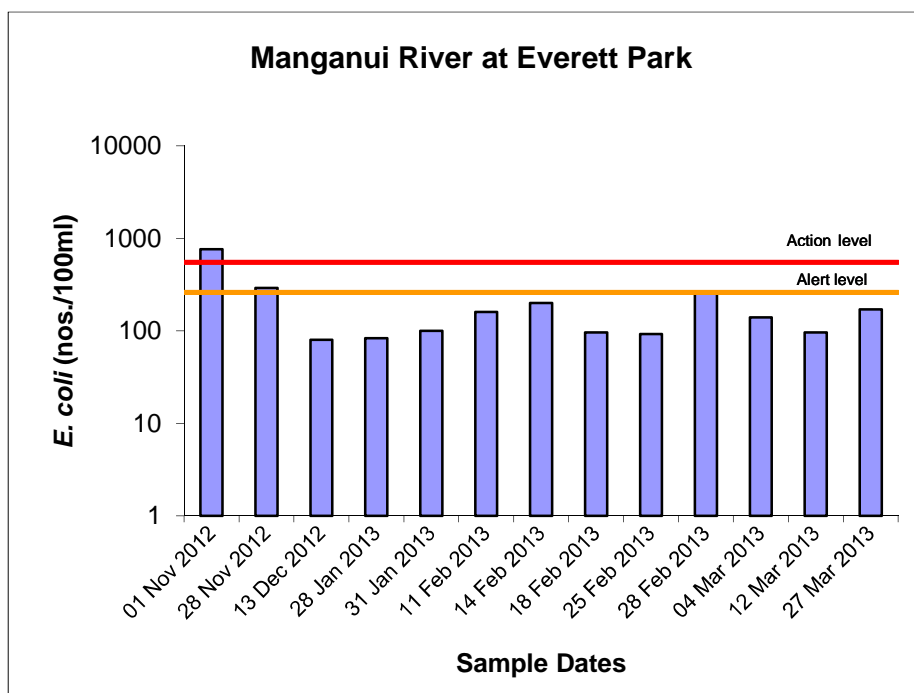


Figure 50 *E. coli* numbers for the Manganui River at Everett Park (downstream of the Kurapete Stream) during the survey season

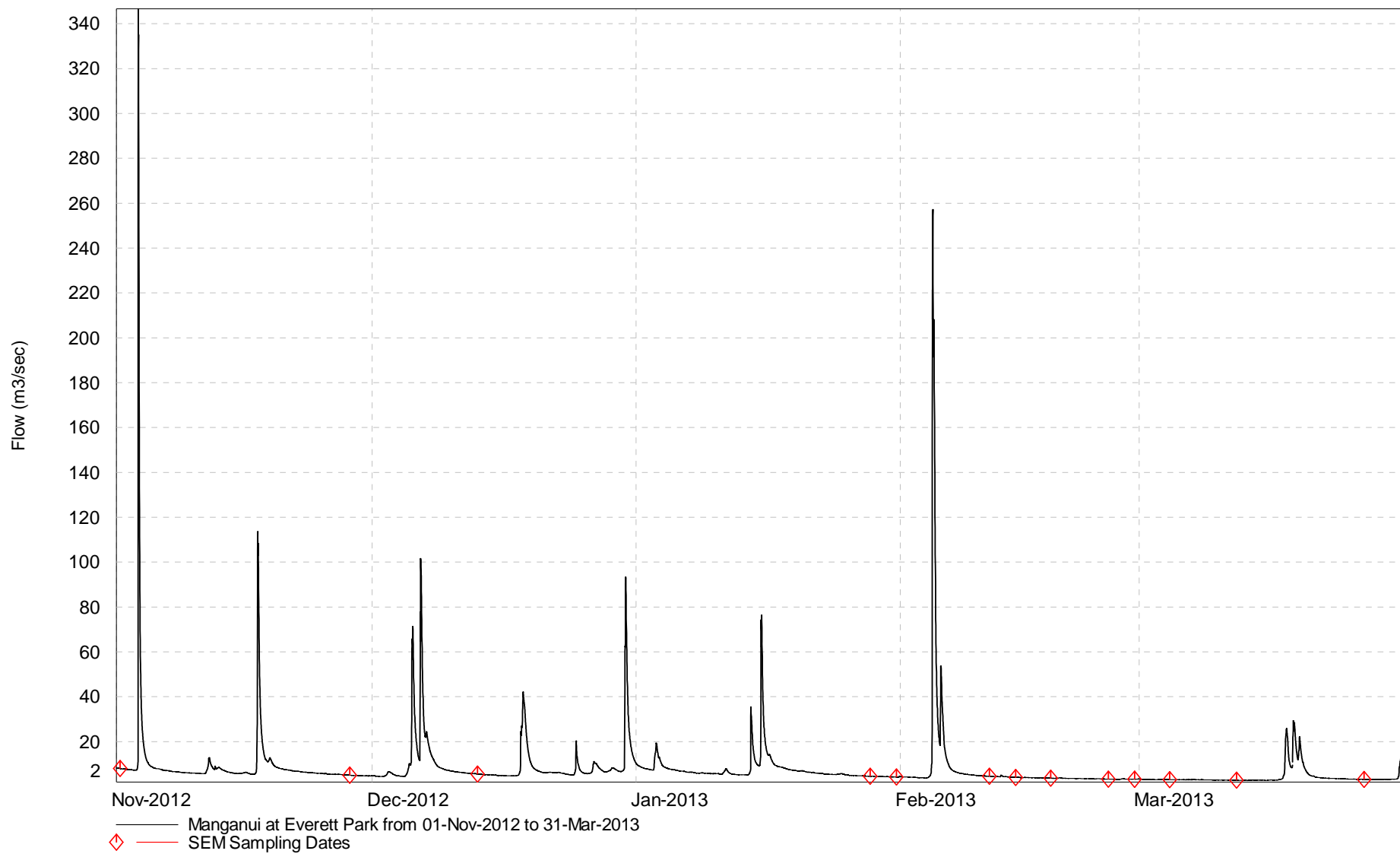


Figure 51 Flow in the Manganui River at Everett Park during the survey period

Table 68 Statistical results summary for the Manganui River at Everett Park (downstream of Kurapete Stream)

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	9.3	10.6	10.0
<i>E. coli</i>	nos/100ml	13	80	760	140
Enterococci	nos/100ml	13	3	200	120
Faecal coliforms	nos/100ml	13	83	760	160
Temperature	°C	13	14.9	19.3	17.4
Turbidity	NTU	13	0.4	1.1	0.6

This ring plain river drains an extensively developed agricultural catchment, the site surveyed being situated at Everett Park approximately 300 m downstream of the Kurapete Stream confluence, and about 500 m below another (less utilised) Manganui River recreational site, upstream of the Kurapete Stream. Since the 1999-2000 season's survey, discharges from the Inglewood municipal oxidation ponds' system into the Kurapete Stream (approximately 8 km upstream of the survey site) have been diverted out of the stream to the New Plymouth wastewater treatment plant.

The river was clear and green/brown at the time of the majority of the sampling surveys, with relatively low conductivity levels. Water temperatures varied over a narrow range of 4.4°C with the maximum temperature (19.3°C) recorded near midday in mid-February 2013. Higher temperatures could be expected later in the day as no sampling surveys were performed after 1230 hrs.

Bacteriological water quality was moderate for this site during the 2012-2013 survey period with all of the counts recorded during the period in excess of 79 *E. coli* per 100 mls (Figure 50). The elevated count in early November 2012 which entered the 'Action' level, coincided with a significant flood three days prior to sampling. Levels decreased below the 'Action' level within the month and returned to low numbers (below the 'Alert' level) by the time of the following survey, where numbers remained for the rest of the period.

3.2.15.1 Comparison with guidelines

Comparison with the 2003 guidelines for freshwater contact usage is summarised in Table 69.

Table 69 Bacterial guidelines performance at the Manganui River at Everett Park (upstream of Kurapete Stream) [% of 13 samples]

Parameter	Number of exceedances of <i>E. coli</i> guidelines	
	ALERT Single sample 261-550/100ml	ACTION Single sample >550/100 ml
<i>E. coli</i>	1 [8]	1 [8]

(Designation: freshwater contact recreational area)

One single sample fell in the 'Alert' mode and one reached the 'Action' mode during the season. The highest of these elevated counts followed a relatively recent significant flood during the very wet spring period.

Bacteriological water quality at this site in terms of contact recreational usage was acceptable considering the impacts of farming activities, particularly in relation to the residual flow remaining in the river in mid-catchment downstream of the Motukawa HEP diversion (ie, significant abstraction of upper catchment water for hydroelectric power production purposes).

3.2.15.2 Comparison with previous summers' surveys

A statistical comparison of each of the seventeen summers' survey data is presented graphically in Appendix V for all sites. These summer data for the Manganui River site at Everett Park are summarised in Table 70 and illustrated in Figure 52.

Table 70 Summary of *E. coli* bacteriological water quality summary data (nos/100ml) for all summer surveys in the Manganui River at Everett Park to date

Summer	96/97	97/98	98/99	99/00	00/01	01/02	02/03	03/04	04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13
Minimum	58	85	76	46	26	100	54	66	83	46	11	54	100	92	100	34	80
Maximum	690	2400	830	350	450	970	460	880	730	240	320	1200	480	370	320	400	760
Median	150	220	160	110	98	210	140	180	180	120	190	160	170	200	170	120	140

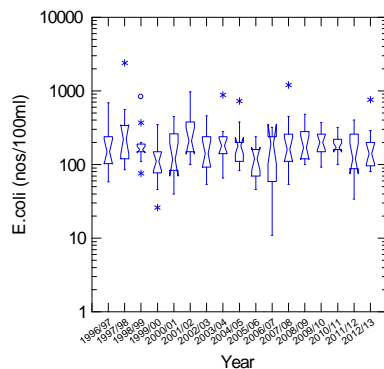
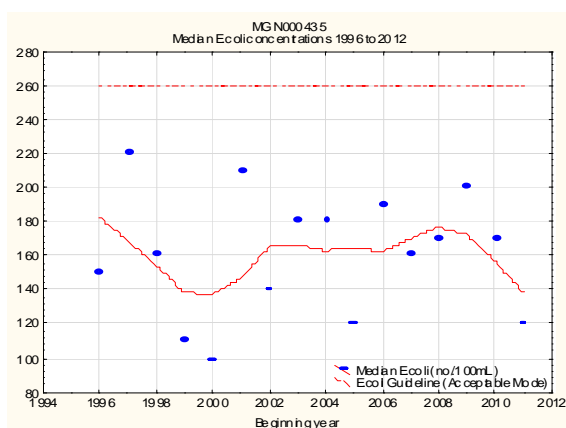


Figure 52

Box and whisker plots for all summer surveys of *E. coli* bacterial numbers in the Manganui River at Everett Park

The median *E. coli* count for the 2012-2013 season was within the range and was the fifth lowest of the seventeen seasons' medians recorded since the inception of the programme in 1996-97 (Figure 52). The range of *E. coli* numbers was wider than the majority of those recorded to date mainly due to a relatively high maximum count of 760 per 100 mls; the sixth highest seasonal maximum recorded to date at this site.

Trend analysis of these median *E. coli* numbers has been performed for the seventeen seasons of data by first applying a LOWESS fit (tension 0.4) to a time scatterplot of the median numbers (Figure 53) and testing the significance of any trend using the Mann-Kendall test at 5% level followed by Benjamini-Hockberg False Discovery Rate (FDR) analysis.



N = 17
 Kendall tau = -0.022
 p level = 0.900 [$>$ FDR, $p = 0.967$]
 N/S at $p < 0.05$

Figure 53 LOWESS trend plot of median *E. coli* numbers (per 100 ml) at the Manganui River, Everett Road site for the 1996 to 2012 period

A minimal and statistically insignificant decrease in median *E. coli* counts has been found over the seventeen seasons of monitoring. None of these seasonal medians exceeded the 'Alert' or 'Action' modes.

3.2.16 Lake Ratapiko

No bathing usage of the lake was noted on any occasion. Boating and picnicking were recorded on only one occasion. No other activities were recorded at the time of any of the sampling surveys. However, the lake is commonly used for boating and fishing purposes, particularly at weekends and holidays. Ducks were present in moderate numbers on the lake and a shag was recorded on one occasion. Stock had access to the lake margins and were recorded on at least two occasions. The lake was drawn down for maintenance purposes toward the end of the season (in late March 2013) when sampling was unable to be performed.

The data for this site are presented in Table 71 and illustrated in Figure 54 with a statistical summary provided in Table 72.

Table 71 Analytical results for Lake Ratapiko

Date	Time	Conductivity @ 20°C	Bacteria			Temperature	Turbidity
	(NZST)	(mS/m)	<i>E. coli</i> (nos/100ml)	Enterococci (nos/100ml)	Faecal coliforms (nos/100ml)	(°C)	(NTU)
01.11.12	0815	7.6	180	8	180	16.0	1.3
28.11.12	1205	7.9	3	<1	4	20.3	1.1
13.12.12	1210	7.6	8	9	8	20.3	1.2
28.01.13	0815	8.5	5	<1	7	21.2	1.4
31.01.13	0910	8.3	7	5	7	22.4	1.3
11.02.13	1150	7.2	3	9	4	20.3	1.1
14.02.13	0855	7.6	12	4	12	20.0	1.2
18.02.13	1600	7.7	240	140	240	22.1	1.5
25.02.13	1200	8.4	24	2	24	21.5	1.6
28.02.13	0805	7.9	34	58	34	21.0	1.4
04.03.13	0940	7.9	4	2	4	21.2	1.1
12.03.13	0810	8.0	16	10	16	19.6	1.1
27.03.13	-	-	-	-	-	-	-

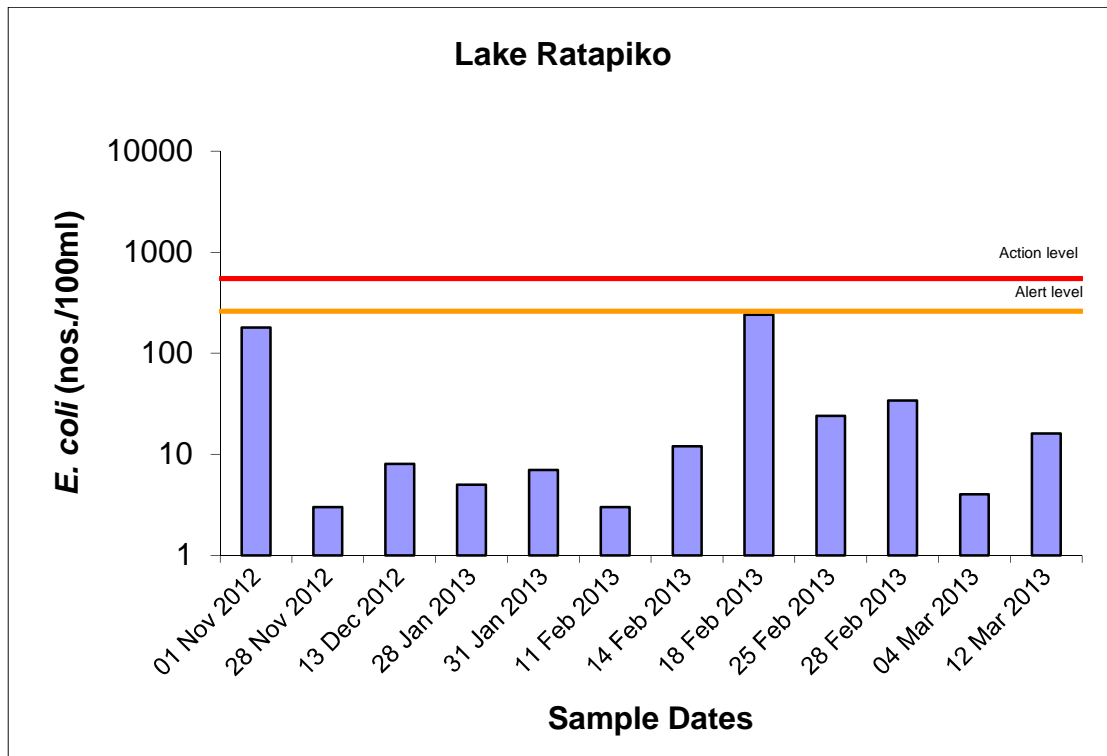


Figure 54 *E. coli* numbers for Lake Ratapiko during the survey season

Table 72 Statistical results summary for Lake Ratapiko

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	12	7.2	8.5	7.9
<i>E. coli</i>	nos/100ml	12	3	240	10
Enterococci	nos/100ml	12	<1	140	6
Faecal coliforms	nos/100ml	12	4	240	10
Temperature	°C	12	16.0	22.4	20.6
Turbidity	NTU	12	1.1	1.6	1.2

The lake is replenished by diversion water flow from the mid reaches of the Manganui River via the Motukawa HEP scheme. Water quality was generally very good with minimal variation in clarity (median turbidity: 1.2 NTU; range of turbidity: 0.5 NTU) as a result of low suspended algae populations possibly due to short retention times. Water temperatures were moderate ranging over 6.4°C for the period with a moderately high maximum of 22.4°C (mid-morning in late January 2013) although all but one of the measurements were recorded prior to 1215 hrs. Conductivity showed minimal variation (less than 1.5 mS/m) during the period.

Generally bacteriological quality was good considering that the inflow to the lake is from the mid reaches of a river draining a developed farmland catchment. Only two counts exceeded 34 *E. coli* per 100 mls despite the wet spring period. No sampling was possible at the very end of the season coincident with the HEP scheme lake lowering for maintenance purposes.

3.2.16.1 Comparison with guidelines

Comparison with the 2003 guidelines for freshwater contact usage is summarised in Table 73.

Table 73 Bacterial guidelines performance at Lake Ratapiko [% of 12 samples]

Parameter	Number of exceedances of <i>E. coli</i> guidelines	
	ALERT Single sample 261-550/100ml	ACTION Single sample >550/100 ml
<i>E. coli</i>	0 [0]	0 [0]

(Designation: Freshwater contact recreational area)

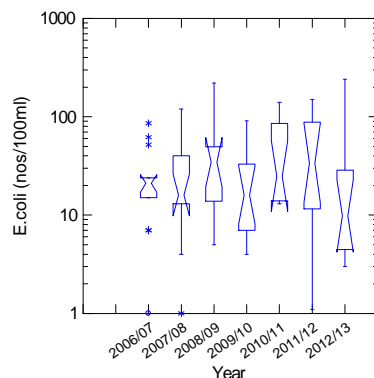
No single sample exceedances of the 'Action' mode occurred and no samples were recorded within the 'Alert' mode during the entire period.

3.2.16.2 Comparison with previous summers' surveys

A statistical comparison of all sites' summers' *E. coli* survey data is presented graphically in Appendix V for all sites. Data from the seven summer surveys for the Lake Ratapiko site are summarised in Table 74 and illustrated in Figure 55.

Table 74 Summary of *E. coli* bacteriological water quality data (nos/100ml) for all summer surveys at Lake Ratapiko to date

Summer	06/07	07/08	08/09	09/10	10/11	11/12	12/13
Minimum	1	1	5	4	13	1	3
Maximum	86	120	220	91	140	150	240
Median	21	16	35	16	25	35	10

**Figure 55** Box and whisker plots for all summer SEM surveys of *E. coli* bacteria numbers at Lake Ratapiko

A very low median *E. coli* number was found by the latest season's survey and a moderate range of counts was recorded. All seasonal medians have been low, but this season's was the lowest of the seven seasons' medians to date. Trend analysis of median *E. coli* numbers will not be performed for this site until ten seasons' data are available.

3.2.16.3 Cyanobacteria

There was no visual evidence of any nuisance algal blooms during the survey period. Microscopic scans of samples collected on seven sampling occasions were performed, with the results of these analyses presented in Table 75.

Table 75 Cyanobacteria counts (cells /ml) for Lake Ratapiko [Health warning: >15,000 cells /ml]

Date	Cyanobacteria total cell count (cells/ml)
6.11.12	nil
19.12.12	nil
07.1.13	nil
22.1.13	nil
07.2.13	nil
21.2.13	nil
22.8.13	nil

No cyanobacteria were detected in any of the samples. None had been found in this lake during the 2006-2007, 2008-2009, 2009-2010, 2010-2011, or 2011-2012 seasons, but low numbers of *Anabaena* had been present in the latter part of the 2007-2008 season following a lengthy, extremely low flow period. The relatively short lake water residence time (due to hydroelectric power generation usage) may be a factor in the control of these bacteria populations.

3.2.17 Lake Rotokare

Cyanobacteria monitoring of this lake was instigated in the 2007-2008 season in recognition of this small lake's recreational usage, particularly for boating activities. The boating season is restricted to the period from 1 December to 1 May by the STDC in recognition of the status of the Rotokare Scenic Reserve.

Some bacteriological water quality monitoring was also undertaken in conjunction with the cyanobacteria monitoring during the 2012-2013 season, with the lake visited on nine occasions between early November 2012 and mid April 2013. [Note: bacteriological monitoring is not a component of the SEM programme at this lake].

Usage of the lake included walkers (visitors) and picnicking throughout the season. The boat ramp remaining locked throughout the period until late February, 2013 following a series of lower cyanobacteria counts. A few pukeko were noted at the lake margin and a few ducks and swans were noted from time to time on the lake which appeared mainly slightly turbid, brownish throughout most of the period.

The bacteriological water quality data for this site are presented in Table 76 with a statistical summary provided in Table 77.

Table 76 Analytical results for Lake Rotokare

Date	Time	Conductivity @ 20°C	Bacteria			Temperature	Turbidity
	(NZST)	(mS/m)	<i>E. coli</i> (nos/100ml)	Enterococci (nos/100ml)	Faecal coliforms (nos/100ml)	(°C)	(NTU)
08.11.12	1025	11.6	<1	4	<1	17.1	1.0
22.11.12	0955	11.5	3	1	3	18.3	3.8
29.11.12	0900	11.5	69	4	69	17.5	3.4
10.12.12	1030	11.4	<1	1	<1	19.0	6.8
10.01.13	1445	11.7	11	130	11	22.2	5.7
23.01.13	1355	-	-	-	-	23.9	-
07.02.13	0720	11.4	4	200	4	20.3	3.2
20.02.13	1415	11.6	3	3	3	23.7	0.9
07.03.13	1110	11.7	4	15	4	21.5	1.3
21.03.13	1345	12.1	3	1	3	21.2	2.1
11.04.13	0945	12.0	<1	<1	<1	17.2	3.4

Table 77 Statistical results summary for Lake Rotokare

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	10	11.4	12.1	11.6
<i>E. coli</i>	nos/100ml	10	<1	69	3
Enterococci	nos/100ml	10	<1	200	4
Faecal coliforms	nos/100ml	10	<1	69	3
Temperature	°C	11	17.1	23.9	20.3
Turbidity	NTU	10	0.9	6.8	3.3

In general, bacteriological water quality was very good, as might be expected for a small, bush clad lake with only small inflows and relatively low wild fowl numbers. Conductivity levels were very stable (range: 0.7 mS/m) through the period despite variations in inflow during the season particularly during spring-early summer wet weather. Water temperatures varied over a moderate range of 6.8°C with a maximum of 23.9°C recorded in mid January 2013. Turbidity was moderate (median: 3.3 NTU) with the range (5.9 NTU) mainly reflecting the variability in abundances of suspended algae in the water column during the season. Maximum turbidity (6.8 NTU) was coincidental with an early peak in cyanobacteria concentration in mid December 2012.

No bacterial counts entered the 'Alert' or 'Action' levels on any occasion during the season although it should be noted that in past seasons the overriding health warnings on both the Regional Council and Area Health Board's websites and on the sites at the lake and road access have related to cyanobacteria level exceedances of guidelines (see below), and not to bacterial counts. It has been noted in the past, that as cyanobacteria numbers decreased later in some seasons, coincidentally *E.coli* bacterial numbers increased, although in 2012-2013 there appeared to be no such trend.

3.2.17.1 Cyanobacteria

Microscopic scans of eleven samples during the recreational monitoring period found a moderate cyanobacteria population in early November 2012 increasing through the period mid January 2013, before decreasing to a very low concentration in mid February, 2013. Very dry weather conditions during late summer/autumn

coincided with increased cyanobacteria counts through to mid April, 2013. However, these elevated concentrations were far lower than maximum numbers found during the 2009-2010 period (by up to 160,000 cells per 1 ml) and during the 2010-2011 period (by up to 4,000 cells per 1 ml) but higher (by more than 13,000 cells per 1 ml) than the maximum count found during the 2011-2012 period. The results of these analyses are presented in Table 78 and illustrated in Figure 56.

Table 78 Cyanobacteria counts (cells/ml) for Lake Rotokare
[Health warning: > 15,000 cells /ml]

Date	Cyanobacteria total cell count (cells/ml)	Principal species
08.11.12	1,025	<i>Anabaena</i>
22.11.12	15,400	<i>Anabaena</i>
29.11.12	8,250	<i>Anabaena</i>
10.12.12	27,000	<i>Anabaena</i>
10.01.13	23,300	<i>Anabaena</i>
23.01.13	9,450	<i>Anabaena</i>
07.02.13	6,300	<i>Anabaena</i>
20.02.13	55	<i>Anabaena</i>
07.03.13	1,700	<i>Anabaena</i>
22.03.13	10,100	<i>Anabaena</i>
11.04.13	13,900	<i>Anabaena</i>
29.04.13	5,050	<i>Anabaena</i>

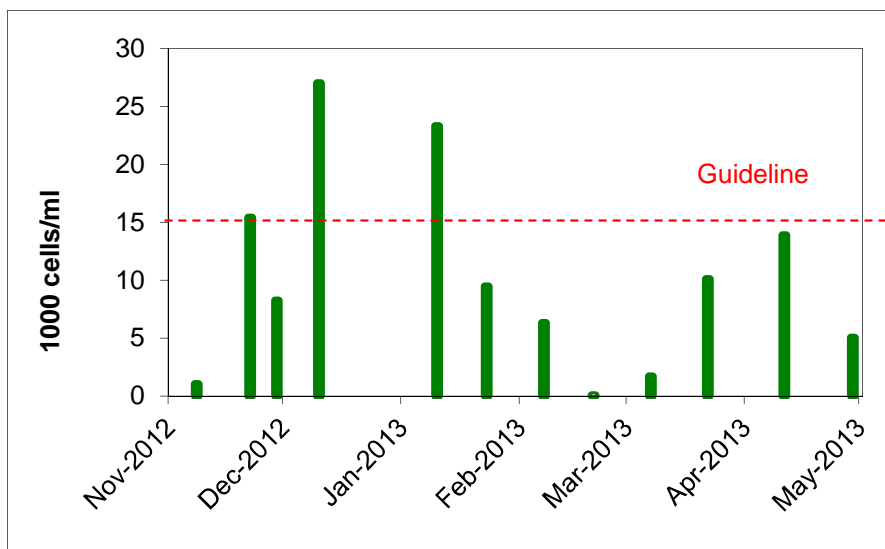


Figure 56 Cyanobacteria counts (cells/ml) at Lake Rotokare [Health warning: >15,000 cells/ml]

A moderate count of *Anabaena* found in the lake in early November 2012 did not necessitate installation of a blue-green algal hazard warning sign by the STDC upon advice from the Taranaki Area Health Board. Increasing counts exceeded the health guideline [15,000 cells/ml] late in November 2012 and therefore there was a requirement for STDC to erect signage at the lake and road access (see Appendix VII), and the boatramp remained closed. *Anabaena* concentrations remained high through summer peaking at about 27,000 cells/ ml in mid January 2013 before decreasing steadily through February 2013 to a very low number by late February 2013. At this time the boatramp had been re-opened for recreational usage of the lake, which remained the case through to the end of the season despite a further

increase in the *Anabaena* population coincident with a very dry late summer-autumn period. These numbers however, did not exceed the health guideline and decreased during a relatively wet April. There was no occurrence of the *Microcystis* bloom which had been found toward the end of the 2007-2008 season, with no instance of *Microcystis* found at all over the 2011-2012 period or 2012-2013 periods. The Area Health Board did not require algal toxin testing during the period.

The warning signage displayed adjacent to the boatramp in past seasons was required for most of the period. No primary contact recreational usage of the lake was recorded at the time of sampling surveys after recreational use of the lake was possible with the boat ramp unlocked later in the summer.

4. General data summary

A comparative summary of results of the seventeenth summer bacteriological quality freshwater survey involving sixteen contact recreational sites in the Taranaki region is provided in Table 79. Results are also illustrated in Figure 57 for each of the bacteriological species and a comparison of all sites' summer data is presented in Appendix V in the form of statistical 'box and whisker' plots.

Table 79 Statistical summary of results for the sites sampled in the SEM freshwater contact recreational water quality survey, 2012-2013

Site		Temperature (°C)	Conductivity @ 20°C (mS/m)	Faecal coliforms (nos/100 ml)	E. coli (nos/100 ml)	Enterococci (nos/100 ml)	Turbidity (NTU)
Lake Rotomanu	Median	22.7	16.2	100	100	37	8.8
	Minimum	19.8	15.2	23	23	5	5.8
	Maximum	25.6	17.1	450	430	280	14
	No. of samples	13	13	13	13	13	13
Waiwhakaiho River at Merrilands Domain	Median	19.4	13.7	52	52	46	0.5
	Minimum	16.3	10.7	11	11	1	0.3
	Maximum	21.6	15.3	4500	3000	5600	0.8
	No. of samples	13	13	13	13	13	13
Waiwhakaiho River adjacent to L. Rotomanu	Median	19.9	14.0	1300	1100	1200	0.8
	Minimum	16.4	10.7	240	230	330	0.4
	Maximum	24.3	1100	5500	5000	8700	1.3
	No. of samples	13	13	13	13	13	13
Te Henui Stream at mouth, East End	Median	18.9	782	1700	1500	1100	1.0
	Minimum	14.8	54.4	300	300	230	0.5
	Maximum	21.4	2870	4500	4200	1700	2.7
	No. of samples	13	13	13	13	13	13
Patea River at King Edward Park, Stratford	Median	16.0	9.3	180	180	430	0.7
	Minimum	12.1	8.6	37	37	24	0.5
	Maximum	18.7	10.0	330	330	800	1.1
	No. of samples	13	13	13	13	13	13
Patea River at boatramp, Patea	Median	20.2	4710	3	3	1	10
	Minimum	16.2	4660	1	1	1	3
	Maximum	21.8	4760	84	84	20	27
	No. of samples	13	13	13	13	13	13
Waingongoro River at Eltham camp	Median	18.1	11.5	160	160	80	1.0
	Minimum	14.4	10.2	74	74	19	0.8
	Maximum	22.1	12.6	450	430	570	2.0
	No. of samples	13	13	13	13	13	13
Waingongoro River at Ohawe Beach	Median	20.2	18.1	110	110	220	1.6
	Minimum	16.6	15.9	48	46	31	1.1
	Maximum	23.8	19.7	2300	2300	1500	2.6
	No. of samples	13	13	13	13	13	13
Kaupokonui River at beach domain	Median	20.3	24.9	140	140	92	1.3
	Minimum	17.0	14.8	28	28	24	1.0
	Maximum	25.0	864	550	540	590	8.6
	No. of samples	13	13	13	13	13	13
Lake Opunake adjacent to boat ramp	Median	20.7	14.4	120	120	440	1.2
	Minimum	16.6	13.2	17	17	20	0.8
	Maximum	24.0	15.5	500	500	2500	1.6
	No. of samples	13	13	13	13	13	13
Timaru Stream at Weld Road (near mouth)	Median	18.6	121	260	250	210	0.5
	Minimum	13.6	9.2	26	26	36	0.3
	Maximum	23.4	911	560	550	700	1.0
	No. of samples	13	13	13	13	13	13
Oakura River d/s of SH45 bridge	Median	18.4	28.3	140	140	160	0.4
	Minimum	14.2	8.1	34	31	17	0.2
	Maximum	23.5	549	530	530	240	1.1
	No. of samples	13	13	13	13	13	13
Waitara River at town wharf, Waitara	Median	19.7	1130	120	120	42	3.3
	Minimum	17.2	477	3	3	17	1.9
	Maximum	23.1	4460	1300	1300	140	33
	No. of samples	13	13	13	13	13	13
Urenui River at estuary	Median	20.3	4720	5	5	3	8.2
	Minimum	16.1	4530	<1	<1	<1	3.1
	Maximum	21.7	4790	60	60	100	21
	No. of samples	13	13	13	13	13	13
Manganui River d/s of Kurapete S. (Everett Park)	Median	17.4	10.0	160	140	120	0.6
	Minimum	14.9	9.3	83	80	3	0.4
	Maximum	19.3	10.6	760	760	200	1.1
	No. of samples	13	13	13	13	13	13
Lake Rataipiko at boat ramp	Median	20.6	7.9	10	10	6	1.2
	Minimum	16.0	7.2	4	3	<1	1.1
	Maximum	22.4	8.5	240	240	140	1.6
	No. of samples	12	12	12	12	12	12

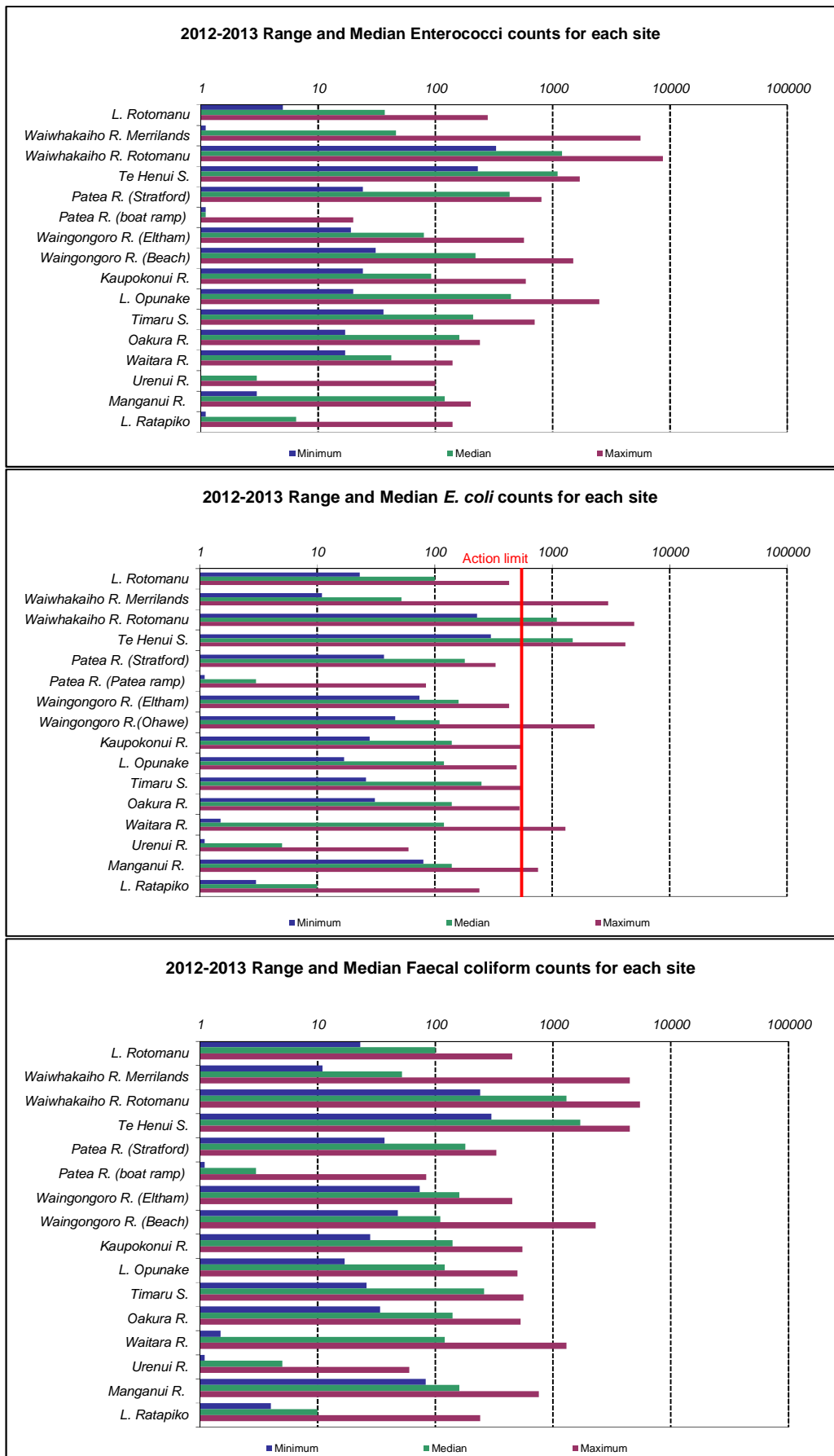


Figure 57 Ranges and medians of bacteria numbers recorded from all sites by the SEM programme over the 2012-2013 survey season

Non-exceedance of the 2003 guidelines has varied at the sixteen freshwater contact recreational sites sampled during the survey period (Figure 57 and Table 80) but not to the same degree as recorded in many of the previous seasons. In relation to the guidelines, two sites (Waiwhakaiho River at Lake Rotomanu and Te Henui at East End beach) regularly failed to meet the *E. coli* 'Action' guideline suitable for contact recreation. In terms of median *E. coli* counts, these were also the only two sites with the median count in the 'Action' (>550 *E. coli* per 100mls) mode, whereas none of the other sites had a median count in the 'Alert' mode.

Table 80 Number of occasions single sample *E.coli* counts entered the 'Alert' and 'Action' modes and percentage [%] of samples which fell below these modes (ie met the guidelines).

Site	'Alert' mode		'Action' mode	
Lake Rotomanu at western beach	1	[92]	0	[100]
Waiwhakaiho River at Merrilands Domain	0	[92]	1	[92]
Waiwhakaiho River adjacent to L Rotomanu	0	[8]	12	[8]
Te Henui Stream at mouth, East End	1	[0]	12	[8]
Patea River at King Edward Park, Stratford	4	[69]	0	[100]
Patea River at boatramp, Patea	0	[100]	0	[100]
Waingongoro River at Eltham Camp	3	[77]	0	[100]
Waingongoro River at Ohawe Beach	1	[77]	2	[85]
Kaupokonui River at beach domain	4	[69]	0	[100]
Lake Opunake at boat ramp	5	[62]	0	[100]
Timaru Stream at Weld Road	4	[69]	0	[100]
Oakura River at SH45	1	[92]	0	[100]
Waitara River at town wharf, Waitara	3	[69]	1	[92]
Urenui River at estuary*	0	[100]	0	[100]
Manganui River at Everett Park	1	[85]	1	[92]
Lake Ratapiko at boat ramp ¹	0	[100]	0	[100]

[Notes: N = 13 samples; * = enterococci count; ¹ = 12 samples]

Three sites maintained counts below the 'Alert' mode at all times throughout the season (compared with four sites over the 2011-2012 season), while an additional seven other sites maintained counts below the 'Action' mode (Table 80) at all times. In terms of the overall monitoring season, twenty-eight 'Alert' levels (14% of counts) and twenty-nine 'Action' levels resulted over the period representing an overall 72% achievement of contact recreational guidelines (compared with 68%, 76%, and 78% achievement in the 2009-2010, 2010-2011, and 2011-2012 seasons respectively).

Overall, a wide range from poor to very good bacteriological water quality was measured at the sixteen sites. In terms of results to date, this represented some improvement despite a very wet spring-early summer which resulted in a more concentrated sampling effort in the latter half of the period. In terms of median *E. coli* counts, by far the best bacteriological quality was again found in the lower (estuarine) reach of the Patea River, at the most estuarine site (Urenui River) which was strongly influenced by seawater penetration during high tide conditions, and Lake Ratapiko where each site's median count was ≤ 10 *E.coli* per 100 mls. The programme focused on high tide periods due to its design and integration with the coastal bathing water quality monitoring programme. While future programmes' designs could give consideration to extending sampling to include low tide timing of sampling (at tidal sites), if this becomes necessary, it is essential that the high-tide format is retained for future trend monitoring purposes.

Based upon median *E. coli* bacterial numbers for the survey period, the following ranking of sites (in descending water quality) may be used to summarise results:

- 1 Patea River at boatramp, Patea
- 2 Urenui River at estuary
- 3 Lake Ratapiko
- 4 Waiwhakaiho River at Merrilands Domain
- 5 Lake Rotomanu
- 6 Waingongoro River at Ohawe Beach
- 7= Lake Opunake at boat ramp
- 7= Waitara River at town wharf, Waitara
- 9= Manganui River at Everett park (d/s of Kurapete Stream)
- 9= Kaupokonui River at beach domain
- 9= Oakura River d/s of SH 45 bridge
- 12 Waingongoro River at Eltham camp
- 13 Patea River at King Edward Park, Stratford
- 14 Timaru Stream at Weld Road (near mouth)
- 15 Waiwhakaiho River adjacent to Lake Rotomanu
- 16 Te Henui Stream at mouth, East End

The biggest improvement in ranking, in comparison with the 2011-2012 season, occurred at the Waitara River at the town wharf site while the two lowest rankings remained at the two sites introduced into the programme for the 2011-2012 season. Lake Opunake slipped furthest down in the rankings (where it was ranked seventh equal) in terms of seasonal median bacteriological water quality, and there was almost a 50% increase in the median *E.coli* count between consecutive seasons (an increase of 40 *E.coli*/100 mls). More sites' median counts increased (10 sites) than decreased reflecting some overall deterioration in bacteriological water quality across the region's sites in 2012–2013, and this also was reflected in part by a slightly lower proportion of samples (5%) meeting the national guidelines in the current season.

4.1 Comparison with sixteen previous summers' surveys

A statistical comparison of each summer's survey *E. coli* data is presented graphically in Appendix VI for all sites. Shorter data periods exist for the Patea River (at King Edward Park, Stratford) and Waingongoro River (at Eltham camp) which were added in 2001-2002, two lakes' sites (Lakes Ratapiko and Opunake) which were added in 2006-2007, the site in the lower reaches of the Patea River which was added in the 2007-2008 season, the site in the lower Waitara River which was added in the 2009-2010 season, and the sites in the lower reaches of the Waiwhakaiho River and Te Henui Stream which were added in the 2011-2012 season.

In general terms, *E. coli* bacteriological water quality was within ranges generally slightly narrower than those recorded over most previous summer bathing seasons due to an absence of very high counts in most cases. There was marked deterioration at two sites and improvement at one site in terms of median counts, in comparison with the previous summer's results. Variability in quality between bathing seasons at each site may be related to a variety of reasons including hydrological conditions, stock access, wildlife presence, and dairy farm wastes disposal practices in particular.

All seasons' results have been summarised in terms of comparisons with the single sample modes of the MfE, 2003 guidelines for each site over the period since the state of the environment monitoring programme commenced (over the 1996-1997 season). This summary is presented in Table 81.

Table 81

Seasonal summaries of single sample *E.coli* counts in 'Surveillance'/'Alert'/'Action' modes for the period 1996 to date (13 samples per season)

[Note:*not included in programme for that season]

Site	Season	1996-1997	1997-1998	1998-1999	1999-2000	2000-2001	2001-2002	2002-2003	2003-2004	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	Average per season																					
Lake Rotomanu at western beach		0	1	0	1	0	0	0	0	0	0	1	2	1	1	0	3	0	0	2	0	2	1	4	1	3	3	1	3	0	0	0	5	1	0	11	1	1		
Waiwhakaiho River at Merrilands Domain		0	1	0	1	1	0	0	0	1	0	2	0	0	0	1	0	1	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	1	12.5	<0.5	<0.5		
Waiwhakaiho River adjacent to L. Rotomanu		0	1	*		3	0	*		2	1	*		3	0	*		2	5	*		1	6	*		7	5	*		1	9	5	5	0	12	6	2.5	4.5		
Te Henui Stream at mouth, East End		*		*		*		*		*		*		7	5	7	4	1	10	1	11	2	10	2	10	1	12	2	11	1	11	4	9	1	12	<0.5	3	10		
Patea River at King Edward Park, Stratford		*		*		*		*		*		5	1	2	2	3	1	5	3	5	3	3	1	3	4	3	1	4	2	0	1	4	0	4	0	8	3.5	1.5		
Patea River at boatramp, Patea		*		*		*		*		*		*		*		*		*		*		*		0	0	0	0	0	0	0	0	0	0	0	0	13	0	0		
Waingongoro River at Eltham Camp		*		*		*		*		*		*		*		*		*		*		*		0	3	0	1	0	1	0	1	0	1	0	3	0	10.5	2	<0.5	
Waingongoro River at Ohawe Beach		2	0	2	2	1	0	0	0	0	2	0	1	1	2	1	0	2	2	1	0	2	0	0	3	1	1	0	1	0	0	0	1	1	2	11	1	1		
Kaupokonui River at beach domain		1	0	3	6	2	1	0	2	1	1	2	0	1	2	0	0	1	1	1	0	0	1	1	1	3	1	2	0	1	0	1	0	4	0	10.5	1.5	1		
Lake Opunake at boat ramp		*		*		*		*		*		*		*		*		*		*		*		1	3	2	1	2	2	5	0	0	3	0	2	5	0	9.5	2	1.5
Timaru Stream at Weld Road		*		7	0	1	1	2	2	3	0	2	1	4	2	4	0	3	3	4	0	2	0	2	3	4	0	6	1	4	0	3	0	4	0	8.5	3.5	1		
Waimoku Stream at Oakura Beach		2	9	2	11	3	10	8	3	5	5	3	9	1	12	1	12	2	11	0	13	2	11	0	13	0	13	0	13	*		*		0.5	2	10.5				
Oakura River at SH45		0	0	2	2	0	0	2	0	2	0	1	1	1	0	0	1	3	2	3	0	4	0	1	1	1	0	4	1	1	0	2	0	1	0	11	1.5	0.5		
Waitara River at town wharf, Waitara		*		*		*		*		*		*		*		*		*		*		*		*		*		2	3	1	1	2	0	3	1	10	2	1		
Urenui River at estuary		0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	0	0		
Manganui River at Everett Park		1	1	3	1	1	1	1	0	3	0	3	2	2	0	1	1	1	1	0	0	2	0	2	1	4	0	3	0	2	0	3	0	1	1	10.5	2	0.5		
Lake Ratapiko at boat ramp		*		*		*		*		*		*		*		*		*		*		*		0	0	0	0	0	0	0	0	0	0	0	0	0	13	0	0	
Average per site		0.7	1.4	2.1	2.7	1.2	1.3	1.4	0.9	1.7	0.9	2.1	1.6	2.2	2.0	1.6	1.8	2.0	3.1	1.5	2.3	1.5	2.2	1.3	2.5	1.9	2.4	1.9	2.3	0.7	2.2	1.6	1.4	1.8	1.8	-				
% overall non-exceedance of 2003 guidelines		82		63		80		82		80		71		67		74		61		71		71		70		67		68		77		78		72		72				

Allowing for some changes in the numbers of sites included in each season's programme, non-exceedance with the guidelines has occurred on 72% of sampling occasions over the combined seventeen seasons to date with the worst season (2004-2005) showing 61% compliance and best seasons (1996-1997 and 1999-2000), 82% with the guidelines. The two previous seasons had shown above historical average non-exceedance and the latest season was equivalent with the historical average.

A ranking of sites based upon the historical average guidelines for the period 1996 to date can be summarised as follows:

- 1= Urenui River at estuary
- 1= Patea River at boatramp, Patea
- 1= Lake Ratapiko
- 4 Waiwhakaiho River at Merrilands Domain
- 5 Oakura River at SH45
- 6= Waingongoro River at Ohawe Beach
- 6= Lake Rotomanu
- 8 Kaupokonui River at beach domain
- 9 Waingongoro River at Eltham Camp
- 10 Manganui River at Everett Park
- 11 Waitara River at town wharf, Waitara
- 12 Lake Opunake
- 13 Timaru Stream at Weld Road
- 14 Patea River at King Edward Park, Stratford
- 15 Waiwhakaiho River adjacent to Lake Rotomanu
- 16 Waimoku Stream at Oakura Beach
- 17 Te Henui Stream at mouth, East End

The two estuarine sites (in the Patea and Urenui Rivers) have never reached the 'Alert' *E.coli* level of the guidelines over the 17 seasons to date. All sites ranked above twelfth have not exceeded guidelines on an average of at least 75% of seasonal sampling occasions. The poorest bacteriological water quality (less than 5% of seasonal sampling occasions within guidelines) has been recorded at the Te Henui and Waimoku Streams' mouths where resident wildfowl population have been the principal contributors to elevated *E.coli* counts.

Temporal trending of season's median *E.coli* counts at each of the eleven sites with a minimum of ten years' data, was undertaken statistically for the period 1996 to 2013. Four sites showed statistically significant ($p < 0.05$ after FDR application) trends in median *E.coli* counts.

- Waiwhakaiho River opposite Lake Rotomanu had a very strong trend of increasing median *E.coli* numbers over the shorter, 10 year period to date which was significant at $p < 0.01$ after FDR application
- Te Henui Stream at the mouth had a strong trend of increasing median *E.coli* numbers over a 11 year period which however, was not significant at $p < 0.01$ after FDR application
- Oakura River below the SH45 bridge had a strong trend of increasing median *E.coli* numbers over the seventeen year period to date which however, was not significant at $p < 0.01$ after FDR application.

- Waingongoro River at Ohawe beach had a strong trend of decreasing median *E. coli* numbers over the seventeen year period to date which was significant at $p < 0.01$ but not after FDR application.

The Oakura River and Waingongoro River site's seasonal median *E. coli* counts did not approach contact recreational 'Alert' (or 'Action') guidelines. A ranking of the order of the significance of the temporal trends at those sites with a minimum of ten seasons' data (eleven sites) is provided in Table 82.

Table 82 Ranking of sites in terms of significant temporal trends in median *E. coli* counts over the period 1996 to 2013 [significant at $p < 0.05$ and $p < 0.01$]

Site location	Valid N	p-level	FDR-corrected p value	Trend
Waiwhakaiho River at Lake Rotomanu	10	0.0005	0.0063	↑↑↑
Oakura River d/s SH45 bridge	17	0.0036	0.0235	↑↑
Te Henui Stream mouth, East End	11	0.0124	0.0424	↑↑
Waingongoro River at Ohawe beach	17	0.0131	0.0424	↓↓
Lake Rotomanu western beach	17	0.0679	0.1764	↑
Patea River at King Edward Park	12	0.2652	0.4925	↓
Waingongoro River at Eltham camp	12	0.6232	0.9670	↓
Urenui River at estuary	17	0.6894	0.9670	↓
Kaupokonui River at Beach Domain	17	0.7689	0.9670	↓
Manganui River at Everett Park	17	0.8998	0.9670	↓
Timaru Stream at end of Weld Road	16	0.9627	0.9670	↓
Waiwhakaiho River at Merrilands Domain	17	0.9670	0.9670	↓

In summary, three sites have shown a significant increasing temporal trend and one site a significant decreasing temporal trend in seasonal median *E. coli* counts. The other less significant trends indicate gradual improvement (six sites) or deterioration (two sites) in seasonal median *E. coli* counts. With the exception of two seasonal median counts at the Timaru Stream site and one at the Kaupokonui River site (which all entered the 'Alert' mode), none of the other seasonal median counts at the sites with insignificant temporal trends have reached 'Alert' or 'Action' modes at any time.

4.2 General

The Taranaki Regional Council will continue to ensure that attention is given to the appropriate timing of dairy shed wastes disposal inspections and repeat inspections when necessary in specific catchments, to ensure that river and stream bacteriological water quality is not compromised by inappropriate wastes disposal practices. There is also a need to encourage farmers to refrain from allowing direct stock access to natural surface waters and/or fording stock through streams particularly under summer-autumn low flow conditions.

It is intended that the improved liaison initiated over the 2000-2001 season with territorial local authorities and the Health Protection Unit of Taranaki Healthcare, and maintained to date, will continue with particular regard to the frequency and immediacy of reporting bathing water quality and cyanobacteria results during the survey period and in particular by usage of the Regional Council's website. All sites' results were displayed on this website throughout the 2012-2013 survey period and

all instances of exceedance of standards were advised to the appropriate authorities. Very few follow-up investigations were necessary over the 2012-2013 season and there were no immediate issues with poor operation of dairy wastes disposal systems contributing to elevated counts in receiving waters. In most cases, mainly at lakes and in the lower reaches of two city streams, wildfowl contamination was responsible for elevation in counts, particularly where public feeding of birds occurred at recreational sites. Very few isolated instances were related to localised rainfall. On a very few occasions, particularly during lower flow periods, stock access problems and/or cumulative impacts of consented wastewater discharges may have contributed.

In particular sub-catchments, appropriate publicity and timing of the annual round of dairy inspections have assisted with mitigation of these effects. Regular reviews of the sites' grading system will be performed and maintenance of the programme of increased sampling frequency (20 samples per season) will continue at the two principal freshwater contact recreation usage sites. Cyanobacteria monitoring will also continue at designated sites (at a slightly lesser frequency to the bacteriological monitoring) and the recently instigated benthic cyanobacteria periphyton monitoring will continue at the river/stream sites.

Generally, cyanobacteria were not found at the five designated monitoring sites with the exception of Lake Rotokare where numbers were moderate in comparison with the previous five seasons, but exceeded public health warning levels for a period during the 2012-2013 season.

The Suitability for Recreation Grading (SFRG) referenced earlier in this report (Section 2.2) may now be re-assessed to include the 2012-2013 microbiological data enabling a comparison of the five year 2007-2012 period (Table 1) with the latest SFRG for the 2008-2013 period (presented in Table 83).

Table 83 Suitability for recreation grade for freshwater sites for the period November 2008 to March 2013

Site	Sanitary Inspection Category	Microbiological assessment <i>E.coli</i> (nos/100ml)			SFR Grade	% of all samples not exceeding 'Action' level (ie: ≤ 550 <i>E.coli</i>)
		95 %ile	Number of samples	Category		
L Rotomanu: western beach	High	2625	65	D	Very poor	83
Waiwhakaiho R: Merrilands domain	High	208	65	B	Poor	96
Waiwhakaiho R at L Rotomanu	High	3340	52	D	Very poor	40
Te Henui S: mouth	High	4720	66	D	Very poor	15
Patea R: King Edward Park	High	580	65	D	Very poor	93
Patea R. boatramp, Patea	High	83	65	A	Poor	100
Waingongoro R: Eltham camp	High	355	65	C	Poor	100
Waingongoro R: Ohawe beach	High	903	65	D	Very poor	92
Kaupokonui R: Beach domain	High	480	65	C	Poor	98
L Opunake: adjacent boatramp	High	1625	65	D	Very poor	89
Timaru S: Lower Weld Road	High	470	65	C	Poor	98
Oakura R: d/s SH45	High	443	65	C	Poor	98
Waitara R: Town wharf	High	1239	52	D	Very poor	90
Urenui R: estuary	High	55	65	A	Poor	100
Manganui R: Everett Park	High	378	65	C	Poor	98
L Ratapiko: boatramp	High	164	61	B	Poor	100
L Rotokare: adjacent boatramp	Low	84	46	A	Very good	100

Very few differences between the two five-year periods were apparent when comparing Tables 1 and 83. These related to the improvement in gradings at the Timaru Stream site where the 95 percentile *E.coli* number had decreased more recently by 95 per 100 mls improving the MAC from D to C and resulting in a SFR grading improvement from 'Very poor' to 'Poor'. There were fewer samples in excess of the 'Action' level over the most recent five year period at eight of the monitored sites while two sites (Te Henui Stream and Waiwhakaiho River at Lake Rotomanu) had 3% to 11% more samples in the 'Action' mode. Otherwise there were no changes in MAC or SFR grades.

5. Recommendations

As a result of the 2012-2013 summer freshwater contact recreation bacteriological survey it is recommended:

1. THAT the 2013-2014 survey be performed at sixteen regular sites and also at the Waimoku site (every third year) continuing with the existing sampling protocols during the season extending from 1 November to 31 March (and into April, if necessary).
2. THAT the 2013-2014 survey includes an additional seven samples collected at the two principal usage sites (Lake Rotomanu and Waiwhakaiho River at the Merrilands Domain) in accordance with MfE, 2003 guidelines.
3. THAT the 2013-2014 summer survey includes cyanobacteria monitoring at the three lake sites and an additional lake (Rotokare) site.
4. THAT follow-up sampling (after guideline exceedances) be performed when deemed necessary by TRC staff.
5. THAT appropriate timing of the annual dairy farms inspection round be incorporated into the programme for catchments where issues relating to exceedances of contact recreational standards have been identified and advice and publicity be provided in relation to the prevention of stock access to natural water.
6. THAT reporting of results be performed as appropriate during the season, and in an Annual Report upon completion of the season's programme.
7. THAT the appropriate statistical trend detection procedures be applied to the data and reported in the Annual Report.
8. THAT appropriately worded generic signage be displayed on a permanent basis at sites in the lower reaches of the Waiwhakaiho River, Te Henui Stream, Waitara River, and Waimoku Stream warning of frequent exceedances of the recreational guidelines for reasons appropriate to individual sites.

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Appendix I

MAC assessments for all sites

(for the 2007-2012 period)

Lake Rotomanu

Freshwater MAC Assessment

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

Import data

Site Name
Name of site from the MAC file: LRM000002

MAC Data Summary

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedances (E. coli / 100 mL)		Days in Compliance (%days < 550/ year)
			260 to 550	>550	
2011	13	120.1	1	5	61 %
2010	13	34.0	0	0	100 %
2009	13	100.1	1	3	76 %
2008	13	220.1	3	3	76 %
2007	13	180.1	4	1	92 %
Total	65	140.1	9	12	81 %

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

Calculate MAC

MAC Results
MAC category: D 95%ile (/100 mL): 2625.0
Interim Result?: Interim Data Set (< 5 years, or < 100 samples used)

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

Save MAC Report

OK

Freshwater Suitability for Recreational Grade

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

SIC Assessment Results
SIC Assessment: High
Primary SIC Impact: 10: The incidence and density of birdlife

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment

Calculate SFRG

Reassessment of the MAC and / or SIC is required or press "Irreconcilable Followup" to assign a conservative grade

Irreconcilable Followup

SFRG Assessment Results
Site name: LRM000002
SFRG Assessment: Very Poor

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

Save as a Single Entry File

Save SFRG Assessment to a Multiple Summary File
Press "Save to database format file" to save summary data as one row in a comma-delimited file.

Save to Database format File

☐ Print the column labels to the file "ColumnLabelsFresh.txt".

OK

Waiwhakaiho River at Merrilands Domain

Freshwater MAC Assessment

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

Import data

Site Name
Name of site from the MAC file: Waiwhakaiho Merrilands

MAC Data Summary

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedances (E. coli / 100 mL)		Days in Compliance (%days < 550/ year)
			260 to 550	>550	
2011	13	40.0	0	0	100 %
2010	13	54.0	0	0	100 %
2009	13	110.1	0	1	92 %
2008	13	46.0	0	0	100 %
2007	13	48.0	0	0	100 %
Total	65	60.0	0	1	98 %

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

Calculate MAC

MAC Results
MAC category: B 95%ile (/100 mL): 170.0
Interim Result?: Interim Data Set (< 5 years, or < 100 samples used)

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

Save MAC Report

OK

Freshwater Suitability for Recreational Grade

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

SIC Assessment Results
SIC Assessment: High
Primary SIC Impact: 7: Intensive agricultural use

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment

Calculate SFRG

Reassessment of the MAC and / or SIC is required or press "Irreconcilable Followup" to assign a conservative grade

Irreconcilable Followup

SFRG Assessment Results
Site name: Waiwhakaiho Merrilands
SFRG Assessment: Poor

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

Save as a Single Entry File

Save SFRG Assessment to a Multiple Summary File
Press "Save to database format file" to save summary data as one row in a comma-delimited file.

Save to Database format File

☐ Print the column labels to the file "ColumnLabelsFresh.txt".

OK

Patea River at Stratford

Freshwater MAC Assessment

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

Site Name
Name of site from the MAC file: Patea at Stratford

MAC Data Summary

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedances (E. coli / 100 mL)		Days in Compliance (%days < 550/ year)
			260 to 550	>550	
2011	13	150.1	4	0	100 %
2010	13	160.1	0	1	92 %
2009	13	250.1	4	2	84 %
2008	13	200.1	2	1	92 %
2007	13	290.1	3	4	69 %
Total	65	190.1	13	8	87 %

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

MAC Results
MAC category: D 95%ile (/100 mL): 667.5
Interim Result?: Interim Data Set (< 5 years, or < 100 samples used)

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

OK

Freshwater Suitability for Recreational Grade

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

SIC Assessment Results
SIC Assessment: High
Primary SIC Impact: 7: Intensive agricultural use

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment

Reassessment of the MAC and / or SIC is required or press "Irreconcilable Followup" to assign a conservative grade

SFRG Assessment Results
Site name: Patea at Stratford
SFRG Assessment: Very Poor

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

Save SFRG Assessment to a Multiple Summary File
Press "Save to database format file" to save summary data as one row in a comma-delimited file.

☐ Print the column labels to the file "ColumnLabelsFresh.txt".

OK

Patea River at boat ramp, Patea

Freshwater MAC Assessment

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

Site Name
Name of site from the MAC file: PAT00095

MAC Data Summary

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedances (E. coli / 100 mL)		Days in Compliance (%days < 550/ year)
			260 to 550	>550	
2011	13	16.0	0	0	100 %
2010	13	4.0	0	0	100 %
2009	13	11.0	0	0	100 %
2008	13	9.0	0	0	100 %
2007	13	5.0	0	0	100 %
Total	65	7.0	0	0	100 %

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

MAC Results
MAC category: A 95%ile (/100 mL): 83.3
Interim Result?: Interim Data Set (< 5 years, or < 100 samples used)

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

OK

Freshwater Suitability for Recreational Grade

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

SIC Assessment Results
SIC Assessment: High
Primary SIC Impact: 7: Intensive agricultural use

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment

Reassessment of the MAC and / or SIC is required or press "Irreconcilable Followup" to assign a conservative grade

SFRG Assessment Results
Site name: PAT00095
SFRG Assessment: Poor

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

Save SFRG Assessment to a Multiple Summary File
Press "Save to database format file" to save summary data as one row in a comma-delimited file.

☐ Print the column labels to the file "ColumnLabelsFresh.txt".

OK

Waingongoro River at Eltham camp

Freshwater MAC Assessment

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

Site Name
Name of site from the MAC file: WGG000492

MAC Data Summary

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedances (E. coli / 100 mL)		Days in Compliance (%days < 550/ year)
			260 to 550	>550	
2011	13	150.1	1	0	100 %
2010	13	140.1	1	0	100 %
2009	13	160.1	1	0	100 %
2008	13	130.1	1	0	100 %
2007	13	160.1	3	0	100 %
Total	65	150.1	7	0	100 %

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

MAC Results
MAC category: C 95%ile (/100 mL): 360.0
Interim Result?: Interim Data Set (< 5 years, or < 100 samples used)

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

OK

Freshwater Suitability for Recreational Grade

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

SIC Assessment Results
SIC Assessment: High
Primary SIC Impact: 7: Intensive agricultural use

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment

Reassessment of the MAC and / or SIC is required or press "Irreconcilable Followup" to assign a conservative grade

SFRG Assessment Results
Site name: WGG000492
SFRG Assessment: Poor

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

Save SFRG Assessment to a Multiple Summary File
Press "Save to database format file" to save summary data as one row in a comma-delimited file.

☐ Print the column labels to the file "ColumnLabelsFresh.txt".

OK

Waingongoro River at Ohawe beach

Freshwater MAC Assessment

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

Site Name
Name of site from the MAC file: WGG000995

MAC Data Summary

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedances (E. coli / 100 mL)		Days in Compliance (%days < 550/ year)
			260 to 550	>550	
2011	13	96.0	0	1	92 %
2010	13	100.1	0	0	100 %
2009	13	96.0	0	1	92 %
2008	13	120.1	1	1	92 %
2007	13	100.1	0	3	76 %
Total	65	100.1	1	6	90 %

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

MAC Results
MAC category: D 95%ile (/100 mL): 1200.0
Interim Result?: Interim Data Set (< 5 years, or < 100 samples used)

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

OK

Freshwater Suitability for Recreational Grade

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

SIC Assessment Results
SIC Assessment: High
Primary SIC Impact: 7: Intensive agricultural use

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment

Reassessment of the MAC and / or SIC is required or press "Irreconcilable Followup" to assign a conservative grade

SFRG Assessment Results
Site name: WGG000995
SFRG Assessment: Very Poor

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

Save SFRG Assessment to a Multiple Summary File
Press "Save to database format file" to save summary data as one row in a comma-delimited file.

☐ Print the column labels to the file "ColumnLabelsFresh.txt".

OK

Kaupokonui River at beach domain

Freshwater MAC Assessment

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

Import data

Site Name
Name of site from the MAC file: Kaupokonui at Beach

MAC Data Summary

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedances (E. coli / 100 mL)		Days in Compliance (%days < 550/ year)
			260 to 550	>550	
2011	13	120.1	1	0	100 %
2010	13	76.0	1	0	100 %
2009	13	100.1	2	0	100 %
2008	13	210.1	3	1	92 %
2007	13	77.0	1	1	92 %
Total	65	100.1	8	2	96 %

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

Calculate MAC

MAC Results
MAC category: C 95%ile (/100 mL) 465.0
Interim Result? Interim Data Set (< 5 years, or < 100 samples used)

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

Save MAC Report

OK

Freshwater Suitability for Recreational Grade

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

SIC Assessment Results
SIC Assessment: High
Primary SIC Impact: 7. Intensive agricultural use

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment

Calculate SFRG

Reassessment of the MAC and / or SIC is required or press "Irreconcilable Followup" to assign a conservative grade

Irreconcilable Followup

SFRG Assessment Results
Site name: Kaupokonui at Beach
SFRG Assessment: Poor

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

Save as a Single Entry File

Save SFRG Assessment to a Multiple Summary File
Press "Save to database format file" to save summary data as one row in a comma-delimited file.

Save to Database format File

☐ Print the column labels to the file "ColumnLabelsFresh.txt".

OK

Lake Opunake

Freshwater MAC Assessment

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

Import data

Site Name
Name of site from the MAC file: LOP000001

MAC Data Summary

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedances (E. coli / 100 mL)		Days in Compliance (%days < 550/ year)
			260 to 550	>550	
2011	13	80.0	0	2	84 %
2010	13	80.0	0	3	76 %
2009	13	220.1	5	0	100 %
2008	13	210.1	2	2	84 %
2007	13	130.1	2	1	92 %
Total	65	140.1	9	8	87 %

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

Calculate MAC

MAC Results
MAC category: D 95%ile (/100 mL) 1625.0
Interim Result? Interim Data Set (< 5 years, or < 100 samples used)

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

Save MAC Report

OK

Freshwater Suitability for Recreational Grade

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

SIC Assessment Results
SIC Assessment: High
Primary SIC Impact: 10. The incidence and density of birdlife

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment

Calculate SFRG

Reassessment of the MAC and / or SIC is required or press "Irreconcilable Followup" to assign a conservative grade

Irreconcilable Followup

SFRG Assessment Results
Site name: LOP000001
SFRG Assessment: Very Poor

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

Save as a Single Entry File

Save SFRG Assessment to a Multiple Summary File
Press "Save to database format file" to save summary data as one row in a comma-delimited file.

Save to Database format File

☐ Print the column labels to the file "ColumnLabelsFresh.txt".

OK

Timaru Stream at Weld Road

Freshwater MAC Assessment

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

Site Name
Name of site from the MAC file: TMR000497

MAC Data Summary

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedances (E. coli / 100 mL)		Days in Compliance (%days < 550/ year)
			260 to 550	>550	
2011	13	160.1	3	0	100 %
2010	13	180.1	4	0	100 %
2009	13	230.1	6	1	92 %
2008	13	230.1	4	0	100 %
2007	13	180.1	2	3	76 %
Total	65	210.1	19	4	93 %

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

MAC Results
MAC category: D 95%ile (/100 mL): 565.0
Interim Result? Interim Data Set (< 5 years, or < 100 samples used)

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

OK

Freshwater Suitability for Recreational Grade

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

SIC Assessment Results
SIC Assessment: High
Primary SIC Impact: 7: Intensive agricultural use

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment

Reassessment of the MAC and / or SIC is required or press "Irreconcilable Followup" to assign a conservative grade

SFRG Assessment Results
Site name: TMR000497
SFRG Assessment: Very Poor

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

Save SFRG Assessment to a Multiple Summary File
Press "Save to database format file" to save summary data as one row in a comma-delimited file.

☐ Print the column labels to the file "ColumnLabelsFresh.txt".

OK

Oakura River d/s SH45

Freshwater MAC Assessment

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

Site Name
Name of site from the MAC file: OKR000497

MAC Data Summary

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedances (E. coli / 100 mL)		Days in Compliance (%days < 550/ year)
			260 to 550	>550	
2011	13	140.1	2	0	100 %
2010	13	100.1	1	0	100 %
2009	13	150.1	4	1	92 %
2008	13	180.1	1	0	100 %
2007	13	140.1	1	1	92 %
Total	65	140.1	9	2	96 %

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

MAC Results
MAC category: C 95%ile (/100 mL): 442.5
Interim Result? Interim Data Set (< 5 years, or < 100 samples used)

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

OK

Freshwater Suitability for Recreational Grade

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

SIC Assessment Results
SIC Assessment: High
Primary SIC Impact: 7: Intensive agricultural use

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment

Reassessment of the MAC and / or SIC is required or press "Irreconcilable Followup" to assign a conservative grade

SFRG Assessment Results
Site name: OKR000497
SFRG Assessment: Poor

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

Save SFRG Assessment to a Multiple Summary File
Press "Save to database format file" to save summary data as one row in a comma-delimited file.

☐ Print the column labels to the file "ColumnLabelsFresh.txt".

OK

Waitara

Freshwater MAC Assessment

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

Import data

Site Name
Name of site from the MAC file: WTR000922

MAC Data Summary

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedances (E. coli / 100 mL)		Days in Compliance (%days < 550/ year)
			260 to 550	>550	
2011	13	150.1	2	0	100 %
2010	13	76.0	1	1	92 %
2009	13	230.1	2	3	76 %
2008	0	0.0	0	0	0 %
2007	0	0.0	0	0	0 %
Total	39	160.1	5	4	89 %

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

Calculate MAC

MAC Results
MAC category D 95%ile (/100 mL) 1080.5
Interim Result? Interim Data Set (< 5 years, or < 100 samples used)

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

Save MAC Report

OK

Urenui River at estuary

Freshwater MAC Assessment

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

Import data

Site Name
Name of site from the MAC file: URN000480

MAC Data Summary

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedances (E. coli / 100 mL)		Days in Compliance (%days < 550/ year)
			260 to 550	>550	
2011	13	9.0	0	0	100 %
2010	13	4.0	0	0	100 %
2009	13	4.0	0	0	100 %
2008	13	7.0	0	0	100 %
2007	13	3.0	0	0	100 %
Total	65	4.0	0	0	100 %

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

Calculate MAC

MAC Results
MAC category A 95%ile (/100 mL) 50.8
Interim Result? Interim Data Set (< 5 years, or < 100 samples used)

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

Save MAC Report

OK

Freshwater Suitability for Recreational Grade

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

SIC Assessment Results
SIC Assessment High
Primary SIC Impact 7: Intensive agricultural use

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment

Calculate SFRG

Reassessment of the MAC and / or SIC is required or press "Inconceivable Followup" to assign a conservative grade

Inconceivable Followup

SFRG Assessment Results
Site name URN000480
SFRG Assessment Poor

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

Save as a Single Entry File

Save SFRG Assessment to a Multiple Summary File
Press "Save to database format file" to save summary data as one row in a comma-delimited file.

Save to Database format File

☐ Print the column labels to the file "ColumnLabelsFresh.txt".

OK

Manganui River at Everett Park

Freshwater MAC Assessment

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

Import data

Site Name
Name of site from the MAC file: MGN000435

MAC Data Summary

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedances (E. coli / 100 mL)		Days in Compliance (%days < 550/ year)
			260 to 550	>550	
2011	13	120.1	3	0	100 %
2010	13	170.1	2	0	100 %
2009	13	200.1	3	0	100 %
2008	13	170.1	4	0	100 %
2007	13	160.1	2	1	92 %
Total	65	160.1	14	1	98 %

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

Calculate MAC

MAC Results
MAC category: C 95%ile (/100 mL) 412.5
Interim Result?: Interim Data Set (< 5 years, or < 100 samples used)

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

Save MAC Report

OK

Freshwater Suitability for Recreational Grade

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

SIC Assessment Results
SIC Assessment: High
Primary SIC Impact: 7: Intensive agricultural use

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment

Calculate SFRG

Reassessment of the MAC and / or SIC is required or press "Irreconcilable Followup" to assign a conservative grade

Irreconcilable Followup

SFRG Assessment Results
Site name: MGN000435
SFRG Assessment: Poor

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

Save as a Single Entry File

Save SFRG Assessment to a Multiple Summary File
Press "Save to database format file" to save summary data as one row in a comma-delimited file.

Save to Database format File

☐ Print the column labels to the file "ColumnLabelsFresh.txt".

OK

Lake Ratapiko

Freshwater MAC Assessment

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

Import data

Site Name
Name of site from the MAC file: LRP000050

MAC Data Summary

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedances (E. coli / 100 mL)		Days in Compliance (%days < 550/ year)
			260 to 550	>550	
2011	12	34.5	0	0	100 %
2010	12	25.0	0	0	100 %
2009	13	16.0	0	0	100 %
2008	12	34.5	0	0	100 %
2007	13	16.0	0	0	100 %
Total	62	23.0	0	0	100 %

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

Calculate MAC

MAC Results
MAC category: B 95%ile (/100 mL) 140.0
Interim Result?: Interim Data Set (< 5 years, or < 100 samples used)

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

Save MAC Report

OK

Freshwater Suitability for Recreational Grade

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

SIC Assessment Results
SIC Assessment: High
Primary SIC Impact: 7: Intensive agricultural use

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment

Calculate SFRG

Reassessment of the MAC and / or SIC is required or press "Irreconcilable Followup" to assign a conservative grade

Irreconcilable Followup

SFRG Assessment Results
Site name: LRP000050
SFRG Assessment: Poor

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

Save as a Single Entry File

Save SFRG Assessment to a Multiple Summary File
Press "Save to database format file" to save summary data as one row in a comma-delimited file.

Save to Database format File

☐ Print the column labels to the file "ColumnLabelsFresh.txt".

OK

Lake Rotokare

Freshwater MAC Assessment

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

Import data

Site Name
Name of site from the MAC file: LRK000003

MAC Data Summary

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedances (E. coli / 100 mL)		Days in Compliance (%days < 550/ year)
			260 to 550	>550	
2011	9	7.0	0	0	100 %
2010	9	5.0	0	0	100 %
2009	9	3.0	0	0	100 %
2008	9	15.0	0	0	100 %
2007	10	28.5	0	0	100 %
Total	46	8.5	0	0	100 %

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

Calculate MAC

MAC Results
MAC category: A 95%ile (/100 mL): 102.8
Interim Result?: Interim Data Set (< 5 years, or < 100 samples used)

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

Save MAC Report

OK

Waiwhakaiho at Lake Rotomanu

Freshwater MAC Assessment

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

Import data

Site Name
Name of site from the MAC file: WKH000950

MAC Data Summary

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedances (E. coli / 100 mL)		Days in Compliance (%days < 550/ year)
			260 to 550	>550	
2011	13	460.1	5	5	61 %
2010	13	800.1	1	9	30 %
2009	0	0.0	0	0	0 %
2008	13	490.1	7	5	61 %
2007	0	0.0	0	0	0 %
Total	39	550.1	13	19	51 %

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

Calculate MAC

MAC Results
MAC category: D 95%ile (/100 mL): 2710.0
Interim Result?: Interim Data Set (< 5 years, or < 100 samples used)

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

Save MAC Report

OK

Freshwater Suitability for Recreational Grade

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

SIC Assessment Results
SIC Assessment: High
Primary SIC Impact: 7: Intensive agricultural use

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment

Calculate SFRG

Reassessment of the MAC and / or SIC is required or press "Irreconcilable Followup" to assign a conservative grade

Irreconcilable Followup

SFRG Assessment Results
Site name: WKH000950
SFRG Assessment: Very Poor

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

Save as a Single Entry File

Save SFRG Assessment to a Multiple Summary File
Press "Save to database format file" to save summary data as one row in a comma-delimited file.

Save to Database format File

☐ Print the column labels to the file "ColumnLabelsFresh.txt".

OK

Te Henui Stream: mouth

Freshwater MAC Assessment

Import MAC Data

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

Import data

Site Name

Name of site from the MAC file: THN000499

MAC Data Summary

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedances (E. coli / 100 mL)		Days in Compliance (%days < 550/ year)
			260 to 550	>550	
2011	13	110C	4	9	30 %
2010	14	985I	1	12	14 %
2009	13	930I	2	11	15 %
2008	13	110C	1	12	7 %
2007	13	110C	2	10	23 %
Total	66	105C	10	54	18 %

Calculate MAC

Press "Calculate MAC" to determine a MAC assessment

Calculate MAC

MAC Results

MAC category	D	95%ile (/100 mL)	4640.0
Interim Result?	Interim Data Set (< 5 years, or < 100 samples used)		

Save MAC Assessment

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

Save MAC Report

OK

Freshwater Suitability for Recreational Grade

MAC Assessment Results

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

SIC Assessment Results

SIC Assessment	High
Primary SIC Impact	7: Intensive agricultural use

Calculate Marine SFRG

Press "Calculate SFRG" to determine a SFRG assessment

Calculate SFRG

Reassessment of the MAC and / or SIC is required or press "Irreconcilable Followup" to assign a conservative grade

Irreconcilable Followup

SFRG Assessment Results

Site name	THN000499
SFRG Assessment	Very Poor

Save this SFRG Assessment to a Single Summary File

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

Save as a Single Entry File

Save SFRG Assessment to a Multiple Summary File

Press "Save to database format file" to save summary data as one row in a comma-delimited file.

Save to Database format File

☐ Print the column labels to the file "ColumnLabelsFresh.txt".

OK

Appendix II

High tide times

High tide times (NZST) at New Plymouth for 2012-2013 sampling dates

Date		Time of HT
Thursday	1 November 2012	1055
Wednesday	28 November 2012	0928
Thursday	13 December 2012	0916
Monday	28 January 2013	1032
Thursday	31 January 2013	1217
Monday	11 February 2013	1025
Thursday	14 February 2013	1225
Monday	18 February 2013	1525
Monday	25 February 2013	0931
Thursday	28 February 2013	1116
Monday	4 March 2013	1422
Tuesday	12 March 2013	1003
Wednesday	27 March 2013	0934

Appendix III

**Sampling conditions and public usage
recorded at each site by the SEM programme**

Site Lake Rotomanu (Site Code: LRM000002)

Sampling Date	Weather		Conditions			Site usage		Rainfall (mm)	
	General	Cloud Cover	Algae	Appearance	Surface	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
1 November 2012	Fine, overcast	8/8	None	Turbid, brown	N/R	0/4 (boating/banks)	Ducks and seagulls common	0	0
28 November 2012	Fine	1/8	None	Slightly turbid, brown	Ripple	0/19 (kayaking, banks)	Few ducks	0.5	3
13 December 2012	Fine	2/8	N/R	Turbid, brown	Flat	0/0	Ducks common; few gulls	0	0
28 January 2013	Fine	0/8	None	Turbid, brown	Ripple	1/2 (banks/boating)	Few ducks	0	0
31 January 2013	Fine	3/8	None	Turbid, brown	Ripple	0/1 (banks)	Ducks and gulls common; 2 dogs	0	0
11 February 2013	Fine	0/8	None	Slightly turbid, brown	Flat	0/0	Few ducks; lake low	0	0
14 February 2013	Fine	2/8	N/R	Slightly turbid, brown	Ripple	0/2 (kayaking)	Few ducks and gulls	0	0
18 February 2013	Fine	0/8	N/R	Slightly turbid, pale brown	Flat	0/0	Few ducks	0	0
25 February 2013	Fine	0/8	None	Turbid, brown	Ripple	0/1 (bank)	Few ducks and gulls	0	0
28 February 2013	Fine	6/8	None	Turbid, brown	Small ripples	0/0	None	0	0
4 March 2013	Fine, overcast	8/8	None	Slightly turbid, brown	Small ripples	0/0	One duck	0	8.5
12 March 2013	Fine	0/8	None	Slightly turbid, brown	Small ripples	0/0	Few ducks	0	0
27 March 2013	Fine	0/8	N/R	Slightly turbid, brown	Ripple	0/8 (boating, banks)	Gulls very common	0	0

Site Waiwhakaiho River at Merrilands (Site Code: WKH000800)

Sampling Date	Weather		Conditions			Site usage		Rainfall (mm)	
	General	Cloud Cover	Algal cover	Appearance	Direction of Flow	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
15 November 2012	Fine, overcast	7/8	None	Clear, brown-green	D/S	0/0		0	0
28 November 2012	Fine	0/8	None	Slightly turbid, brown-green	D/S	0/0	Some foam	0.5	3.0
18 December 2012	Fine	0/8	None	Slightly turbid green-brown	D/S	0/0	Few birds; some foam	0	0
28 January 2013	Fine	1/8	Thin mats	Clear, brown-green	D/S	4/9 (banks)	Gull; some foam	0	0
31 January 2013	Fine	4/8	Thin mats, widespread	Clear, colourless	D/S	0/1 (bank)	Few gulls; some foam; one dog	0	0
11 February 2013	Fine	0/8	None	Clear, colourless	D/S	0/0	Some foam	0	0
14 February 2013	Fine	4/8	Thin mats	Clear, pale brown	D/S	0/0		0	0
18 February 2013	Fine	1/8	Patchy, mats	Clear, pale green	D/S	0/2 (banks)	Few gulls	0	0
25 February 2013	Fine	0/8	70%	Clear, colourless	D/S	0/0		0	0
23 February 2013	Fine	0/8	80% mats and filamentous	Clear, brown	D/S	0/2 (banks)	Two dogs in river	0	0
4 March 2013	Fine, overcast	8/8	80% mats	Clear, brown-green	D/S	0/1 (bank)	One dog in river	0	8.5
12 March 2013	Fine	0/8	30%	Clear, brown	D/S	0/0	None	0	0
27 March 2013	Fine	0/8	50%	Clear, colourless	D/S	0/0	None	0	0

Site Waiwhakaiho River adjacent to Lake Rotomanu (Site Code: WKH000950)

Sampling Date	Weather		Conditions			Site usage		Rainfall (mm)	
	General	Cloud Cover	Algal cover	Appearance	Direction of Flow	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
12 November 2012	Fine, overcast	8/8	None	Clear, brown-green	D/S	0/2 (whitebaiting)		0	0
28 November 2012	Fine	0/8	10% filaments	Clear, brown	D/S	0/1 (whitebaiting)	Few seagulls; ducks	0.5	3
13 December 2012	Fine	0/8	None	Clear, colourless	D/S	0/0	Few birds	0	0
28 January 2013	Fine	1/8	10% mats	Clear, brown	D/S (v. slow)	0/0		0	0
31 January 2013	Fine	1/8	60% mats	Clear, colourless	D/S	0/0	Gulls extremely common	0	0
11 February 2013	Fine	0/8	Thin mats	Clear, colourless	D/S	0/0	Few ducks; gulls very common u/s	0	0
14 February 2013	Fine	2/8	Widespread mats	Clear, colourless	D/S	0/0	Gulls common u/s	0	0
18 February 2013	Fine	0/8	Mats	Sl. turbid, pale brown	D/S	0/0	Ducks common; gulls extremely common	0	0
25 February 2013	Fine	0/8	100%	Clear, colourless	D/S	0/0	Gulls common u/s	0	0
28 February 2013	Fine	6/8	100%	Clear, green-brown	D/S	0/0	Gulls extremely abundant u/s	0	0
4 March 2013	Fine, overcast	8/8	90% mats	Slightly turbid, brown	D/S	0/0	Gulls extremely abundant	0	8.5
12 March 2013	Fine	0/8	10% mats	Sl. turbid, brown-green	D/S	0/0	Gulls extremely abundant	0	0
27 March 2013	Fine	0/8	75%	Clear, colourless	D/S	0/0	Gulls extremely abundant u/s	0	0

Site Te Henui Stream at mouth, East End (Site Code: THN000499)

Sampling Date	Weather		Conditions			Site usage		Rainfall (mm)	
	General	Cloud Cover	Algal cover	Appearance	Direction of Flow	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
11 November 2012	Fine, overcast	8/8	100% mats	Clear, green-brown	D/S	0/4 (whitebaiting)	Ducks common, few gulls, one dog	0	0
28 November 2012	Fine	2/8	100% mats	Clear, brown-green	D/S (slow)	0/0	Ducks common	0.5	3
13 December 2012	Fine, overcast	7/8	100% mats	Turbid, green	D/S (slow)	0/6 (banks)	Ducks very common	0	0
28 January 2013	Fine	0/8	100% thin mats	Sl. turbid, green-blue	U/S (slow)	0	Ducks and gulls common	0	0
31 January 2013	Fine	0/8	100% mats	Sl. turbid, brown-green	U/S (slow)	0/12 (banks)	Ducks common (being fed), one seagull	0	0
11 February 2013	Fine	4/8	100% mats	Slightly turbid, green	D/S	0/15 (banks)	Ducks very common, few gulls, one goose	0	0
14 February 2013	Fine	4/8	N/R	Turbid, green	D/S (slow)	0/40 (banks)	Ducks very common, few gulls	0	0
18 February 2013	Fine	1/8	Thin mats	Slightly turbid, green	D/S	0/4 (banks)	Ducks and gulls common	0	0
25 February 2013	Fine	0/8	100%	Slightly turbid, green	U/S (slow)	0/10 (banks)	Ducks very common; few gulls	0	0
28 February 2013	Fine	6/8	N/R	Sl. turbid, blue-green	U/S (surging)	0/3 (banks)	Ducks very common; few gulls	0	0
4 March 2013	Fine	2/8	N/R	Turbid, green	D/S (slow)	0/0	Ducks common	0	8.5
12 March 2013	Fine	0/8	N/R	Sl. turbid, green-blue	U/S (surging)	0/0	Ducks very common; few gulls	0	0
27 March 2013	Fine	0/8	N/R	Turbid, green	D/S (slow)	0/10 (banks)	Ducks very common	0	0

Site Patea River, King Edward Park and Stratford (Site Code: PAT000297)

Sampling Date	Weather		Conditions			Site usage		Rainfall (mm)	
	General	Cloud Cover	Algal cover	Appearance	Direction of Flow	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
1 November 2012	Fine	3/8	Thin patchy mats	Slightly turbid, green	D/S	0/0		0	0
28 November 2012	Fine	0/8	Widespread	Sl. turbid, brown-green	D/S	0/1 (boating)		0	0
13 December 2012	Fine	2/8	Widespread thin mats	Sl. turbid, green-blue	D/S	0/2 (banks)		0	0.5
28 January 2013	Fine	0/8	Thin, widespread	Slightly turbid, green	D/S	6/20 (fishing)		0	0
31 January 2013	Fine	3/8	Thin, widespread	Slightly turbid, green	D/S	0/0	Few ducks	0	0
11 February 2013	Fine	2/8	20%	Sl. turbid, uncoloured	D/S	0/1 (fishing)	Few ducks	0	0
14 February 2013	Fine	0/8	Thin, widespread	Slightly turbid, green	D/S	0		0	0
18 February 2013	Fine	2/8	50%	Clear, uncoloured	D/S	0/2 (banks)	None	0	0
25 February 2013	Fine	0/8	Widespread mats	Slightly turbid, green	D/S	0/1 (bank)	One dog	0	0
28 February 2013	Fine	0/8	25%	Clear, uncoloured	D/S	0/0	None	0	0
4 March 2013	Fine	4/8	Widespread	Slightly turbid, green	D/S	0/0	One duck	0	0
12 March 2013	Fine	0/8	Patchy	Slightly turbid, green	D/S	0/0		0	0
27 March 2013	Fine	0/8	Widespread	Clear, uncoloured	D/S	0/0	None	0	0

Site Patea River, boatramp, Patea (Site Code: PAT000995)

Sampling Date	Weather		Conditions			Site usage		Rainfall (mm)	
	General	Cloud Cover	Algal cover	Appearance	Direction of Flow	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
1 November 2012	Fine	2/8	N/A	Slightly turbid, green	U/S (surging)	0/0		0	0
28 November 2012	Fine	4/8	N/A	Slightly turbid, green	D/S (slow & surging)	0/0		0	0
13 December 2012	Fine	0/8	N/A	Slightly turbid, green	D/S (slow & surging)	0/1 (boating)		0	0
28 January 2013	Fine	0/8	N/A	Clear, green	U/S (slow)	0/0	Many boat trailers in park	0	0
31 January 2013	Fine	0/8	N/A	Slightly turbid, green	D/S (slow)	0/6 (boating)		0	0
11 February 2013	Fine	6/8	N/A	Turbid, green	U/S (slow)	0/0		0	0
14 February 2013	Fine	0/8	N/A	Slightly turbid, green	U/S (surging)	0/0		0	0
18 February 2013	Fine	0/8	N/A	Slightly turbid, green	U/S (slow)	2/2 (fishing)	Dog	0	0
25 February 2013	Fine	0/8	N/A	Slightly turbid, green	U/S	0/0		0	0
28 February 2013	Fine	0/8	N/A	Sl. turbid, pale green	U/S	0/2 (banks)	One dog	0	0
4 March 2013	Fine, overcast	7/8	N/A	Slightly turbid, green	U/S (surging)	0/0		0	0
12 March 2013	Fine	0/8	N/A	Slightly turbid, green	U/S (surging)	0/0		0	0
27 March 2013	Fine	0/8	N/A	Sl. turbid, green-brown	D/S (surging)	0/0		0	0

Site Waingongoro River, Eltham Camp (Site Code: WGG000492)

Sampling Date	Weather		Conditions			Site usage		Rainfall (mm)	
	General	Cloud Cover	Algal cover	Appearance	Direction of Flow	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
1 November 2012	Fine	5/8	Thin brown mats	Slightly turbid, green-brown	D/S	0/0	Few sheep in paddock	0	0
28 November 2012	Fine	0/8	Thin brown mats	Slightly turbid, brown	D/S	0/2 (riding horses)	Horses in river	0	0
13 December 2012	Fine	6/8	Thin mats	Slightly turbid, brown	D/S	0/0		0	0.5
28 January 2013	Fine	8/8	Thin brown mats	Sl. turbid, yellow-brown	D/S	0/0		0	0
31 January 2013	Fine	0/8	Thin brown mats, patchy	Sl. turbid, yellow-brown	D/S	0/2 (banks, camping)		0	0
11 February 2013	Fine	1/8	50%	Clear, uncoloured	D/S	0/0		0	0
14 February 2013	Fine	1/8	Patchy, thin mats	Clear, yellow-brown	D/S	0/0		0	0
18 February 2013	Fine	0/8	Widespread mats	Sl. turbid, uncoloured	D/S	0/0		0	0
25 February 2013	Fine	0/8	Patchy mats	Clear, yellow-brown	D/S	0/0		0	0
28 February 2013	Fine	0/8	50%	Clear, uncoloured	D/S	0/40 (banks)	(school group in camp)	0	0
4 March 2013	Fine	5/8	Patchy	Sl. turbid, green-brown	D/S	0/0		0	0
12 March 2013	Fine	0/8	Widespread, thin mats	Clear, green	D/S	0/0		0	0
27 April 2013	Fine	0/8	None	Clear, uncoloured	D/S	0/0		0	0

Site Waingongoro River, near mouth (Site Code: WGG000995)

Sampling Date	Weather		Conditions			Site usage		Rainfall (mm)	
	General	Cloud Cover	Algal cover	Appearance	Direction of Flow	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
1 November 2012	Fine	4/8	Thin mats	Sl. turbid, green-brown	D/S	0/9 (whitebaiting/banks)	One dog	0	0
28 November 2012	Fine	2/8	Thin mats	Sl. turbid, brown-green	D/S (slow surging)	0/10 (whitebaiting)		0	0
13 December 2012	Fine, overcast	7/8	Thin mats	Turbid, brown	Surging	1/0	Two dogs	0	0
28 January 2013	Fine	0/8	Thin mats	Turbid, brown-green	D/S (slow)	0/4 (banks)	Foam very common	0	0
31 January 2013	Fine	1/8	Thin, patchy mats	Sl. turbid, brown-green	D/S (slow)	6/1 (banks)		0	0
11 February 2013	Fine	5/8	Thin, patchy mats	Sl. turbid, yellow-brown	D/S (slow & surging)	0/0		0	0
14 February 2013	Fine	0/8	Thin, patchy mats	Turbid, green-brown	D/S (slow & surging)	0/0	Warning signage being erected	0	0
18 February 2013	Fine	0/8	Widespread mats	Sl. turbid, green	D/S (slow)	0/0	Some cattle u/s (fenced). Signage present	0	0
25 February 2013	Fine	0/8	Widespread mats	Sl. turbid, green-brown	D/S (slow & surging)	0/0	Cattle u/s (near fenced edge)	0	0
28 February 2013	Fine	2/8	N/R	Sl. turbid, pale brown	Ponded	0/0		0	0
4 March 2013	Fine	5/8	Patchy	Sl. turbid, green-brown	U/S (surging)	3/0		0	0
12 March 2013	Fine	0/8	Patchy	Sl. turbid, green-brown	U/S (surging)	0/0	Two ducks	0	0
27 March 2013	Fine	0/8	Patchy	Sl. turbid, green-brown	D/S (surging)	0/0	Few ducks	0	0

Site Kaupokonui River, beach domain (Site Code: KPK000995)

Sampling Date	Weather		Conditions			Site usage		Rainfall (mm)	
	General	Cloud Cover	Algal cover	Appearance	Direction of Flow	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
1 November 2012	Fine	5/8	None	Sl. turbid, green-brown	U/S (surging)	0/20 (whitebaiting)		0	0
28 November 2012	Fine	3/8	Some (float)	Sl. turbid, brown-green	D/S (slow & surging)	0/8 (whitebaiting)		0	0
13 December 2012	Fine	2/8	None	Turbid, green	D/S (slow & surging)	0/1 (banks)		0	0
28 January 2013	Fine	0/8	N/R	Turbid, green-brown	U/S (surging)	1/10 (banks)		0	0
31 January 2013	Fine	0/8	N/R	Turbid, green-brown	D/S (slow)	2/15 (banks)		0	0
11 February 2013	Fine, overcast	7/8	N/R	Turbid, green	D/S (surging)	0/0		0	0
14 February 2013	Fine	2/8	N/R	Turbid, green	D/S (surging)	0/0		0	0
18 February 2013	Fine	0/8	Patchy, thin mats	Sl. turbid, brown-yellow	D/S (slow)	0/11 (banks)		0	0
25 February 2013	Fine	0/8	N/R	Sl. turbid, brown-green	D/S (surging)	0/4 (banks)		0	0
28 February 2013	Fine	2/8	N/R	Sl. turbid, pale brown	D/S (slow)	0/3 (fishing, kayaking)		0	0
4 March 2013	Fine, overcast	7/8	N/R	Sl. turbid, green-brown	U/S (surging)	0/0		0	1
12 March 2013	Fine	0/8	N/R	Turbid, green	U/S (surging)	0/0		0	0
27 March 2013	Fine	0/8	N/R	Sl. turbid, brown	D/S (slow & surging)	0/3 (fishing, banks)		0	0

Site Lake Opunake (Site Code: LOP000001)

Sampling Date	Weather		Conditions			Site usage		Rainfall (mm)	
	General	Cloud Cover	Algae	Appearance	Surface	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
1 November 2012	Fine	4/8	None	Slightly turbid, brown	N/R	0/10 (banks)	No ducks; aquatic weed in shallows	0	0
28 November 2012	Fine, overcast	8/8	None	Slightly turbid, brown	Ripple	0/0	Ducks common; aquatic weed near shore	0	2
13 December 2012	Fine	1/8	N/A	Relatively clear	Flat	0/0	Ducks common	0	0
28 January 2013	Fine	0/8	Some floating	Rel. clear, brown	N/R	0/0	Ducks very common; weed common	0	0
31 January 2013	Fine	0/8	Some floating	Slightly turbid, brown	Flat	0/0	Ducks very common	0	0
11 February 2013	Fine	5/8	N/R	Turbid, brown	Flat	0/3 (banks)	Ducks very common; weed common	0	0
14 February 2013	Fine	2/8	N/R	Sl. turbid, light green	Ripple	0/0	Ducks very common	0	0
18 February 2013	Fine	0/8	N/R	Slightly turbid, brown	Flat	0/1 (bank)	Ducks very common; weed common; one dog	0	0
25 February 2013	Fine	0/8	Some floating	Sl. turbid, brown-green	Flat	0/0	Ducks very common	0	0
28 February 2013	Fine	2/8	Common in suspension	Clear, pale green-brown	Flat	0/0	Ducks common	0	0
4 March 2013	Fine	4/8	N/R	Slightly turbid, brown	Flat	0/0	Ducks very common; weed common	0	0
12 March 2013	Fine	0/8	None	Slightly turbid, brown	Ripple	0/0	Ducks very common; weed common	0	0
27 March 2013	Fine	0/8	Thin mats	Clear, uncoloured	Flat	0/0	Ducks extremely common; some weed	0	0

Site Timaru Stream, near mouth (Site Code: TMR000497)

Sampling Date	Weather		Conditions			Site usage		Rainfall (mm)	
	General	Cloud Cover	Algal cover	Appearance	Direction of Flow	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
1 November 2012	Fine, overcast	8/8	Nil	Clear, grey-brown	D/S	0/4 (whitebaiting/banks)		0	0
28 November 2012	Fine,	6/8	Nil	Clear, brown	D/S (slow)	0/0		0	5
13 December 2012	Fine	0/8	Nil	Clear, brown	D/S (slow)	0/2 (bank)	Few seagulls, 3 dogs in water	0	0
28 January 2013	Fine	0/8	30% thin mats	Clear, colourless	U/S (slow)	0/3 (bank)		0	0
31 January 2013	Fine	0/8	Nil	Clear, pale green-brown	D/S (slow)	5/7 (banks/fishing)	One dog and horse in water	0	0
11 February 2013	Fine	4/8	Nil	Clear, pale green-grey	D/S	0/0	Seagulls common on LB	0	0
+14 February 2013	Fine	3/8	Nil	Clear, pale yellow-brown	D/S (slow)	0/3 (camping left bank)	Petrels common	0	0
18 February 2013	Fine	0/8	Thin mat	Clear, colourless	D/S	9/8 (banks)	Few dogs	0	0
25 February 2013	Fine	0/8	60%	Clear, colourless	D/S	0/0	Few gulls	0	0
28 February 2013	Fine	1/8	Nil	Clear, brown	U/S (slow)	0/0		0	0
4 March 2013	Fine	2/8	Nil	Clear, green	D/S	0/0	Few gulls	0	2.5
12 March 2013	Fine	0/8	Nil	Clear, brown	D/S (slow)	0/0	None	0	0
27 March 2013	Fine	0/8	5%	Clear, colourless	D/S (slow)	0/0	Few gulls	0	3

Site Oakura River, near mouth (Site Code: OKR000497)

Sampling Date	Weather		Conditions			Site usage		Rainfall (mm)	
	General	Cloud Cover	Algal cover	Appearance	Direction of Flow	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
1 November 2012	Fine, overcast	8/8	N/A	Clear, dark grey	U/S (v. slow)	0/1 (whitebaiting)		0	0
28 November 2012	Fine	1/8	Nil	Clear, grey-brown	D/S (v. slow)	0/1 (fishing)		0	5
13 December 2012	Fine	3/8	N/A	Clear, pale green	U/S (slow)	0/0	Few birds	0	0
28 January 2013	Fine	0/8	Nil	Clear, brown	U/S (slow)	2/0	Two dogs in river	0	0
31 January 2013	Fine	1/8	Nil	Clear, pale green	U/S (slow)	12/10 (banks)	Two dogs in river	0	0
11 February 2013	Fine	4/8	Nil	Clear, pale green	D/S	0/0	(Litter in river)	0	0
14 February 2013	Fine	6/8	Nil	Clear, pale green	D/S (slow)	1/2 (bank)		0	0
18 February 2013	Fine	2/8	Thin mat	Clear, pale green	U/S (slow)	7/9 (banks)	Few gulls	0	0
25 February 2013	Fine	0/8	Nil	Clear, yellow-brown	D/S (slow)	0/1 (fishing)	Few gulls	0	0
28 February 2013	Fine	3/8	Nil	Clear, blue-green	U/S (slow)	0/0		0	0
4 March 2013	Fine	6/8	Nil	Clear, blue-green	D/S (slow)	0/0		0	2.5
12 March 2013	Fine	0/8	Nil	Clear, green-blue	U/S (slow)	0/2 (bank)		0	0
27 March 2013	Fine	0/8	Nil	Clear, pale green	D/S	0/2 (bank)	One dog	0	3

Site Waitara River at town wharf, Waitara (Site Code: WTR000922)

Sampling Date	Weather		Conditions			Site usage		Rainfall (mm)	
	General	Cloud Cover	S.G. level	Appearance	Direction of Flow	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
1 November 2012	Fine, overcast	7/8	1.8	Brown	D/S	0/25 (banks/whitebaiting)	No signage	0	0
28 November 2012	Fine	1/8	N/R	Turbid, green	D/S (slow)	0/0	Signage present	0	3.5
13 December 2012	Fine	6/8	2.3	Turbid, brown	D/S (slow)	0/3 (fishing/canoeing)	Few ducks	0	0
28 January 2013	Fine	0/8	2.0	Brown	D/S	2/0	Few ducks	0	0
31 January 2013	Fine, overcast	7/8	2.1	Turbid, green	U/S(slow)	6/0	Few ducks	0	0
11 February 2013	Fine	1/8	2.4	Turbid, brown-green	D/S (v. slow)	0/0	Ducks common; 1 shag (some foam)	0	0
14 February 2013	Fine	0/8	2.0	Turbid, green-brown	D/S (slow)	0/1 (bank)	Ducks common	0	0
18 February 2013	Fine	0/8	1.3	Turbid, green	U/S (slow)	0/0	Gulls common	0	0
25 February 2013	Fine	0/8	1.95	Slightly turbid, green	D/S	0/0	Signage missing	0	0
28 February 2013	Fine	0/8	2.3	Turbid, green	D/S (slow)	0/0	Few ducks; signage missing	0	0
4 March 2013	Fine	3/8	1.75	Turbid, green-brown	D/S (v. slow)	0/0	One duck; no signage	0	11
12 March 2013	Fine	0/8	2.25	Turbid, green	D/S	0/4 (boating/fishing)	Gulls common; few ducks	0	0
27 March 2013	Fine	0/8	2.2	Turbid, khaki	D/S (slow)	0/1 (fishing)	Two ducks	0	0

Site Urenui River at estuary (Site Code: URN000480)

Sampling Date	Weather		Conditions			Site usage		Rainfall (mm)	
	General	Cloud Cover	Algal cover	Appearance	Direction of Flow	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
1 November 2012	Fine, overcast	7/8	N/A	Blue-green	U/S (rel. swift)	0/0		0	0
28 November 2012	Fine	1/8	N/A	Slightly turbid, green	D/S	0/0		0	3.5
13 December 2012	Fine	4/8	N/A	Turbid, green	D/S (slow)	0/0		0	0
28 January 2013	Fine	0/8	N/A	Green-blue	U/S	18/2 (kayaking)		0	0
31 January 2013	Fine, overcast	8/8	N/A	Grey-green	U/S	3/8 (banks)		0	0
11 February 2013	Fine	2/8	N/A	Turbid, green	D/S	1/1 (bank)		0	0
14 February 2013	Fine	1/8	N/A	Turbid, green	U/S	0/0		0	6
18 February 2013	Fine	0/8	N/A	Slightly turbid, green-grey	U/S (slow)	0/10 (banks/boat)		0	0
25 February 2013	Fine	0/8	N/A	Relatively clear, blue-green	U/S	0/5 (boats)		0	0
28 February 2013	Fine, overcast	7/8	N/A	Turbid, brown-green	U/S	0/0	One gull	0	0
4 March 2013	Fine	5/8	N/A	Turbid, green-grey	U/S	0/0		0	7
12 March 2013	Fine	0/8	N/A	Turbid, blue-green	U/S	0/7 (banks, fishing)		0	0
27 March 2013	Fine	0/8	N/A	Turbid, green-grey	D/S (slow)	4/2 (banks)	None	0	0

Site Manganui River d/s of Kurapete Stream (Site Code: MGN000435)

Sampling Date	Weather		Conditions			Site usage		Rainfall (mm)	
	General	Cloud Cover	Algal cover	Appearance	Direction of Flow	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
1 November 2012	Fine, overcast	8/8	55%	Clear, uncoloured	D/S	0/0		0	0
28 November 2012	Fine	0/8	Widespread	Brown-green	D/S	0/0		0	2.5
13 December 2012	Fine	2/8	Widespread, thin mats	Sl. turbid, green-brown	D/S	0/0		0	1
28 January 2013	Fine	0/8	Thick mats	Brown	D/S	0/0		0	0
31 January 2013	Fine	1/8	Medium mats	Sl. turbid, brown	D/S	0/0		0	0
11 February 2013	Fine	4/8	Medium mats	Sl. turbid, brown-green	D/S	0/0		0	0
14 February 2013	Fine	0/8	Medium mats	Clear, brown-green	D/S	0/0		0	0
18 February 2013	Fine	2/8	Medium mats	Slightly turbid, green-brown	D/S	0/0		0	0
25 February 2013	Fine	0/8	100% mats	Clear, uncoloured	D/S	0/0		0	4
28 February 2013	Fine	6/8	Medium	Slightly turbid, brown-green	D/S	0/0	One bird	0	0
4 March 2013	Fine	4/8	35%	Clear, uncoloured	D/S	0/0		0	1
12 March 2013	Fine	0/8	None	Clear, green-brown	D/S	0/0		0	0
27 March 2013	Fine	0/8	Medium mats	Slightly turbid, brown	D/S	0/0		0	0

Site Lake Ratapiko (Site Code: LRP000050)

Sampling Date	Weather		Conditions			Site usage		Rainfall (mm)	
	General	Cloud Cover	Algae	Appearance	Surface	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
1 November 2012	Fine, overcast	8/8	N/A	Slightly turbid, pale-green	Flat	0/0	Ducks common; level low	0	0
28 November 2012	Fine	3/8	N/A	Brown	Ripple	0/0	One duck	0	2.5
13 December 2012	Fine	1/8	N/A	Clear, brown	Ripple	0/0	One duck; 10 cows on bank!	0	0
28 January 2013	Fine	0/8	N/A	Brown-green	N/R	0/0	Few ducks	0	0
31 January 2013	Fine, overcast	7/8	Nil	Slightly turbid, brown	Ripple	0/0	Ducks common; herd of cows, opposite bank	0	0
11 February 2013	Fine	2/8	Nil	Slightly turbid, brown	Slight chop	0/0	Few ducks	0	0
14 February 2013	Fine	0/8	Nil	Slightly turbid, brown	Ripple	0/0	Ducks very common	0	0
18 February 2013	Fine	6/8	Nil	Clear, blue-brown	Flat	0/3 (boat/banks)	Few ducks, cattle common at edge	0	0
25 February 2013	Fine	0/8	N/A	Rel. clear, pale brown	Ripple	0/0	Ducks common	0	4
28 February 2013	Fine, overcast	7/8	N/A	Slightly turbid, brown	Ripple	0/0	Few ducks, one shag	0	0
4 March 2013	Fine	4/8	N/A	Slightly turbid, brown	Ripple	0/0	Few ducks	0	1
12 March 2013	Fine	0/8	N/A	Slightly turbid, brown	Slight ripple	0/0	Ducks common	0	0
27 March 2013	Fine	-	N/A	N/A	N/A	-	Lake level very low (maintenance) [No sampling possible]	0	0

Appendix IV

**Sampling conditions and public usage
recorded at two sites by the additional programme**

Dates of additional sampling

Date	Preceding weather
Tuesday 6 November 2012	fine over 48 hours, wet previous day
Wednesday 19 December 2012	wet over 72 hours
Monday 7 January 2013	dry over 72 hours, wet over 120 hours
Tuesday 22 January 2013	dry over 48 hours; some rain over 120 hours
Thursday 7 February 2013	dry over 48 hours; very wet over 72 hours
Thursday 21 February 2013	dry over 72 hours
Thursday 21 March 2013	wet over 72 hours, main over 48 to 72 hours; wet previous 72 to 120 hours

Site Lake Rotomanu (Site Code: LRM000002): additional monitoring (seven samples)

Sampling Date	Weather		Conditions			Site usage		Rainfall (mm)	
	General	Cloud Cover	Algal cover	Appearance	Surface	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
6 November 2012	Fine	0/8	N/R	Slightly turbid, brown	Ripple	0/0		0	0.5
19 December 2012	Fine, overcast	8/8	N/R	Turbid, brown	Flat	0/0	Few ducks	6	9
7 January 2013	Fine	0/8	N/R	Slightly turbid	Ripple	5/15 (banks/boating)		0	0
22 January 2013	Fine	1/8	N/R	Turbid, brown	N/R	0/13 (banks/boating/jet skiing)	Few ducks, one dog	0	5
7 February 2013	Fine	0/8	None	Turbid, brown	Ripple	0/1 (bank)	Few ducks	0	20
21 February 2013	Fine	0/8	None	Slightly turbid, brown	Ripple	0/0	Few ducks	0	0
21 March 2013	Fine	0/8	N/R	Slightly turbid, brown	Ripple	0/2 (banks)	No ducks; one dog	0	21

Site Waiwhakaiho River at Merrilands (Site Code: WKH000800): additional monitoring (seven samples)

Sampling Date	Weather		Conditions			Site usage		Rainfall (mm)	
	General	Cloud Cover	Algal cover	Appearance	Direction of Flow	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
6 November 2012	Fine	0/8	Thin	Slightly turbid, green	D/S	0/0		0	0.5
19 December 2012	Fine, overcast	8/8	N/R	Turbid, brown	D/S	1/0	2 dogs	6	9
7 January 2013	Fine	0/8	Wide-spread, thin	Slightly turbid, green	D/S	0/10 (banks)	8 dogs	0	0
22 January 2013	Fine	0/8	N/R	Rel.clear; green-brown	D/S	0/0		0	5
7 Februray 2013	Fine	0/8	None	Turbid, yellow-green	D/S	0/0		0	20
21 February 2013	Fine	3/8	Thin	Sl. turbid; yellow-breen	D/S	0/1 (banks)	1 dog in water	0	0
21 March 2013	Fine	0/8	Thin	Sl. turbid, green-brown	D/S	0/1 (banks)	2 dogs	0	21

Appendix V

**Sampling conditions and public usage recorded at
three sites during the cyanobacteria programme**

Site Lake Opunake (Site Code: LOP000001)

Sampling Date	Weather		Conditions			Site usage		Rainfall (mm)	
	General	Cloud Cover	Algal cover	Appearance	Surface	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
6 November 2012	Fine	1/8	N/R	Slightly turbid, brown	Ripple	0/0	Few ducks on shore	1	1
19 December 2012	Fine	2/8	N/R	Slightly turbid, brown	Flat	0/1 (bank)	Ducks common, few swans	2	4
7 January 2013	Fine	1/8	Some visible	Turbid brown	Ripple	0/2 (bank)	Few ducks on shore	0	3
22 January 2013	Fine	1/8	N/R	Relatively clear, brown	N/R	0/10 (bank)	Few ducks, weed common	0	4
7 Februray 2013	Fine	0/8	Some floating	Turbid, brown-green	Flat	0/0	Ducks very common	0	54
21 February 2013	Fine	5/8	Some floating	Slightly turbid, brown	Ripple	0/0	Ducks common, weed very common	0	0
21 March 2013	Fine	0/8	None visible	Sl. turbid, pale brown	Ripple	0/0	Ducks very common; weed very common	0	46

Site Lake Ratapiko (Site Code: LRP000050)

Sampling Date	Weather		Conditions			Site usage		Rainfall (mm)	
	General	Cloud Cover	Algal cover	Appearance	Surface	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
6 November 2012	Fine	0/8	N/R	Slightly turbid, brown	Ripple	0/0		0	0
19 December 2012	Fine, overcast	8/8	N/R	Relatively clear, brown	Ripple	0/0	Few ducks	16	46
7 January 2013	Fine	0/8	N/R	Slightly tubid, brown	Ripple	0/0	Few ducks	0	0
22 January 2013	Fine	0/8	None	Relativley clear, brown	Flat	0/0	Few ducks	0	4.5
7 Februray 2013	Fine	0/8	None	Turbid, brown	Flat	0/0	Few ducks	0	47
21 February 2013	Fine	0/8	None	Slightly turbid, yellow	Flat	0/0	Few ducks	0	0
21 March 2013	Fine	0/8	N/R	Turbid, brown	Flat	0/0	Few ducks	0	30

Site Lake Rotokare adjacent to boatramp (Site Code: LRK000003)

Sampling Date	Weather		Conditions			Site usage		Rainfall (mm)	
	General	Cloud Cover	Algal cover	Appearance	Surface	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
8 November 2012	Fine	0/8	Some fine suspended	Slightly turbid, brown	Rel., flat	0/3 (bank)	Boat ramp locked, few ducks	0	0
22 November 2012	Fine	0/8	Some suspended	Sl. turbid, brown-green	Flat	0/30 (bank)	Few ducks	0	0
29 November 2012	Fine, overcast	7/8	Some suspended	Slightly turbid, grey	Choppy	0/5 (walkers)	Few ducks (scaup). Boat ramp closed	0	0
10 December 2012	Fine, overcast	8/8	Suspended	Slightly turbid, brown	Slight ripple	0/0	Boat ramp closed	0	1.5
10 January 2013	Fine, overcast	7/8	Suspended	Turbid, brown	Flat	0/0	Boat ramp closed. Few ducks and swan	0	1
23 January 2013	Fine, overcast	7/8	Suspended	Turbid, brown	Flat	0/0	Boat ramp closed	0	0
7 February 2013	Fine	0/8	Suspended	Rel. clear, green-brown	Ripple	0/10 (walkers)	Boat ramp closed. Few pukeko and ducks	0	55
20 February 2013	Fine	4/8	None visible	Slightly turbid, brown	Ripple	0/10 (walkers)	Few swan	0	0
7 March 2013	Fine	0/8	None visible	Relativley clear, brown	Flat	0/30 (school group)	Boat ramp open	0	0
21 March 2013	Fine	0/8	Some suspended	Slightly turbid, brown	Flat	0/0	Boat ramp open; few ducks	0	23
11 April 2013	Fine	0/8	Suspended	Slightly turbid, green	Flat	0/0	Boat ramp open	0	8
29 April 2013	Fine	2/8	Some suspended	Rel. clear, pale brown	Flat	0/0	Few ducks; boat ramp open	0	2

Appendix VI

**Comparative annual box and whisker plots of SEM data
for *E. coli* for the period 1996 to 2013**

Explanation of box and whisker plots

Box and whisker plots are a useful method of summarising data in a graphical form that allows rapid comparisons of data groups. The data is represented as a box with a whisker from each end.

The median (middle value of the sorted data; half of the data is either side of the median is represented by a single horizontal line. The notch, symmetrically spread around the median represents the 95% confidence interval of the median). It is a feature that allows rapid comparison between groups. If notches overlap, there is no significant difference between groups (at the 95 % confidence interval). If notches do not overlap, a statistical difference is expected.

The top and bottom of the box represent the upper and lower hinges respectively. The median splits the ordered group of data in half and the hinges split the remaining halves in half again. This means that 50% of the data lies within the box.

Hspread, comparable to the interquartile (25% and 75%) range is the difference between the values of the two hinges, ie, Upper hinge – Lower hinge = Hspread. The inner fences are defined as follows:

Lower fence = lower hinge – (1.5 x Hspread)

Upper fence = upper hinge + (1.5 x Hspread)

The outer fences are defined as follows:

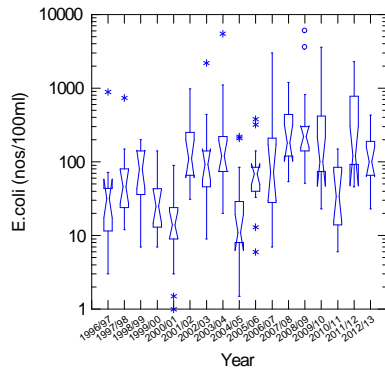
Lower fence = lower hinge – (3 x Hspread)

Upper fence = upper hinge + (3 x Hspread)

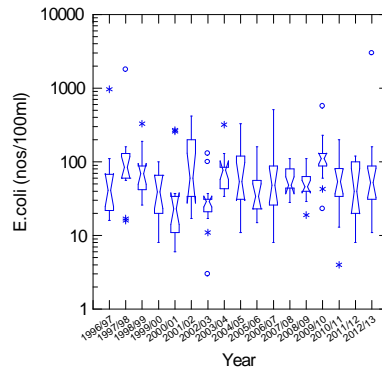
The whiskers show the range of values that lie within the inner fences. Values outside the inner fence (outliers) are plotted as asterisks (*). Values outside the outer fence (extreme outliers) are plotted as °.

E. coli

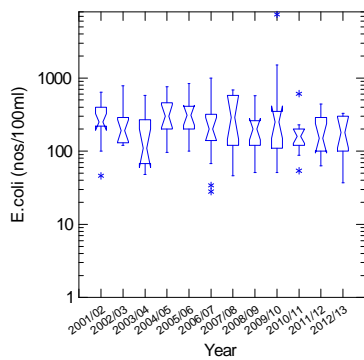
Lake Rotomanu



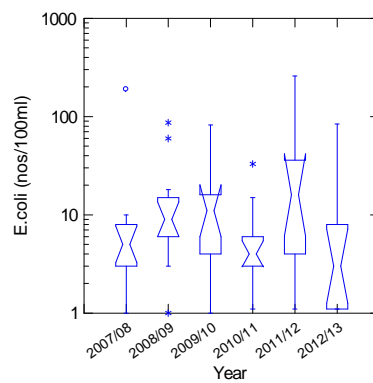
Waiwhakaiho River at Merrilands Domain



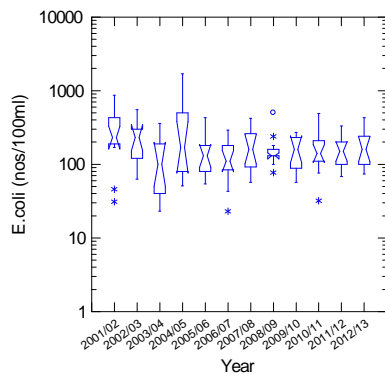
Patea River at Stratford



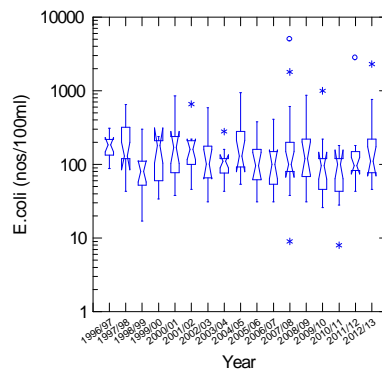
Patea River at Patea boat ramp



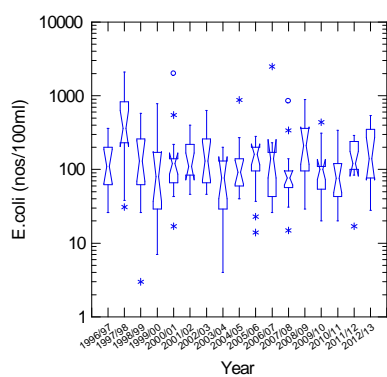
Waingongoro River at Eltham



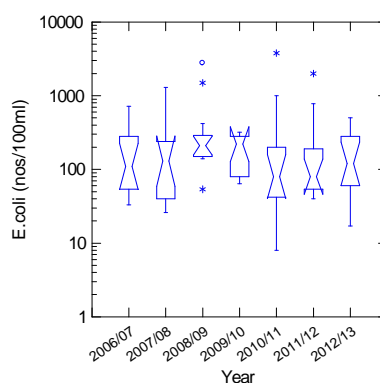
Waingongoro River at Ohawe



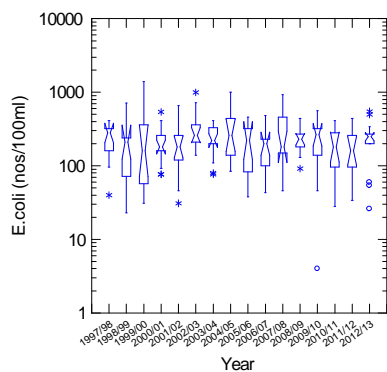
Kaupokonui River



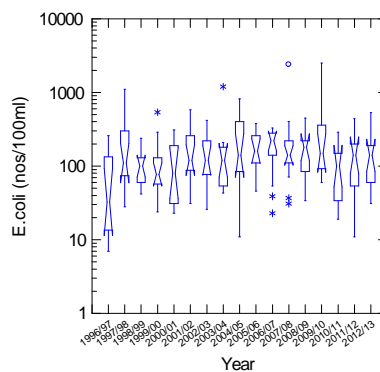
Lake Opunake



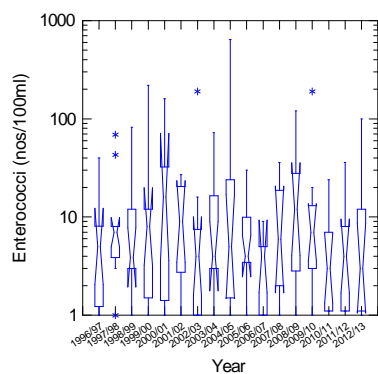
Timaru Stream



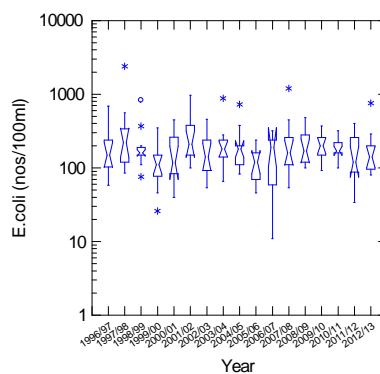
Oakura River



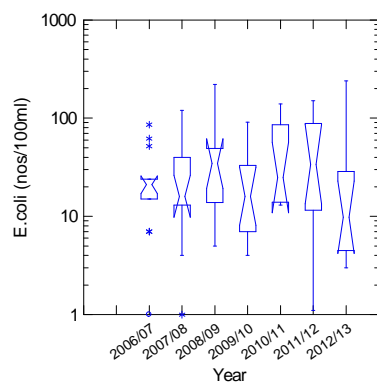
Urenui River



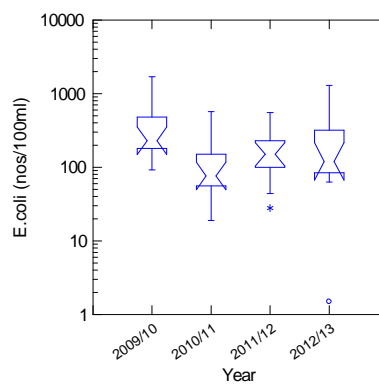
Manganui River



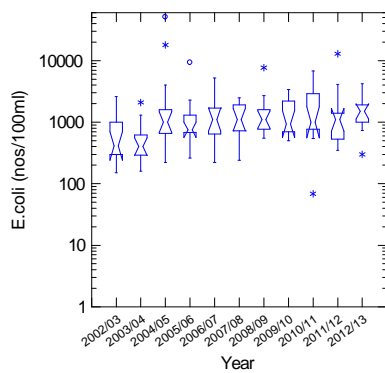
Lake Ratapiko



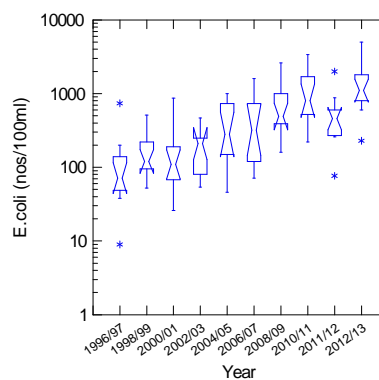
Waitara River at town wharf



Te Henui mouth East End



Waiwhakaiho adjacent to Lake Rotomanu



Appendix VII

Examples of publicity during the 2012-2013 season

SouthTaranaki.com - Council

Rotokare Lake Closed

Print 



Monday, November 26, 2012

Due to high levels of a potentially toxic blue-green algal bloom (Cyanobacter), the lake at Rotokare Reserve is closed to all users until further notice. The grounds at Lake Rotokare Reserve remain open for visitors.

Cyanobacter is a naturally occurring algae capable of producing toxins, most commonly causing skin and eye irritation, but depending on the toxin can cause, sore throats, asthma symptoms, weakness, paralysis, and vomiting or diarrhoea. Any visitors to the reserve showing these symptoms should consult their doctor immediately or contact the Taranaki District Health Board Public Health Unit on 06 753 7798 for further information.

Visitors to the lake should not to collect or eat fish and plant life or come into contact with the water.

The South Taranaki District Council properties and facilities manager John Sargeant says the lake will remain closed until cleared by the Taranaki District Health Board.

Alternatives for water skiing and lake activities are suggested on Lake Rotorangi at Glenn Nui, Tangahoe or Patea Dam Camp site off Ball Rd.

- ENDS -

Freshwater quality



Click on an icon for more information

Last updated: 11/04/2013 12:00 am

KEY		Public health
	Surveillance mode Less than 261 E. coli/100ml in single sample.	District Health Board warnings may still remain in place when a site moves from red to green. Click here for more information, or call Health Protection on 06 753 7798 (24 hours).
	Alert mode 261 - 550 E. coli/100ml in single sample.	
	Action mode More than 550 E. coli/100ml in single sample.	
	High cyanobacteria risk More than 15,000 cells/ml in single sample.	

The Taranaki Regional Council undertakes microbiological water quality monitoring at a number of river sites around Taranaki during the summer months (November to March) to:

- Assess the water quality of popular bathing sites in Taranaki.
- Compare bathing water quality in Taranaki with national guidelines for contact recreational use of water.
- Monitor trends in bathing water quality over time.

The Council conducts bacteriological of samples from the freshwater sites on the map above, and additionally tests for cyanobacteria at Lake Rotomanu, the Waiwhakaiho River at Merrilands, Lake Ratapiko, Lake Rotokare and Lake Opunake.

Bacteriological

Bathing water quality is assessed according to concentrations of indicator bacteria. For freshwater river sites, this is a type of bacterium known as *Escherichia coli* (E. coli), which is an indicator of faecal contamination. If there is faecal contamination there is a possibility of the presence of disease-causing organisms such as bacteria, viruses and protozoa. These organisms may pose a health hazard when the water is used for recreational activities such as swimming, board riding and other high-contact activities. Poor recreational water quality can possibly cause gastrointestinal illness and respiratory health effects, such as coughs and colds.

A high concentration of the indicator bacteria means that it is more likely that disease-causing organisms are present. It does not mean that anyone swimming in the water at the time will actually be affected.

Water quality safety is assessed and reported according to the Ministry for the Environment and Ministry of Health 'Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas' revised and issued in 2003.

These guidelines categorise recreational bathing sites into one of three 'mode' categories according to single sample results of E. coli (freshwaters) and enterococci (marine waters) bacterial counts. For freshwater sites, these categories are:

E. coli/100ml	Mode
No single sample greater than 260	Surveillance/Green
One single sample between 261 and 550	Alert/Amber
One single sample greater than 550	Action/Red

The safety category is reassessed after each additional sample is collected. Sites on the maps reflect the coloured safety category and level of compliance with the guidelines at the time of the most recent sample.

In Taranaki, it is known that significant rainfall events substantially increase bacterial levels in rivers and streams (and subsequently in coastal waters along the shoreline) due to rural and urban runoff for up to several days after rainfall. This may increase numbers into the Action mode category for recreational usage. However, for trend detection purposes the Taranaki Regional Council does not sample river and beach waters within three days of any significant rainfall.

The results of the water samples collected from fresh water and coastal sites during the bathing season are updated on this site as they are received from the laboratory.

Cyanobacteria

Cyanobacteria, or blue-green algae, are very small plant-like organisms found in freshwater lakes and rivers where they can build up to very large numbers under certain conditions.

Cyanobacteria can cause skin irritation, and some species contain toxic substances and have been linked to negative effects on human and animal health.

They can cause nausea, stomach upsets, and tingling and numbness around the mouth or tips of fingers. If toxin levels are really high, involuntarily or accidentally drinking the water could result in severe liver damage.

The Taranaki Regional Council is monitoring summer cyanobacteria levels as well as bacteriological levels at Lake Rotomanu, the Waiwhakaiho River at Merrilands, Lake Ratapiko, Lake Rotokare and Lake Opunake.

There are three alert levels:



Cyanobacteria cells per ml of water	Mode
Less than 2,000	Low risk
Between 2,000 and 15,000	Medium risk
More than 15,000	High risk

High risk will be denoted on the bacteriological water quality map with a barred circle on a purple background at the relevant monitoring site.

For more information contact the Taranaki Regional Council:

Email: info@trc.govt.nz

Phone: 06 765 7127

Fax: 06 765 5097

<http://www.trc.govt.nz/freshwater-quality/>

26/04/2013

The full monitoring programme runs from November to March or April. When monitoring is being carried out and results are available, data on this website is updated three times a day, at 10am, 3pm and 6pm.

Public health status: Click [here](#) to access Taranaki District Health Board information on the public health status of monitored sites.

The graph and its associated Database are set to a minimum count of 1.2 to allow adequate visual presentation. So a reading of 1.2 reflects an actual sample result of 1 or less than 1 bacterium per 100mls.

Graph **Raw data**

Y-axis: 1, 3, 10, 31, 100, 316, 1000

Legend:

- Action level (Red line)
- Alert level (Orange line)
- E. coli (Blue bars)

Month	E. coli Count (approx.)
Oct	0
Nov	1
Dec	70
Jan	15
Feb	4
Mar	3
Apr	3
May	1
Jun	0
Jul	0

[Back to map](#)

Current values:

- E. coli: 1.2 nos/100ml (2013-04-11 00:00:00)
- Cyanobacteria: 13850 cells/1ml (2013-04-11 00:00:00) (Cyanobacteria risk: Medium)



Between 13 and 20 samples will be collected during the annual summer bathing season from November to early April. Purple vertical bars show the bacterial count measured in the water on particular days. These are single sample counts.

Note the logarithmic scale of the bacterial indicator axis. It is not a linear graph where the intervals are unchanged up the scale.

A bathing site is considered safe for swimming unless two consecutive sample counts for marine water are more than the Action Limit of 280 enterococci/100ml at beach sites or when the single sample count for freshwater is more than 550 *E. coli* /100ml.

Should single sample counts be greater than the Action Limit, this indicates that the maximum recommended value for safe swimming has been exceeded and additional sampling, and investigations may be initiated.

The Medical Officer of Health advises users "that bacterial counts are high after heavy rainfall. Recreational use should be reduced for two-three days after heavy rainfall".

For more information contact the Taranaki Regional Council:

Appendix VIII

Bacterial marker investigations in the lower Waingongoro and Oakura Rivers and Kaupokonui and Timaru Streams

Results of microbial source tracking investigations

[DNA analyses undertaken by Cawthron Institute, Nelson: *E. coli* analyses by TRC laboratory]

Site: Waingongoro River u/s of Ohawe township

(WGG000985) [GPS: 1702957E 5618209N]

Date	22 Jan 2013	8 Apr 2013
Source ¹	R	R, W
<i>E. coli</i> (nos/100ml)	51	92
Flow conditions	low	low
Tide	LT	LT

[¹ source: R= ruminant; H= human; W= wildfowl]

Site: Waingongoro River at Ohawe beach

(WGG000995) [GPS: 1702531E 5617624N]

Date	22 Jan 2013	8 Apr 2013
Source ¹	R	R, W
<i>E. coli</i> (nos/100ml)	43	60
Flow conditions	low	low
Tide	LT	LT

[¹ source: R= ruminant; H= human; W= wildfowl]

Site: Kaupokonui Stream at beach domain

(KTK000995) [GPS: 1691110E 5619893N]

Date	22 Jan 2013	8 Apr 2013
Source ¹	R	R, W
<i>E. coli</i> (nos/100ml)	26	17
Flow conditions	low	low
Tide	LT	LT

[¹ source: R= ruminant; H= human; W= wildfowl]

Site: Timaru Stream at lower Weld Road

(TMR000497) [GPS: 1679649E 5669497N]

Date	22 Jan 2013	8 Apr 2013
Source ¹	R	R, W
<i>E. coli</i> (nos/100ml)	80	40
Flow conditions	low	low
Tide	LT	LT

[¹ source: R= ruminant; H= human; W= wildfowl]

Site: Oakura River u/s of Oakura township

(OKR000450) [GPS: 1683124E 5669661N]

Date	22 Jan 2013	8 Apr 2013
Source ¹	- ²	R
<i>E. coli</i> (nos/100ml)	80	23
Flow conditions Tide	low LT	low LT

[¹ source: R= ruminant; H= human; W= wildfowl][² origin not detectable; likely due to limited faecal contamination]**Site: Oakura River d/s of SH45 bridge**

(OKR000497) [GPS: 1682721E 5670440N]

Date	22 Jan 2013	8 Apr 2013
Source ¹	R	R, W
<i>E. coli</i> (nos/100ml)	100	20
Flow conditions Tide	low LT	low LT

[¹ source: R= ruminant; H= human; W= wildfowl]