NORTHLAND FRESHWATER BATHING SITES

WATER QUALITY MONITORING SUMMER 2003-04

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EXECUTIVE SUMMARY

- Seventeen popular swimming sites at fifteen of Northland's rivers, lakes and streams were sampled over a twelve week period, from the start of December 2003 through to the end of February 2004

- Pollution indicator bacteria (*Escherichia coli*) counts were carried out on the samples, and the results were compared with the Ministry for the Environment and Ministry of Health's **Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas**

- Results are forwarded on to the relevant district councils, as well as Northland Health, as they become available, for action when levels of *E. coli* are elevated above the MfE guidelines

- The water quality of the two lakes sampled, Ngatu on the Aupouri Peninsula, and Taharoa in the Kai Iwi lakes group, was generally excellent over the course of the entire survey

- Results for the rivers and streams were variable. The Omamari Beach Stream and the Waipapa Stream met the guidelines for most of the sampling period, however samples taken from the Otiria and Wairoa Stream locations consistently contained *E. coli* well in excess of the recommended levels

- Interim grades, based on the MfE guidelines, have been produced for sites with data stretching back over at least five summers. Grades for other sites have been postpones until a long enough record is collated. The process has tended to be conservative and have overstated the health risks at some sites

- For the summer of 2004-05, it is recommended that monitoring of the sites be continued. In addition, it is proposed that Hikurangi Lake should be added to the programme

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1 INTRODUCTION

The Northland Regional Council, in conjunction with Northland Health and Northland's district councils, conducts a survey of the water quality at a number of the region's most popular freshwater bathing sites. Freshwater sites are not always safe for recreational activities, as waterways can sometimes become contaminated with human or animal effluent, effluent that contains large numbers of organisms capable of causing illness. These organisms, called pathogens, include such "bugs" as giardia (*Giardia lamblia),* and campylobacter *(Campylobacter jejuli)*

The purpose of the annual survey is to determine the relative health of each site. The Northland Regional Council can then use this data to identify problem areas and, with the co-operation of Northland Health and the relevant district councils, work towards providing solutions.

1.1 ILLNESS

The most common symptoms of bathing-related illness are ear infections, rashes, and stomach cramps. More serious cases will cause vomiting and diarrhoea (especially associated with *Giardia lamblia*, commonly known as "traveller's diarrhoea"), but it is extremely rare for symptoms to be anymore severe. More recently, the pathogens that thrive in sewage-contaminated water have been shown to cause respiratory problems, problems usually associated with colds and the flu.

It is very rare for such illnesses to be fatal, although the elderly, infants and people already sick tend to be more at risk. Nonetheless, contracting a pathogenic illness can be particularly unpleasant, and the associated medical and social costs can be significant.

1.2 ACCEPTABLE RISKS

The amount of pathogens a person needs to ingest before becoming sick varies from many thousands to a single pathogen, and depends on a number of factors. When you consider how small bacteria and viruses are, and how big lakes and rivers can get, it makes it impossible to ever guarantee that any waterway is safe to swim in. This uncertainty is the reason that health authorities always recommend you boil untreated water before consuming it.

Instead, when determining how safe a body of water is for recreation, it is better to consider things in terms of maximum acceptable risk. If only one person in a million became ill after swimming somewhere, it is unlikely that anyone would be overly worried. On the other hand, every swimmer got sick, the risks become unacceptable. The maximum acceptable risk falls somewhere in between; some people may get sick, but not so many as to become a strain on health resources or present a threat to peoples' lives.

For freshwater recreation in New Zealand, the Ministry for the Environment and the Ministry of Health has set the maximum acceptable risk at 8 in every 1000 users falling ill as a result of freshwater recreation (MfE, 2002; MfE 2003). This number is based on a combination of local and international studies.

2 WHEN TO AVOID CONTACT RECREATION

In order to minimise the risk when taking advantage of our waterways, a number of simple steps should be followed:

CLARITY
It may seem to be stating the obvious, but stagnant and murky water tends to contain many more pathogens than crystal clear and flowing water. There is a loose correlation between suspended solids (which reduce clarity) and agricultural run-off (high in potential pathogens), and a good way to reduce your risk is to only swim[1] in water in which you can see your feet when you are knee deep.

DISCOLOURATION, FOAMS AND ODOUR
Water can be unsafe for swimming in if it has an unpleasant or unusual smell, or if there is foam or slicks on the water's surface. Even if the water is relatively clear, foams and odour are often signs of upstream sewage discharges.

RAINFALL
Rainfall has a big impact on waterways. When it rains, run-off from farmland and urban areas can be washed into rivers, streams and lakes, carrying potentially substantial loads of pathogens into the water. After heavy rainfall, it is recommended to wait several days, to allow for any run-off to pass through, even if water passes the other tests.

[1] It is unwieldy to continually use the term "freshwater recreational contact use", so for the sake of brevity and clarity, swimming will be assumed to be synonymous, and any recommendations equally applicable to any other use, from jet skiing to diving.

3 RECREATIONAL CONTACT GUIDELINES

The Ministry for the Environment and Ministry of Health released national Microbiological Water Quality Guidelines in June 2003. The Northland Regional Council's monitoring programme has incorporated the recommendations presented in the guidelines where possible, and the NRC can therefore determine the quality of Northland's freshwater bathing sites using national standards. This section provides an outline and discussion of the key aspects of the Ministry's guidelines, available online at:

www.mfe.govt.nz/publications/water/microbiological-quality-jun03/

3.1 THE MICROBIOLOGICAL ASSESSMENT CATEGORY (MAC)

The Ministry for the Environment has grouped the possible range of microbiological results into four categories, ranging from A to D as presented in Table 1. These categories are determined using the 95th percentiles[2] of datasets with at least 100 data points stretching over 5 years. Where there is not enough data, all grading using the MfE guidelines should only be considered provisional.

Table 1 Microbiological Assessment Category (MAC) definitions (MfE, 2003)

A	Sample 95th percentile ≤ 130 Escherichia coli per 100 mL
B	Sample 95th percentile 131-260 Escherichia coli per 100 mL
C	Sample 95th percentile 261-550 Escherichia coli per 100 mL
D	Sample 95th percentile > 550 Escherichia coli per 100 mL

3.2 THE SANITARY INSPECTION CATEGORY (SIC)

The **sanitary inspection category** is used to classify the likely dominant source of faecal contamination of a given water body. In order to determine the SIC for a river, stream or lake, the potential and probable suppliers of faecal bacteria are listed. In most cases, one source will dominate, such as run-off in agricultural catchments or stormwater in urban catchments. The Ministry for the Environment has grouped the most commonly occurring sources into five categories as shown in Table 2. Once the major source of faecal contamination into a body of water has been identified, a **sanitary inspection category** can be chosen.

[2] Calculated using the hazen method.

Table 2 Sanitary Inspection Category (SIC) Definitions (MfE, 2003)

SANITARY INSPECTION CATEGORY	EXAMPLES OF SOURCE
VERY LOW	No significant source, indirect run-off from forests.
LOW	Indirect run-off horticulture or low-intensity agriculture, direct run-off from forests.
MODERATE	Stormwater (free of sewage), direct run-off from horticulture or low-intensity agriculture, indirect run-off from high-intensity agriculture, marina, or boat moorings, unrestricted access of stock to tributaries.
HIGH	Indirect discharge of untreated sewage or on-site waste treatment systems, urban stormwater, unrestricted access of stock to waterway, direct run-off from intensive agriculture, dense bird populations.
VERY HIGH	Direct discharge of untreated sewage or on-site waste treatment systems (including leaking septic tanks).

3.3 THE SUITABILITY FOR RECREATION GRADE (SFRG)

The **suitability for recreation grade** is determined by combining the MAC and SIC of a recreational bathing site. There are five grades, ranging from very good to very poor. As mentioned previously, if there is insufficient data to fulfil the basic assumptions of the MAC determination (100 data points over 5 years of sampling), then these grades should be considered interim grades rather than absolute ones. Table 3 show how the MAC and SIC categories combine, and an explanation of the various grade follows.

Table 3 Suitability for Recreation Grade guidelines (MfE, 2003)

SUSCEPTIBILITY TO FAECAL INFLUENCE		MICROBIOLOGICAL ASSESSMENT CATEGORY			
		A	B	C	D
SANITARY INSPECTION CATEGORY	VERY LOW	Very Good	Very Good	Follow Up♠	Follow Up♠
	LOW	Very Good	Good	Fair	Follow Up♠
	MODERATE	Follow Up♣	Good	Fair	Poor
	HIGH	Follow Up♣	Follow Up♣	Poor	Very Poor
	VERY HIGH	Follow Up♣	Follow Up♣	Follow Up♣	Very Poor

♣ Unexpected results, which require further investigation (either SIC or MAC needs to be reassessed)

♠ Implies non-sewage source of faecal contamination, and this needs to be verified

SFRG = VERY GOOD
Without any significant sources of faecal contamination, a site with a "Very Good" SFRG may be considered suitable for contact recreation at all times. A site with a "Very Good" SFRG may not require regular sampling in the future

SFRG = GOOD
While water quality is generally good at a "Good" site, potential sources of faecal contamination such as indirect agricultural run-off or non-sewage stormwater can make the site unsuitable for contact recreation during and after periods of significant rainfall. Regular monitoring of such sites is necessary as there is the possibility that the water quality could deteriorate with future development of the upstream catchment.

SFRG = FAIR
At sites with a "fair" grade, water is usually suitable for contact recreation, but sources of contamination such direct discharges from low-intensity agriculture and stormwater drains or indirect discharges from intensive agriculture mean that these sites should not be used during or immediately after rain events. The MfE recommends that such sites should be monitored weekly over loading periods (such as the summer school holidays).

SFRG = POOR
The water at sites with a "Poor" grade tends to breach alert guidelines (> 260 *E. coli* per 100 mL) more often than not. Because of direct discharges from intensive agriculture and tertiary treated sewage, or indirect discharges from leaking septic tanks and other untreated wastes, the site is generally unsuitable for swimming or other recreational activities, and that infants, the elderly, or the sick in particular should avoid using such sites for recreational contact. This recommendation applies even during dry periods, and territorial authorities may choose to erect permanent warning signs, especially if weekly sampling is discontinued at such sites.

SFRG = VERY POOR
Sites that receive a grade of "very poor" should not be used for recreational activities. Direct discharges of faecal material from sources such as leaking septic tanks or untreated wastewater mean that local authorities should erect permanent warning signs at such sites, advising that the water is categorically unsuitable for use.

3.4 SINGLE SAMPLE GUIDELINES

In additional to providing guidelines on how to handle information at the conclusion of freshwater contact surveys, the Ministry for the Environment has also set a recommended course of action for the treatment of data during surveys. Under the current guidelines, each sample will fall into one of three categories: Acceptable (green), Alert (yellow), or Action (red), as shown in Table 4.

Table 4 Single sample guidelines for contact recreational surveys (MfE, 2003)

E. coli COUNT	CATEGORY	SUGGESTED RESPONSE
Sample < 260 per 100 mL	Acceptable	▪ No response necessary – Continue weekly sampling
260 < Sample > 550 per 100 mL	Alert	▪ Increase sampling to daily ▪ Undertake sanitary survey to isolate source of faecal contamination
Sample > 550 per 100 mL	Action	▪ Increase sampling to daily ▪ Undertake sanitary survey ▪ Erect warning signs ▪ Inform public through the media that a public health risk exists

In practise, the Northland Regional Council undertakes the regular weekly sampling, and passes the results onto Northland Health, who in turn alert the relevant District Council (Far North, Whangarei or Kaipara) if results from a site are above the 260 *E. coli* per 100 mL threshold and further sampling is required. Sanitary surveys may be undertaken as solo or co-operative efforts between the relevant local bodies.

4 METHODS

4.1 TECHNIQUE

It is an expensive and difficult procedure to identify and count pathogens in water. Instead, the Council uses an indicator bacteria called *Escherichia coli*, which is much easier to measure. *E. coli* are the faecal pollution indicator recommended in the MfE guidelines, as scientific studies have shown that when we find *E. coli* in a river, we can safely assume that there will be pathogens in the water as well (MfE, 2002).

4.2 SITES

The Northland Regional Council does not have the resources to monitor every swimming hole in Northland, nor would it be practical to do so. The Council reviews the number of sites used in the annual surveys at the beginning of each summer, chooses sites based on popularity, and/or because of a specific request from the public.

The locations of sites monitored in the 2003-04 freshwater recreational contact survey are shown overleaf as Figure 1 and in Table 5.Three new sites were added to the programme: Kapiro Stream at the Parerua Road bridge, the Mangakahia River just below the Tokiri marae (south of Titoki), and Omamari Beach Stream.

4.3 PROTOCOLS

The Northland Regional Council collected 10 samples per site over the course of the summer of 2003-04, with the exception of the Kapiro Stream site, which was not added to the programme until the middle of January. Sampling was conducted approximately once per week, (preferably on a Thursday morning) although no samples could be collected over the Christmas/New Years period.

For each visit, three replicate samples were taken on site, which were later mixed into one composite sample. This composite sample was analysed for E. coli and total coliforms using Colilert™. Temperature and dissolved oxygen were noted at each site using handheld YSI meters.

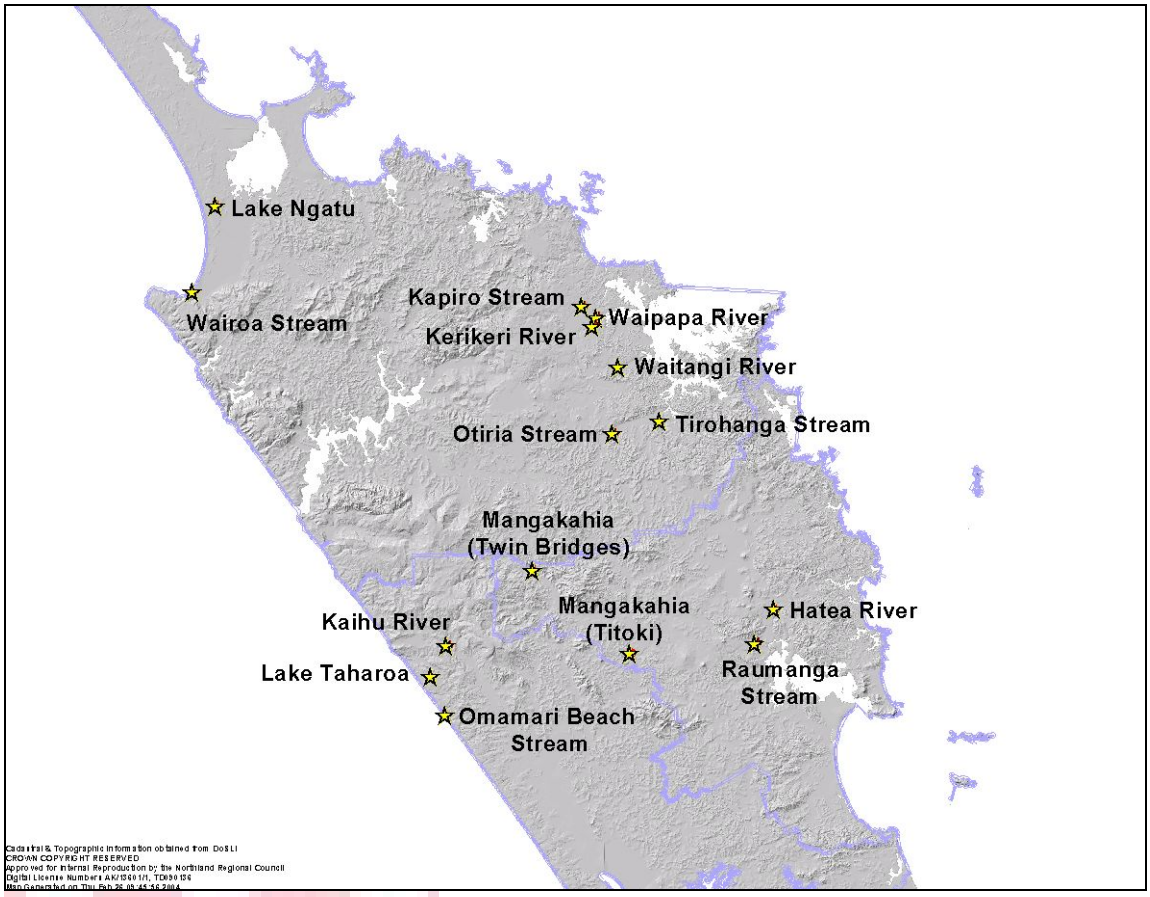

Figure 1 Sites sampled during the 2003-04 Freshwater Recreational Contact Survey

Table 5 Details of the sites used in the 2003-04 Survey

WATER BODY	LOCATION	DISTRICT
Lake Ngatu	DoC Reserve South End	Far North
Wairoa Stream	Ahipara Bridge	
Kapiro Stream	Parerua Swimming Hole	
Waipapa River	Waipapa Landing	
Kerikeri River	Kerikeri Basin	
Waitangi River	Lily pond Reserve	
Tirohanga Stream	Tirohanga Road	
Otiria Stream	Otiria Falls	
Mangakahia River	Twin Bridges Reserve Tokiri Reserve	Whangarei
Waitaua Stream	Whangarei Falls	
Raumanga Stream	Raumanga Valley Reserve	
Kaihu River	Motor Camp	
Lake Taharoa	Promenade Point Camp Ground	Kaipara
Omamari Beach Stream	Omamari	

5 RESULTS & INTERPRETATIONS

5.1 LAKE NGATU

SIC: LOW **MAC: C** **SFRG: FAIR**

Lake Ngatu lies within the Aupouri peninsula, north of Kaitaia. With no permanent streams flowing into or out of Lake Ngatu, rainfall is the predominant input. Seepage and evaporation are the major outputs. There are few potential sources of *E. coli* to the lake, although with heavy use over summer, the occasional contamination event has occurred.

Table 6 Collated results for Lake Ngatu

	2003-04 SURVEY	ALL SURVEYS
Median	< 10 *E. coli* per 100 mL	10 *E. coli* per 100 mL
95th Percentile	216 *E. coli* per 100 mL	359 *E. coli* per 100 mL
Alert Compliance	95 %	94 %
Action Compliance	100 %	98 %

As is obvious from Table 6 (above), and Figure 2 (below), the bacteriological water quality of Lake Ngatu was excellent for the bulk of the sampling period. There were two 'spikes', one in December, and another at the beginning of February.

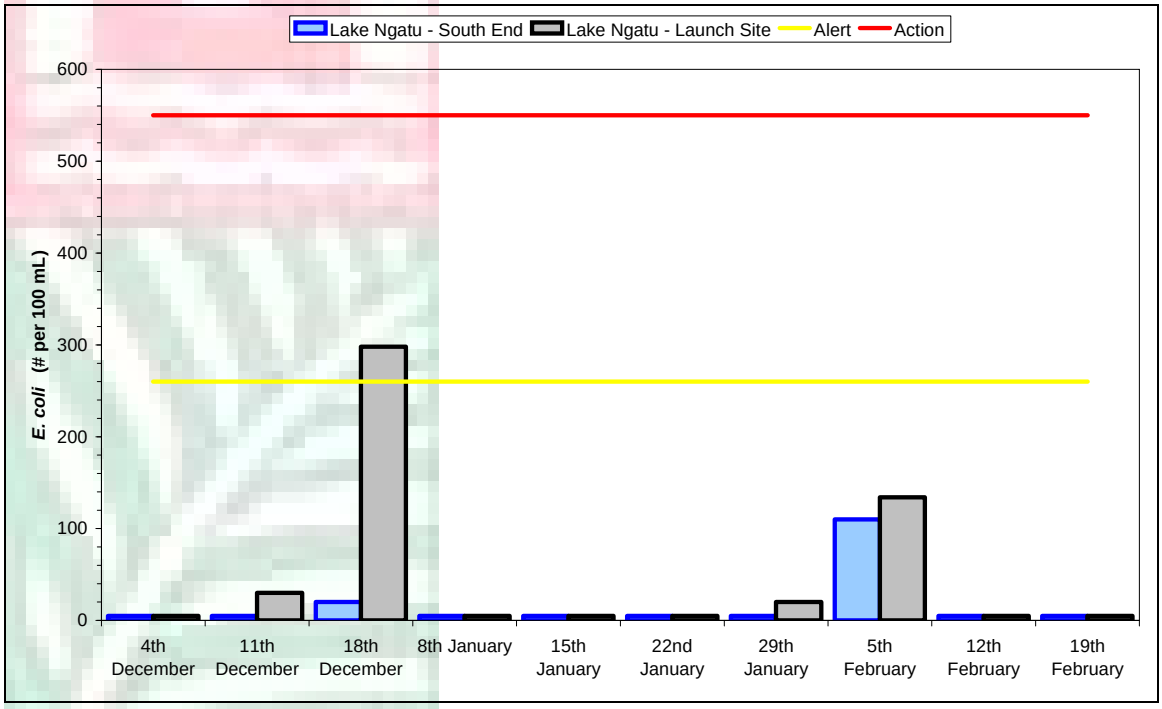

Figure 2 Results from the 2003-04 freshwater recreational contact study for Lake Ngatu

After a comparison between *E. coli* results and rainfall data (Figure 3), it appears that likely source of the elevated *E. coli* levels detected at the beginning of February is probably surface run-off. Identifying the cause of the spike in December is not so clear-cut, given that there had been no rain for over a week and a half, and there is no record of any people or boats using the lake at the time of sampling. Discharge from a septic tank is a possibility, but any such link is only conjectural.

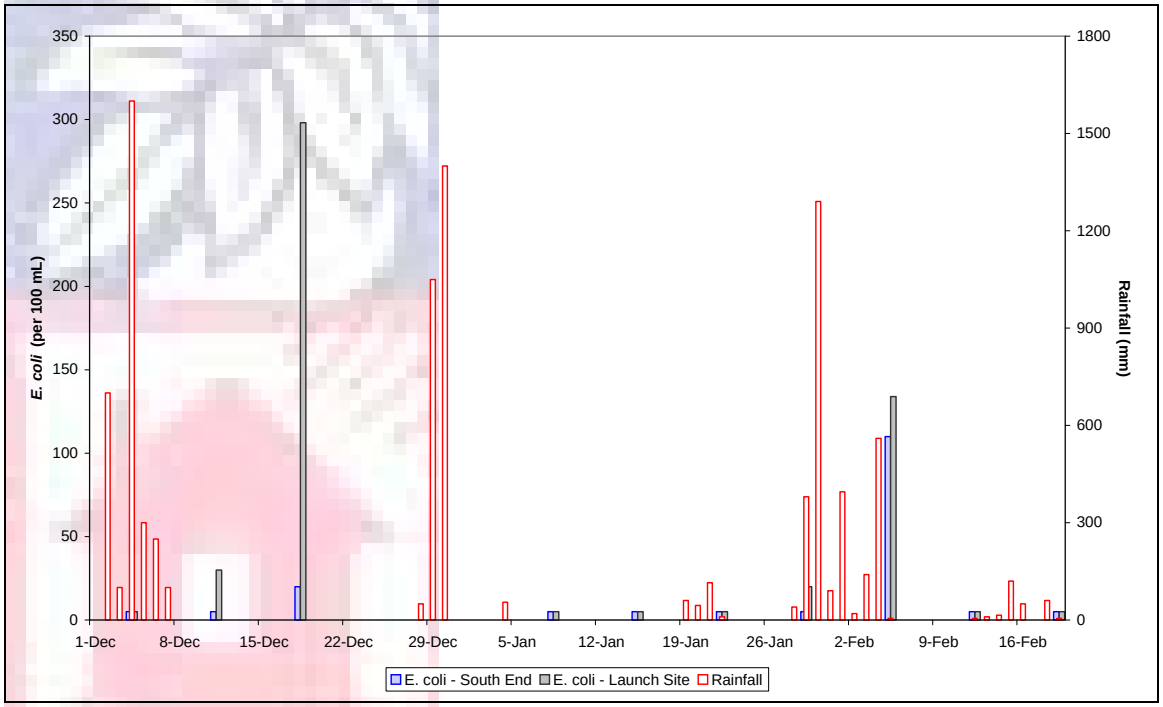

Figure 3 Rainfall and *E. coli* at Lake Ngatu over the summer of 2003-04

The Regional Council has collected 69 samples from Lake Ngatu over the last five years, so the SFRG grade is only an interim one. The trend appears to be toward a level of alert compliance about 95 %, it is expected that the SFRG grade will rise from "fair" to "good" as the data set increases. There has only been one sample collected since the end of 1999 that exceeded the action threshold, and overall the lake was generally safe for contact recreation during the course of the 2003-04 summer.

5.2 WAIROA STREAM

SIC: HIGH **MAC: INSUFFICIENT DATA** **SFRG: N/A**

Wairoa Stream is located just east of the Ahipara Township at the southern end of Ninety-Mile Beach. Intensive agriculture in the catchment means that the Wairoa Stream's water quality is historically poor; nonetheless, many people continue to swim at the site.

Table 7 Collated results for the Wairoa Stream

	2003-04 SURVEY	ALL SURVEYS
Median	512 *E. coli* per 100 mL	544 *E. coli* per 100 mL
95th Percentile	1353 *E. coli* per 100 mL	1785 *E. coli* per 100 mL
Alert Compliance	9 %	23 %
Action Compliance	55 %	50 %

The results presented as Figure 4 show that the Wairoa Stream's water quality over the summer was generally poor. As summarised in Table 7, the median, 95th percentiles and action compliance during 2003-04 were slightly above average. However, alert compliance was a surprisingly low nine percent, significantly lower than what might be expected.

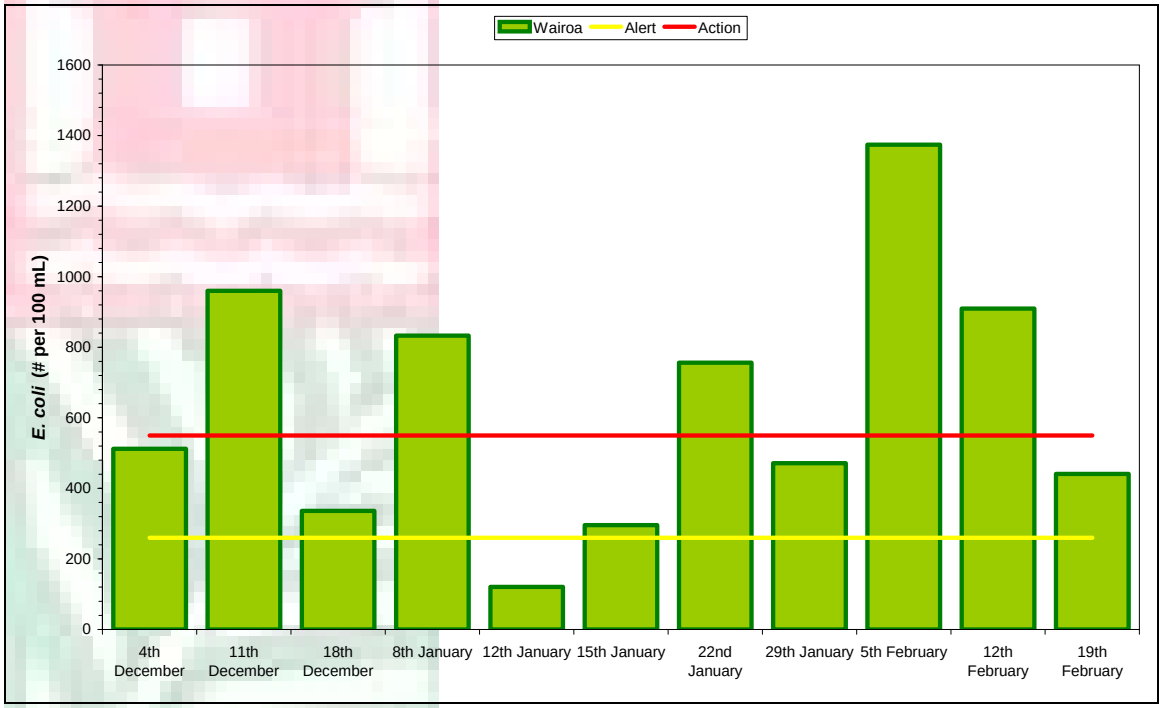

Figure 4 Results from the 2003-04 survey. Data from January 12th courtesy of FNDC

Figure 5 shows rainfall and *E. coli* over the 2003-04 summer. There is a case for rainfall being the trigger of high *E. coli* populations in the Wairoa Stream as most of the "spikes" occur after rainfall sometime in the previous week, although there is one exception (on the 15th of January). The levels of *E. coli* detected in the weeks following the major rain event in February suggest that the Wairoa Stream appears to be slow to recover from rain events.

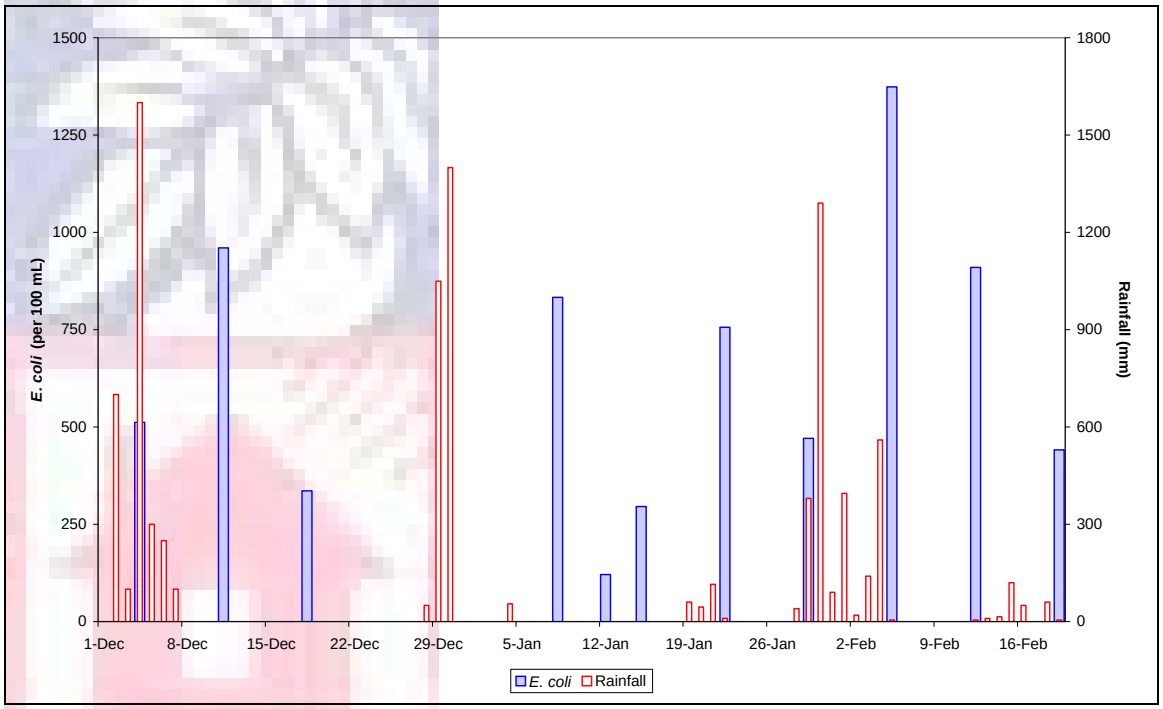

Figure 5 *E. coli* and rainfall in the Wairoa Stream from December 2003 to February 2004

A MAC for the Wairoa Stream cannot be determined until the end of summer, as data for the site only stretches back to the summer of 2000-01. With a running median above 500 *E. coli* per 100 mL, and an historic alert compliance well below 50 % (23 %), it is likely that the eventual SFRG will not be favourable.

Given its poor record, the Wairoa Stream has been the subject of several sanitary surveys in the past, especially because the historical quality of the stream's water has been poor even during dry periods, meaning run-off is not always the principle cause. Ahipara is on a reticulated sewage system, and occasional faults with the system may be responsible for the occasional contamination event as well.

Investigations by the Far North District Council appear to have isolated the source(s) of the continual pollution (Andrew Prangley, FNDC, pers. comm.). Once those sources have been "cleaned-up", future surveys should observe a marked improvement.

5.3 TIROHANGA STREAM

SIC: MODERATE **MAC: INSUFFICIENT DATA** **SFRG: N/A**

The Tirohanga Stream is located east of the Kawakawa Township, and drains into the Bay of Islands. The sampling site is located 50 m downstream of the Far North District Council's water take for Kawakawa. Recreational users are a common sight at the sample area.

Table 8 Collated results for the Tirohanga Stream

	2003-04 SURVEY	ALL SURVEYS
Median	190 *E. coli* per 100 mL	290 *E. coli* per 100 mL
95th Percentile	832 *E. coli* per 100 mL	2264 *E. coli* per 100 mL
Alert Compliance	58 %	63 %
Action Compliance	83 %	81 %

The bacteriological quality of the water in the Tirohanga Stream was generally up to standard until the end of January (as presented in Figure 6), after which time the number of *E. coli* grew to levels generally unacceptable for recreational use (in terms of health risks). Compared to the complete set of data for the Tirohanga Stream, the median and 95th percentile were significantly lower than average, while compliance rates remained similar to previous years.

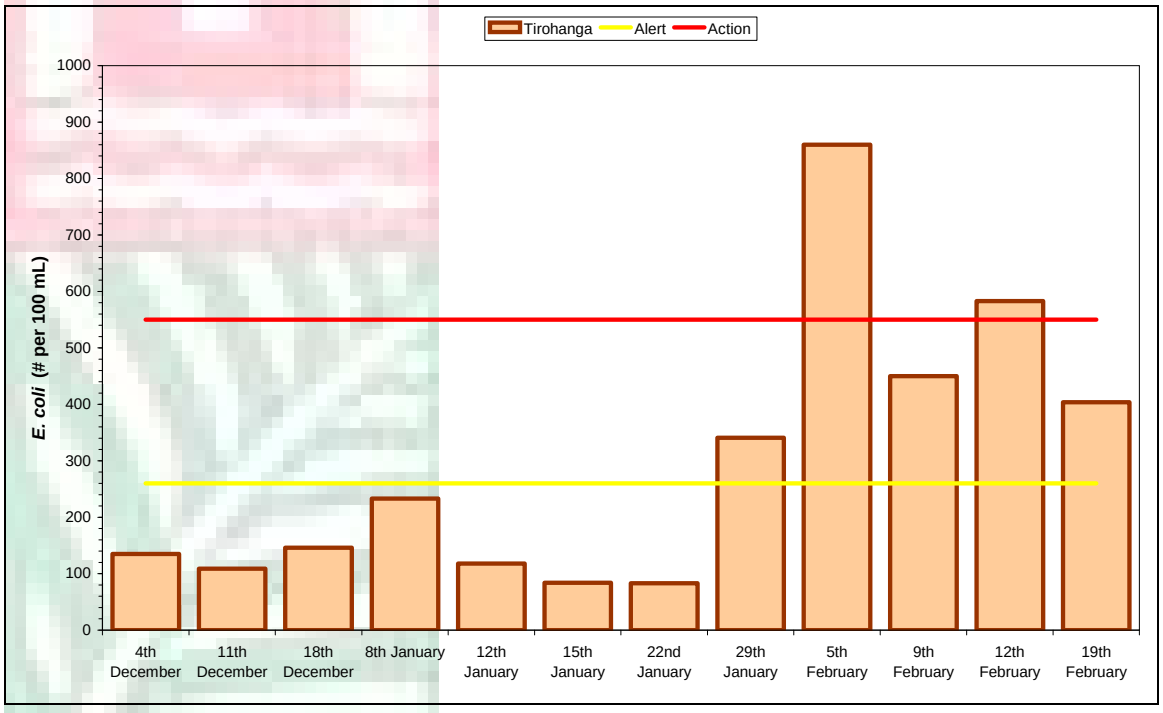

Figure 6 Results for the Tirohanga Stream, data from the 12th of January and the 9th of February supplied courtesy of the FNDC

Moderately intensive beef and dairy farming are the dominant land-uses in the upstream catchment, but it is unlikely that runoff from those farms is the sole source of faecal contamination into the Tirohanga. As shown in Figure 7, there was only one major rain event over the course of the survey (at the beginning of February), but sampling showed elevated populations during dry periods as well (such as on the 8th or 29th of January).

Septic tanks may also be an influencing factor. Poorly maintained tanks could provided small amounts of contamination during dry periods, and a greater part in wetter conditions when soils are wet and seepage is much more significant.

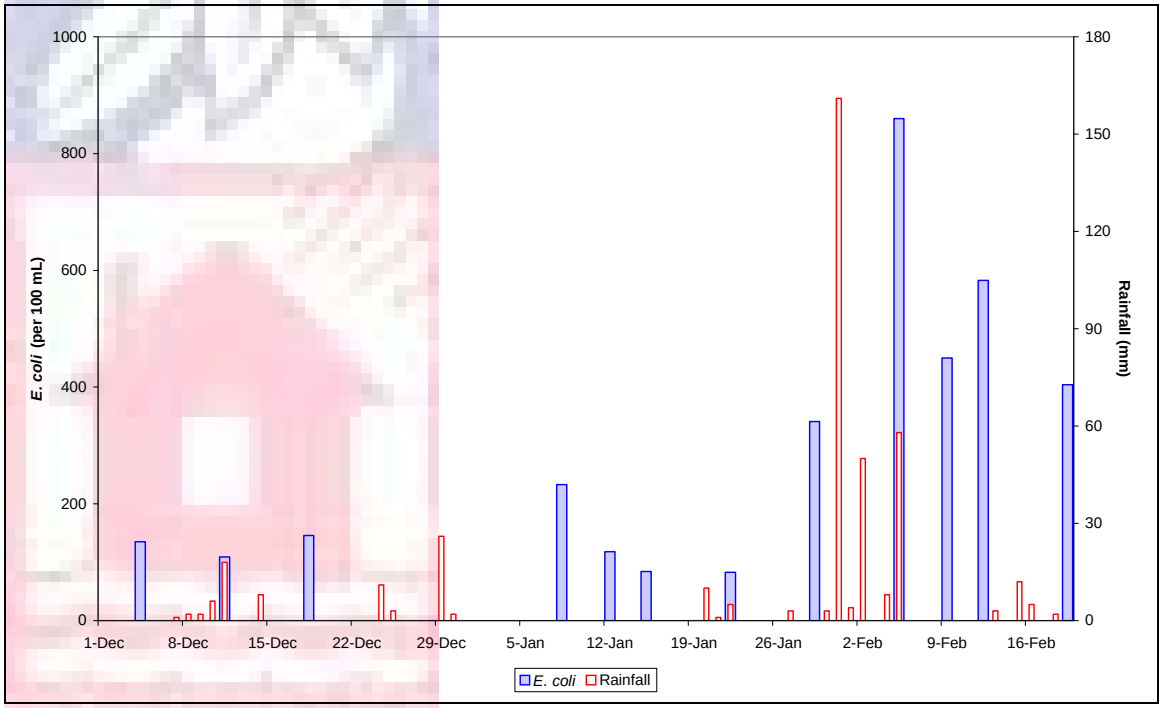

Figure 7 *E. coli* and rainfall data from the Tirohanga Stream during the 2003-04 survey

The Tirohanga Stream, stream appeared to be suitable for swimming for the bulk of the sampling period, but the persistence of high *E. coli* counts from the end of January onwards is a genuine cause for concern. It is unclear whether the persistence of *E. coli* after heavy rainfall (such as that witnessed in February) is a common occurrence, or whether the phenomenon observed over the 2003-04 summer was an isolated event.

The data set for the Tirohanga Stream compromises results from surveys beginning in 2000. The determination of a MAC (and therefore the SFRG) will therefore be delayed until the completion of surveying next summer ('04/'05), in order that at least one of the two minimum criteria for grading is met (Complete sets require 100 data points collected over 5 summers).

5.4 WAITANGI RIVER

SIC: HIGH **MAC: D** **SFRG: VERY POOR**

The Waitangi River flows from the middle of Northland (just to the east of Lake Omapere) through into the Bay of Islands, just north of Paihia. The sampling site is located in the middle reaches of the river catchment and at a popular swimming hole, situated immediately below a waterfall. Upstream agricultural land use and increasing lifestyle block developments significantly impact upon this stony bottomed and fast flowing river.

Table 9 Collated results for the Waitangi River

	2003-04 SURVEY	ALL SURVEYS
Median	207 *E. coli* per 100 mL	157 *E. coli* per 100 mL
95th Percentile	2701 *E. coli* per 100 mL	2670 *E. coli* per 100 mL
Alert Compliance	58 %	65 %
Action Compliance	83 %	78 %

The quality of the Waitangi River was generally worse this season than in past ones with a higher median count and a lower alert compliance (Table 9). However, the frequency of events that made the river very unsafe was lower than in recent years, with only two samples greater than 550 *E. coli* per 100mL (shown on Figure 8).

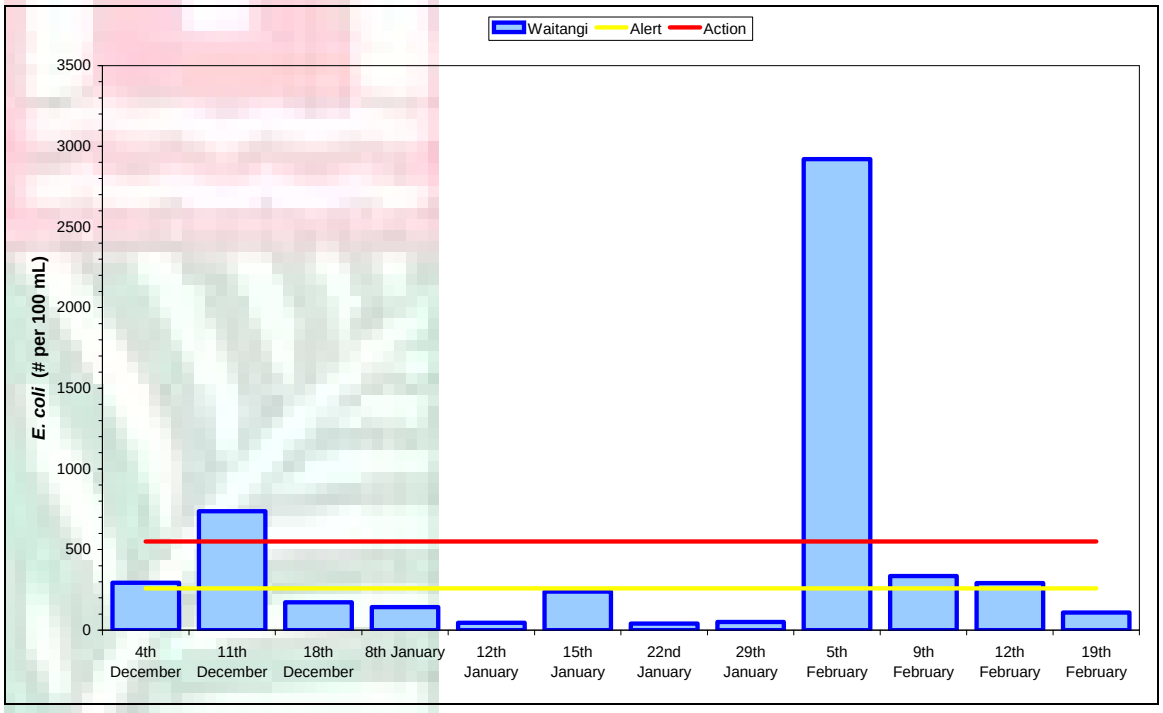

Figure 8 Results from the 2003-04 survey for the Waitangi River. Data from the 12th of January and the 9th of February supplied courtesy of the FNDC

Sustained rainfall appears to be the dominant control of significant *E. coli* population spikes, as both breaches of the 550 *E. coli* per 100 mL action threshold occurred immediately after consecutive days of rain (Figure 9). Rainfall cannot be the only factor influencing *E. coli* populations in the river though, as populations appear to fluctuate even during dry periods (such as that observed during early to mid-January).

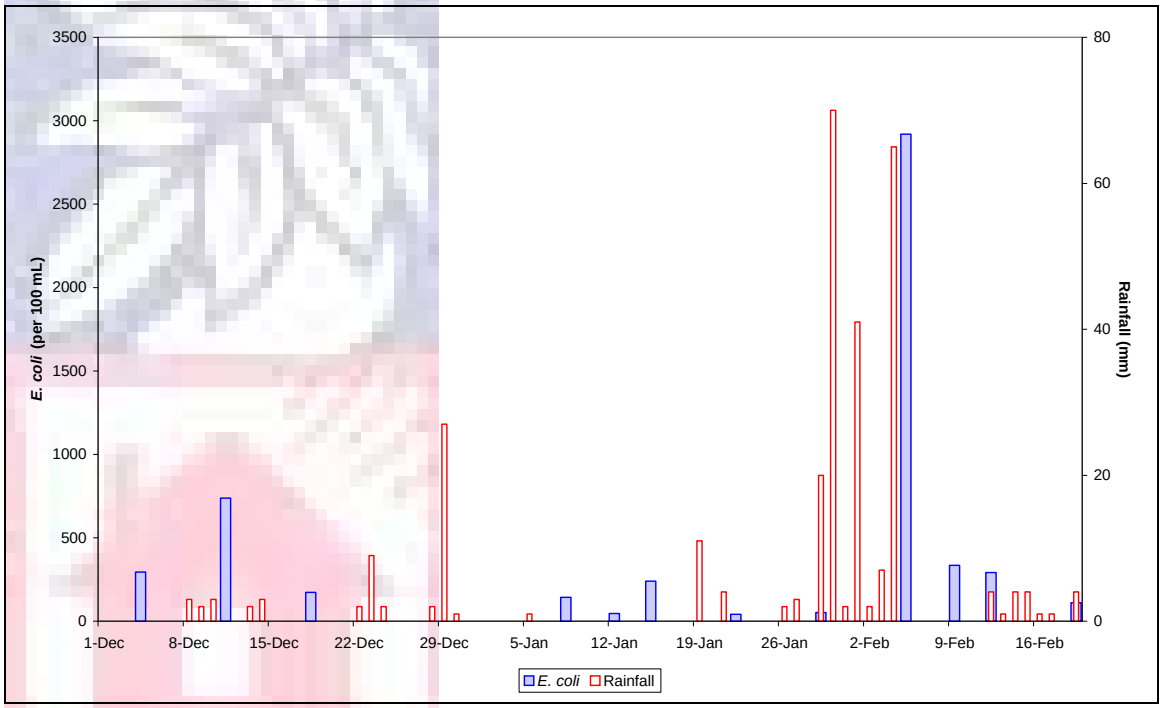

Figure 9 Rainfall and *E. coli* in the Waitangi River over the 2003-04 survey

The Council used forty samples, collected over five summers, to develop the interim SFRG for the Waitangi River. A grading of "very poor" is unfair, given a relatively low historic median (157 *E. coli* per 100 mL) and an historic alert compliance at about 65 %. Only two serious breaches of the 550 "action" threshold occurred over the 2003-04 summer, both probably caused by rainfall in the preceding days. With this in mind, a grading of "fair" is probably more accurate.

5.5 KERIKERI RIVER

SIC: HIGH **MAC: INSUFFICIENT DATA** **SFRG: N/A**

The Kerikeri basin lies at the base of the Kerikeri River, a river that drains from an intensive horticultural and agricultural catchment through a predominantly urban area. Some parts of the Kerikeri Township remain on septic tanks, and these along with agricultural run-off are the chief sources of pathogenic bacteria into the basin. Stormwater discharges and sewage reticulation system failures may also have a significant influence.

Table 10 Collated Results for the Kerikeri River

	2003-04 SURVEY	ALL SURVEYS
Median	145 *E. coli* per 100 mL	285 *E. coli* per 100 mL
95th Percentile	8357 *E. coli* per 100 mL	10789 *E. coli* per 100 mL
Alert Compliance	67 %	40 %
Action Compliance	83 %	64 %

Bacteriological counts for the Kerikeri River were much lower over the 2003-04 summer than average (Table 10). However, the NDC has only been sampling the Kerikeri River as part of the project since the 2001-02 summer and therefore the dataset is still quite small (25 samples all up). As shown in Figure 10, there were only two breaches of the action limit, one in early January, and the other at the beginning of February.

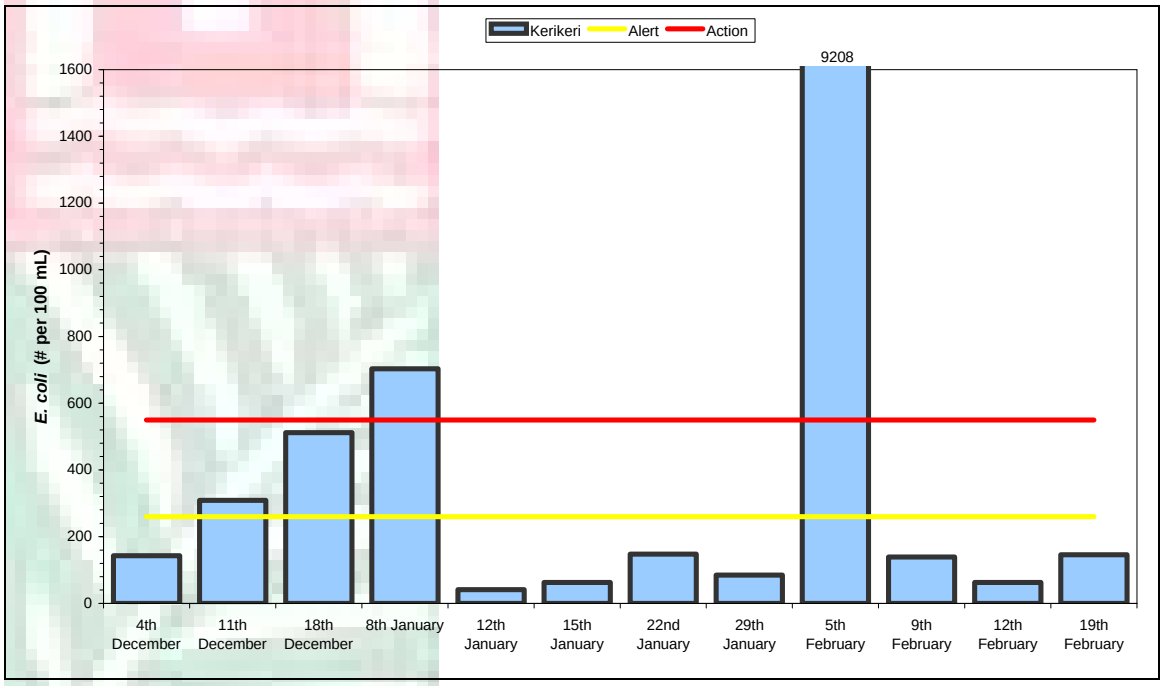

Figure 10 2003-04 results for the Kerikeri River. Data from the 15th of January and the 12th of February provided courtesy of the FNDC

The heavy rainfall at the beginning of February aside, as shown in Figure 11, there is no obvious correlation between rainfall and *E. coli* in the Kerikeri River, at least at the river basin. Heavy rainfall is the most likely principle cause of the extremely high levels observed on the 5th of February, but lesser rainfall evens, such as that which occurred throughout the middle of December appeared to have little effect. Indeed, both run-off and stormwater cannot have contributed to the first breach of the action threshold, as the spike occurred during an extended dry period (late December-early January).

Intermittently leaking or overflowing septic tanks are a possible explanation for high *E. coli* during drier periods, although blockages and other problems associated with reticulated sewage systems are more likely. Another possibility is birds fouling the waterways. Large numbers of ducks are often observed in the Kerikeri Basin, and it is possible that their excrement is an uncontrollable source of pathogens into the water. However, when samples were taken from both upstream and downstream of a group of ducks, there were no significant differences in *E. coli* populations.

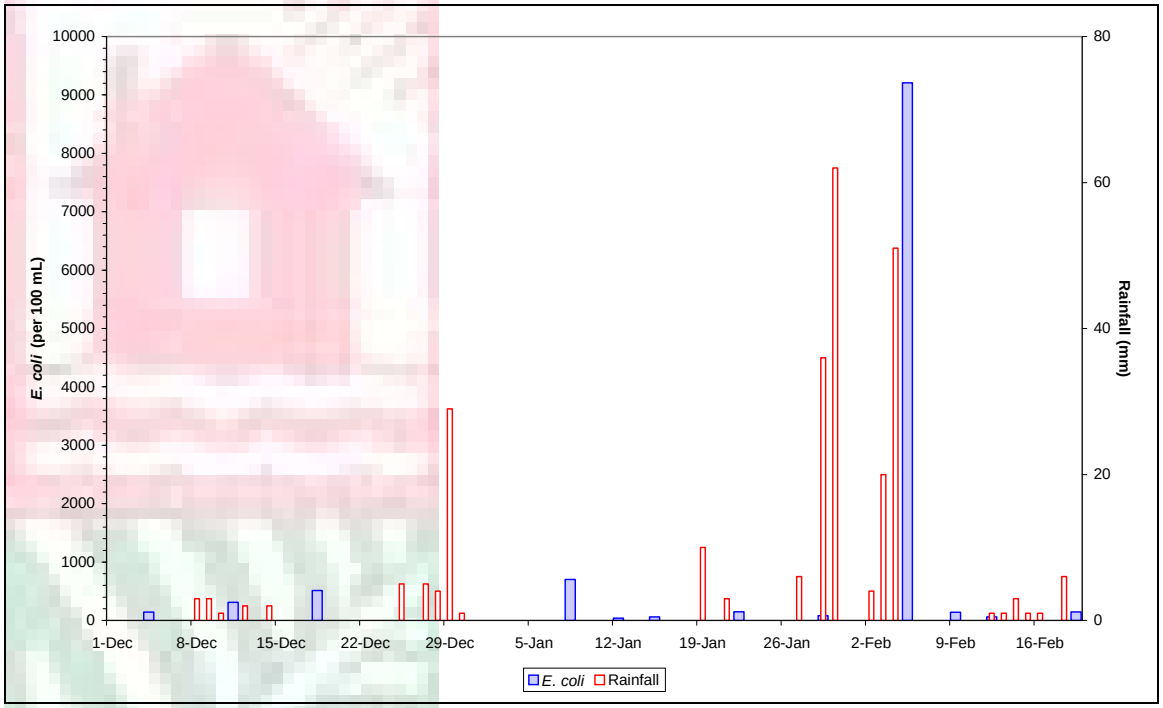

Figure 11 *E. coli* and rainfall for the Kerikeri River over the summer of 2003-04

As previously mentioned, the data set for the Kerikeri River is rather limited, particularly because the river has only been sampled over the last three years. Therefore, even an interim grading is premature. The Kerikeri River over the '03-'04 season had quite a low median, and an action compliance above 80 %, suggesting that the river is one of the more suitable for contact recreation in Northland, but further data is required before any definite conclusions can be made.

5.6 KAPIRO STREAM

SIC: MODERATE **MAC: INSUFFICIENT DATA** **SFRG: N/A**

Kapiro Stream drains north of Kerikeri into the Bay of Islands through a predominantly agricultural and horticultural catchment. Local children frequently use the swimming hole at the Pararua Road Bridge in particular during the summer, and the site was added to the programme after public request was made to Northland Health in the middle of January 2004. There is no historical bacteriological data for this site.

Table 11 Collated results for the Kapiro Stream

	2003-04 SURVEY
Median	211 *E. coli* per 100 mL
95th Percentile	Insufficient data
Alert Compliance	50 %
Action Compliance	83 %

With only six samples collected, and no historic data, it is premature to read anything into the results of the 2003-04 survey (Results presented as Table 11). Samples exceeded the action guidelines once, at the beginning of February, and two samples contained *E. coli* above the alert (260 *E. coli* per 100 mL) threshold (Figure 12). 95th percentiles using the hazen method require at least 10 data points, and therefore could not be calculated for the Kapiro Stream.

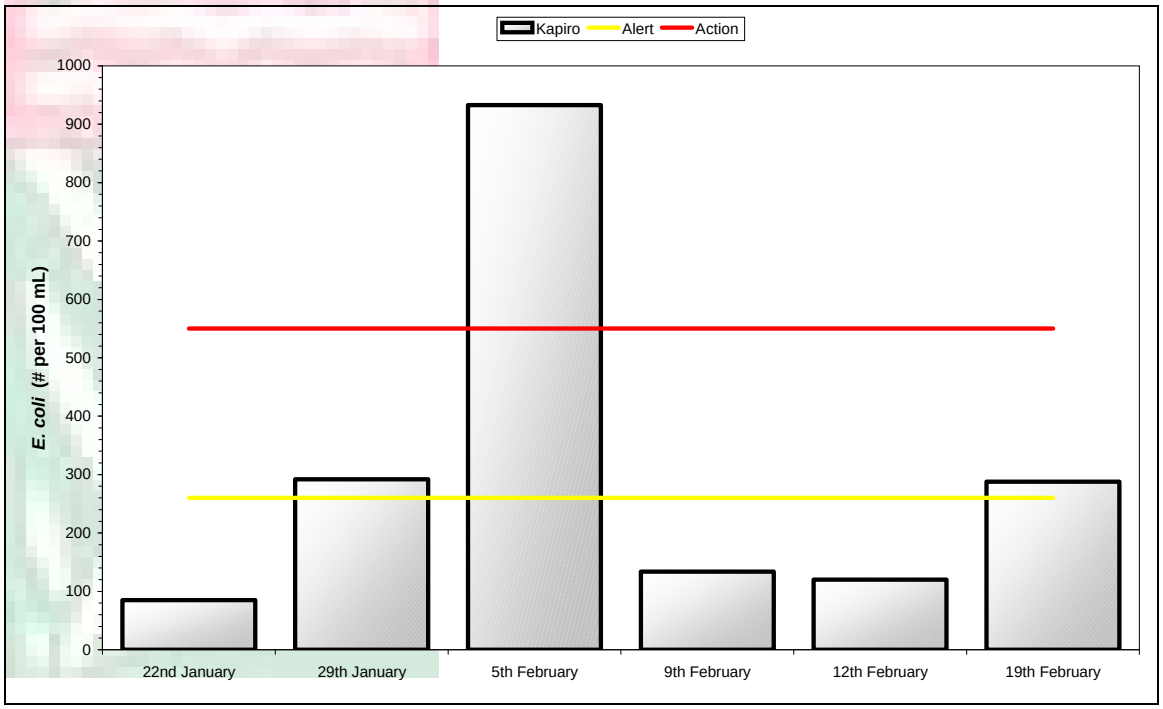

Figure 12 Results for the Kapiro Stream over the 2003-04 summer. Sample data from the 9th of February courtesy of the FNDC

The correlation between rainfall and *E. coli* populations is not particularly clear-cut (Figure 13). The elevated levels on the 29th of January and the 5th of February are probably linked to rainfall; very little rain fell immediately preceding the 19th of February (at which time *E. coli* were above the 260 alert threshold). While the possibility exists that as little rainfall as 5 to 6 mm causes *E. coli* spikes in the Kapiro Stream, there is inadequate data to test, let alone confirm any hypotheses at this site.

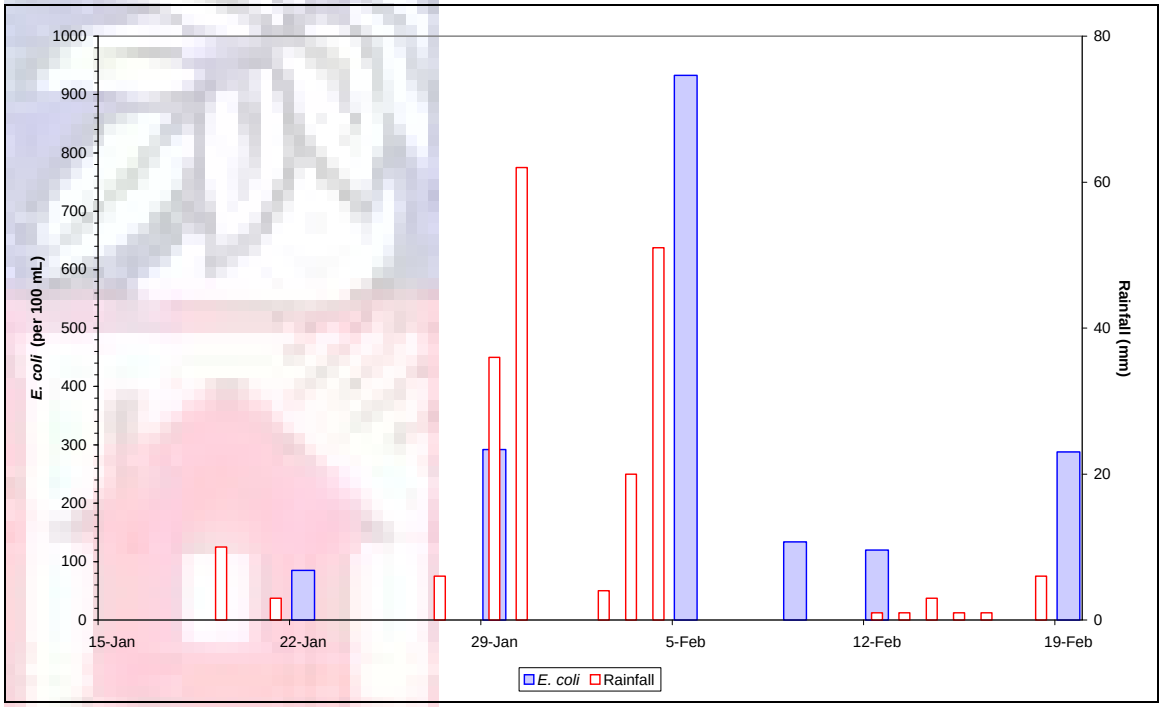

Figure 13 Rainfall and *E. coli* data for Kapiro Stream

As has been mentioned *ad nauseum*, the data set for the Kapiro Stream is severely limited and therefore, no MAC or SFRG will be assigned to the site. It is recommended that the Kapiro Stream be monitored as part of future surveys, at least until any direct link between rainfall greater than 5 mm and *E. coli* population spikes can be tested.

5.7 OTIRIA STREAM

SIC: VERY HIGH **MAC: D** **SFRG: VERY POOR**

The Otiria Waterfall is a popular swimming hole for the people of Moerewa, but the water quality at the site has been particularly poor. The Far North District Council has done some preliminary work in the area, and agricultural effluent appears to be a major contributor (Andrew Prangley, pers. comm.). A combination of this intensive upstream agriculture, along with the high likelihood of leaking septic tanks have made the Otiria Stream unfit for swimming all year round, regardless of weather conditions or water clarity.

In light of the findings, local authorities have erected permanent sign at the falls warning people of the elevated health risk. Northland Health and local community groups continue to work on improving the stream's health.

Table 12 Collated results for the Otiria Stream

	2003-04 SURVEY	ALL SURVEYS
Median	1017 *E. coli* per 100 mL	900 *E. coli* per 100 mL
95th Percentile	2436 *E. coli* per 100 mL	6041 *E. coli* per 100 mL
Alert Compliance	0 %	5 %
Action Compliance	0 %	20 %

Water quality at the Otiria Falls site was extremely poor over the entire summer (Figure 14). All collected samples exceeded the action threshold, suggesting that water quality at the site has deteriorated compared to historical records (Table 12).

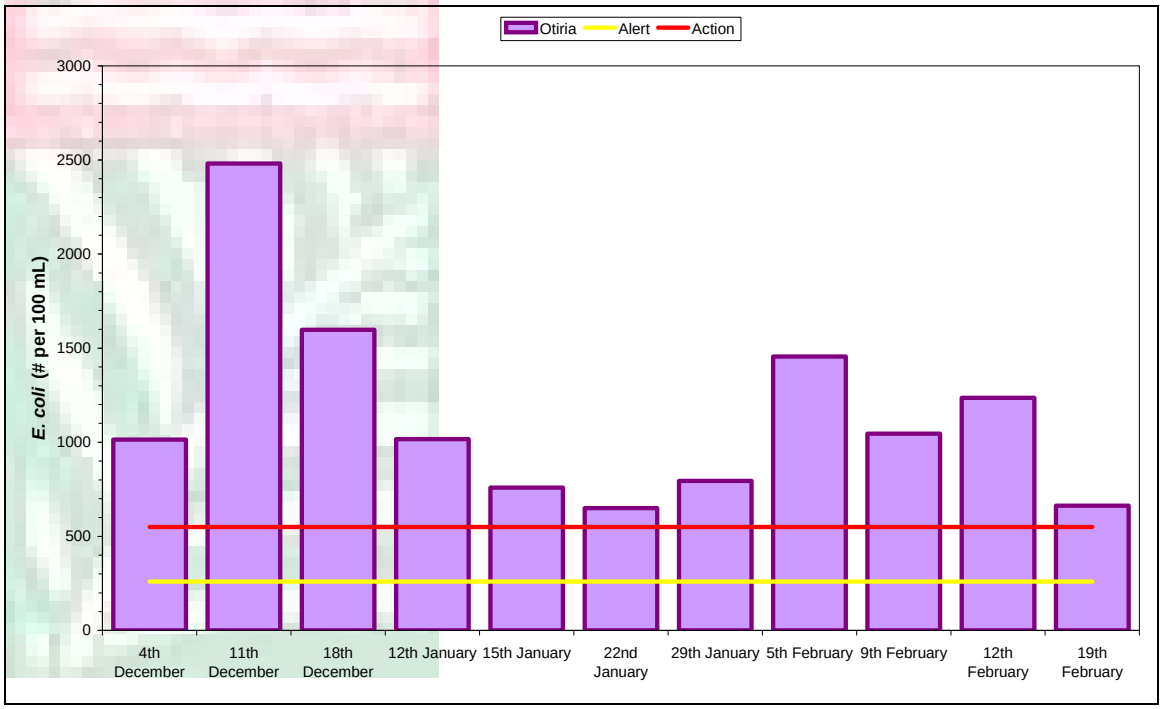

Figure 14 Results for the Otiria Stream over the 2003-04 summer. Sample data from the 9th of February courtesy of the FNDC

The most disturbing aspect of a comparison between rainfall and E. coli information for the Otiria Falls swimming hole is that rain appears to have no

effect upon the situation (Figure 15). Some of the higher E. coli peaks occur in dry periods, but there is also no obvious inverse relationship either[3], because over the episode of heavy rain between the 29th of January and the 5th of February the *E. coli* population increased, and the greatest spike (11th of December) occurred after several days of rain.

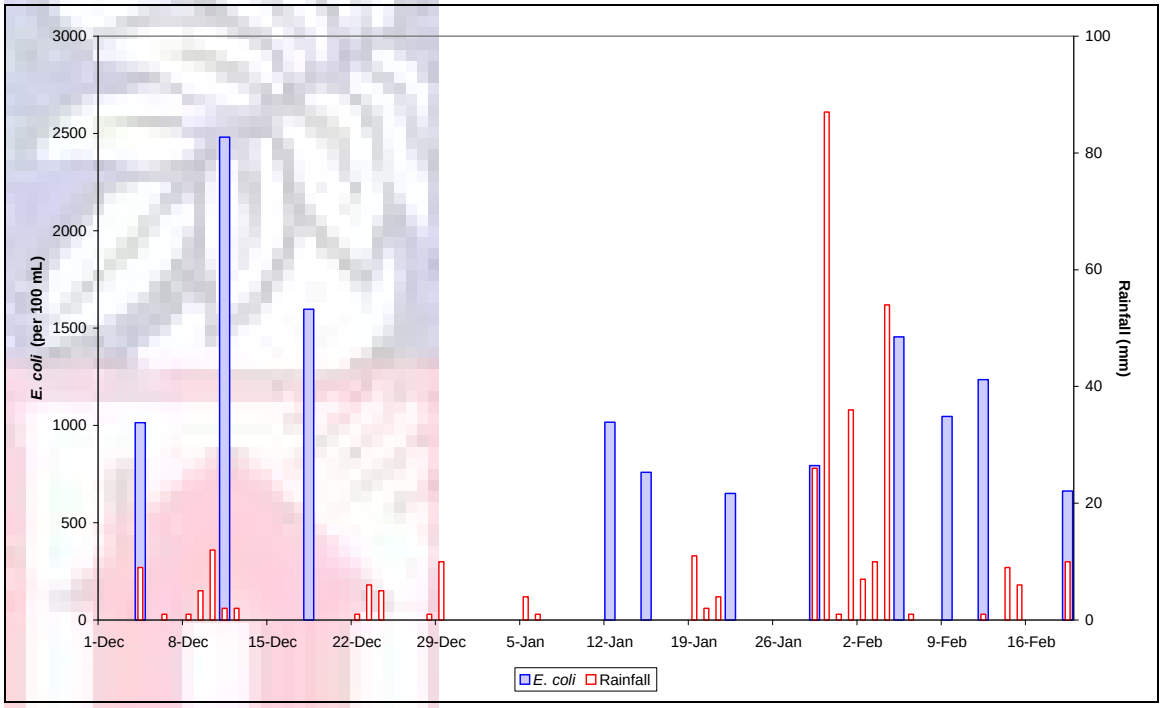

Figure 15 Rainfall and *E. coli* data for Otiria Stream over the 2003-04 summer

The interim grading of "very poor" is acceptable for this site. While the interim grade is only built from 39 samples, there is little doubt that, unless the mitigating circumstances improve dramatically, any further sampling will simply serve to confirm the conclusions already presented in this report: Otiria Stream is in extremely poor health, and should not be used for contact recreation until further notice.

[3] Such an inverse relationship might have been expected if septic tank leakage was the only factor. In such a case, in periods of reduced rainfall, and therefore reduced flow, one would expect *E. coli* counts to be high, whereas during periods of high rainfall and flow the resultant dilution would lower *E. coli* counts.

5.8 WAIPAPA STREAM

SIC: MODERATE **MAC: D** **SFRG: POOR**

Lake Manuwai, one of the Kerikeri irrigation dams, is the major source of water into the Waipapa River. From the lake, the river winds through an agricultural and horticultural catchment. Historically, the Waipapa landing on the Waipapa Stream has been a popular site for water users and for picnickers.

Table 13 Collated results for the Waipapa Stream

	2003-04 SURVEY	ALL SURVEYS
Median	122 E. coli per 100 mL	130 E. coli per 100 mL
95th Percentile	1320 E. coli per 100 mL	1645 E. coli per 100 mL
Alert Compliance	82 %	72 %
Action Compliance	91 %	86 %

While, for the most part the Waipapa Stream was suitable for freshwater contact over the 2003-04 summer (Table 13), a significant spike occurred on the 5th of February, during which time there were about ten times more E. coli in the water than usual (Figure 16). The spike notwithstanding, water quality at the Landing was better than average.

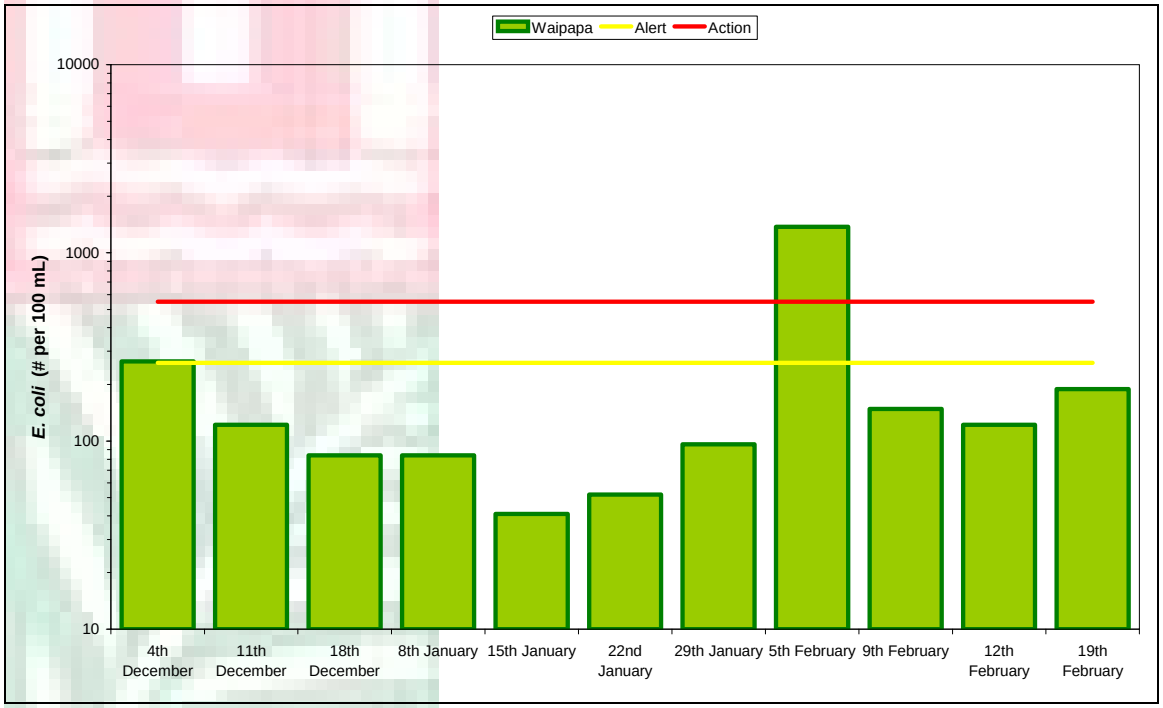

Figure 16 Results for the Waipapa Stream over the 2003-04 summer. Sample data from the 9th of February courtesy of the FNDC

It is likely that heavy rainfall caused the large spike observed on the 5th of February (Figure 17). The sample from the 9th of February showed that the recovery time for the Waipapa Stream is relatively short, as levels fell below even the 260 E. coli per 100 mL alert threshold within 4 days.

The sightly elevated levels of E. coli at the beginning of the summer is not so easy to explain, but a one off point source, such as excrement from transient birds, stock or perhaps people could be a possible explanation for the early spike.

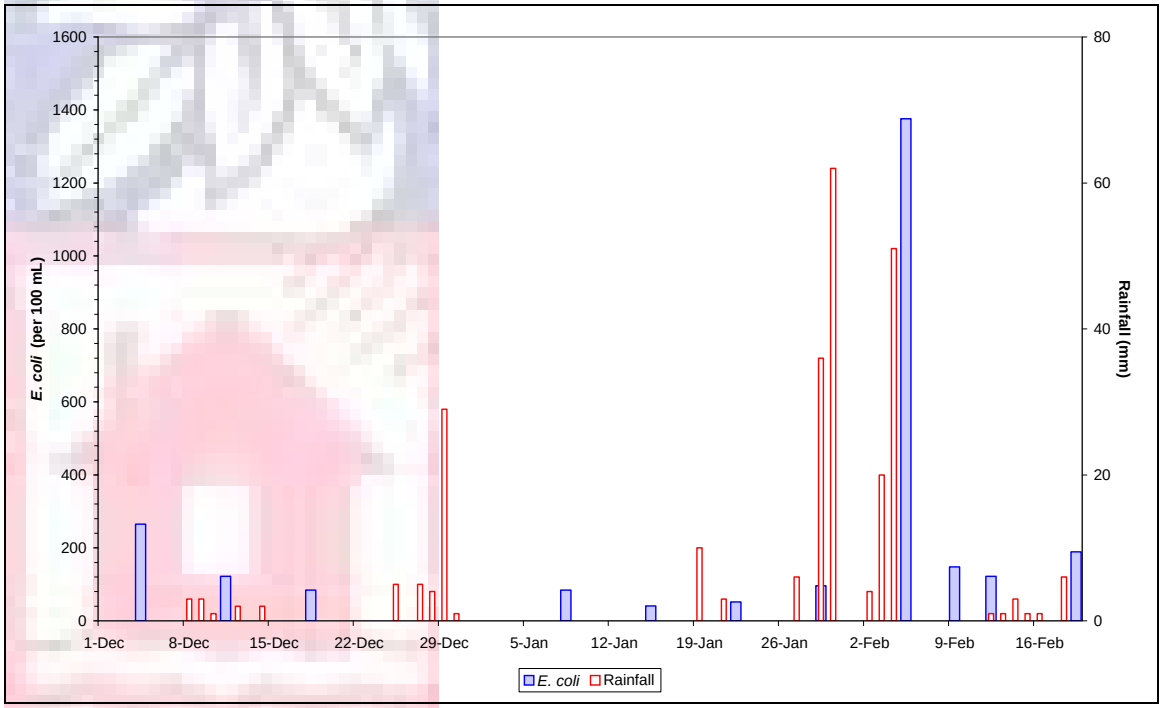

Figure 17 Rainfall and *E. coli* data for the Waipapa Stream

An interim SFRG of "poor" is not an accurate reflection of the state of the Waipapa Stream (grading based on 36 samples over five summers). Spikes after heavy rainfall have created a D MAC, but for the bulk of the summer the stream's water quality is good. A grading of "fair" or "good" would be a true reflection of the situation at the Landing, and therefore it is recommended that any public description of the site should explain this particular discrepancy. Such a site is a good example of where the MfE guidelines are perhaps too rigid, as any site that has significant rain more than 5 % of the time can potentially fail (an SFRG of poor or very poor), even if for the rest of the time water quality is very good.

5.9 WAITAUA STREAM

SIC: HIGH MAC: D SFRG: VERY POOR

Unlike most of the sites sampled in the survey, the Whangarei Falls site is largely unaffected by agriculture. While the upper catchment does contain some mixed beef farming, the catchment is for the most part a mix of lifestyle blocks and urban areas. The mostly urban lower catchment has the potential for bacterial contamination if septic tanks are not well maintained or if problems arise with the reticulated sewage system.

Historically, E. coli populations have been consistently elevated, high enough that a permanent warning sign has been erected. In spite of the warning sign, children are frequently observed swimming at the site during sampling, and it may be assumed that usage is heavy throughout summer.

Table 14 Collated data for the Waitaua Stream

	2003-04 SURVEY	ALL SURVEYS
Median	307 E. coli per 100 mL	320 E. coli per 100 mL
95th Percentile	5794 E. coli per 100 mL	5262 E. coli per 100 mL
Alert Compliance	50 %	40 %
Action Compliance	90 %	82 %

According to Table 14, the water quality of the Waitaua Stream at the Whangarei Falls was marginally better than average, with only one breach of the 550 *E. coli* per 100 mL action threshold. Overall, *E. coli* populations were higher in the Waitaua Stream than at most sites around Northland, with a median above the 260 *E. coli* per 100 mL alert guidelines. As shown in Figure 18, water quality at the site was variable throughout the summer, but generally worse after the spike on the 5th of February.

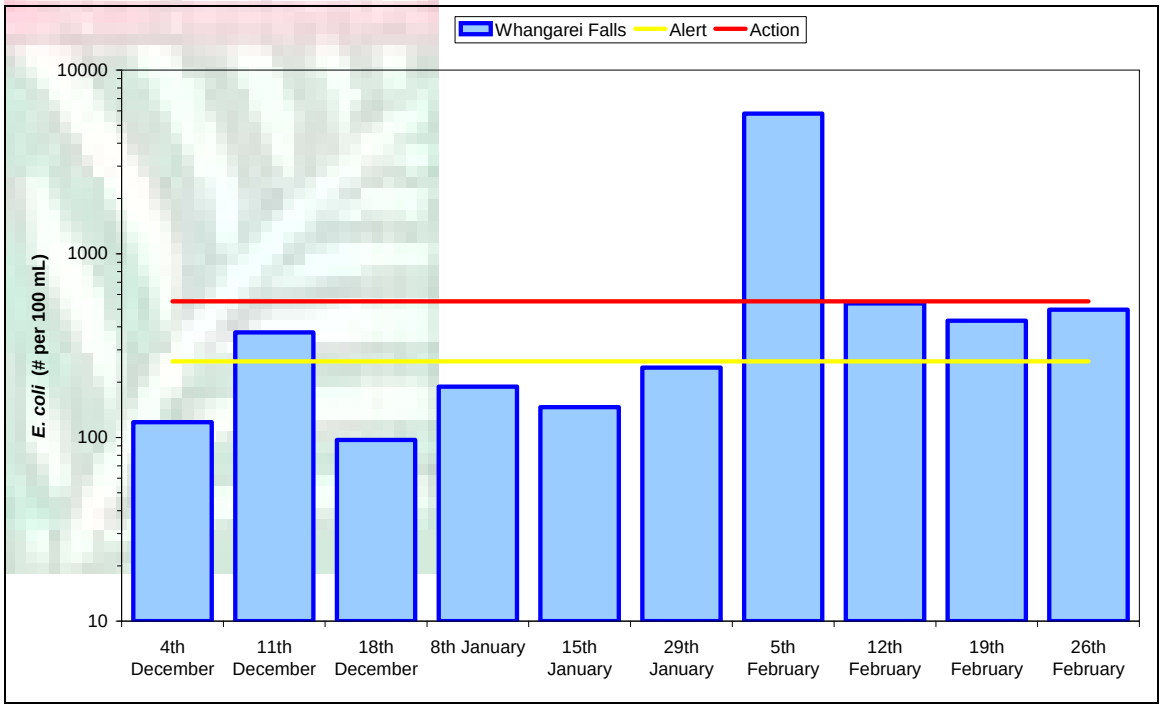

Figure 18 Results for the Whangarei Falls over the 2003-04 summer.

From Figure 19, it is obvious that rainfall is the likely trigger for the spike observed on the 5th of February. The week preceding was the only period of sustained heavy rainfall recorded over the summer, and may explain why the action threshold was only breached once, given the high median *E. coli* population at the site.

The breaches of the 260 E. coli per 100 mL (alert) threshold also appear to be rainfall driven. If rainfall occurred within two days of sampling, then E. coli at the site were elevated, and in all but one case would break the alert limits (the exception still elevated at 240 E. coli per 100 mL). Over drier periods, E. coli levels tended to be significantly lower. The strong links between rainfall and elevated levels suggest that the source(s) of contamination are a combination of stormwater discharges and agricultural run-off.

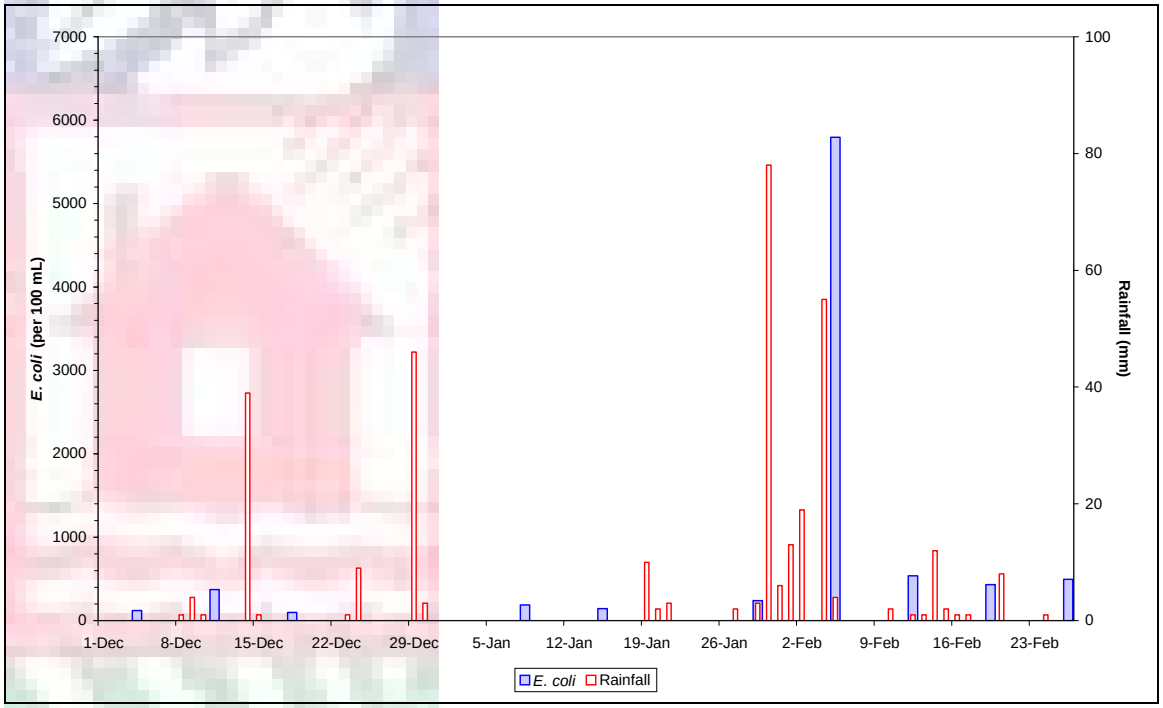

Figure 19 Rainfall and E. coli data for the Waitaua Stream over the 2003-04 summer

Although from a percentage compliance standpoint the Waitaua Stream is in relatively good shape when compared to other Northland swimming holes, an historic (and recent) median above 300 *E. coli* per 100 mL suggests that an SFRG grade of "Very Poor" is not overly extreme. A "poor" SFRG is probably the most accurate grading though, given that action thresholds are not regularly breached.

5.10 RAUMANGA STREAM

SIC: MODERATE MAC: D SFRG: POOR

The Raumanga Stream flows through a similar catchment to the Waitaua Stream. The land use is chiefly urban so any problems with reticulated sewage will impact upon the stream, while lifestyle blocks and low-intensity agriculture in the upper catchment also present possible sources of contamination.

The Raumanga Stream is sampled at a swimming hole in the Raumanga Valley Reserve, a particularly popular park over summer. Water quality is variable, reflected in low compliances historically. Nonetheless, the swimming hole is very popular, especially for children. Stormwater is the likely source of most of the bacteriological contamination into the river.

Table 15 Collated results for the Raumanga Stream

	2003-04 SURVEY	ALL SURVEYS
Median	252 *E. coli* per 100 mL	300 *E. coli* per 100 mL
95th Percentile	1357 *E. coli* per 100 mL	3383 *E. coli* per 100 mL
Alert Compliance	50 %	40 %
Action Compliance	70 %	72 %

Similar to the Waitaua Stream site, median E. coli values have been quite high at the Raumanga Stream site (Table 15). As shown in Figure 20, the action threshold was breached several times over the summer months, and exceeded the alert levels as often as they did not. The results from the 2003-04 summer were slightly better than average, but this may simply due to more samples being taken than in previous years.

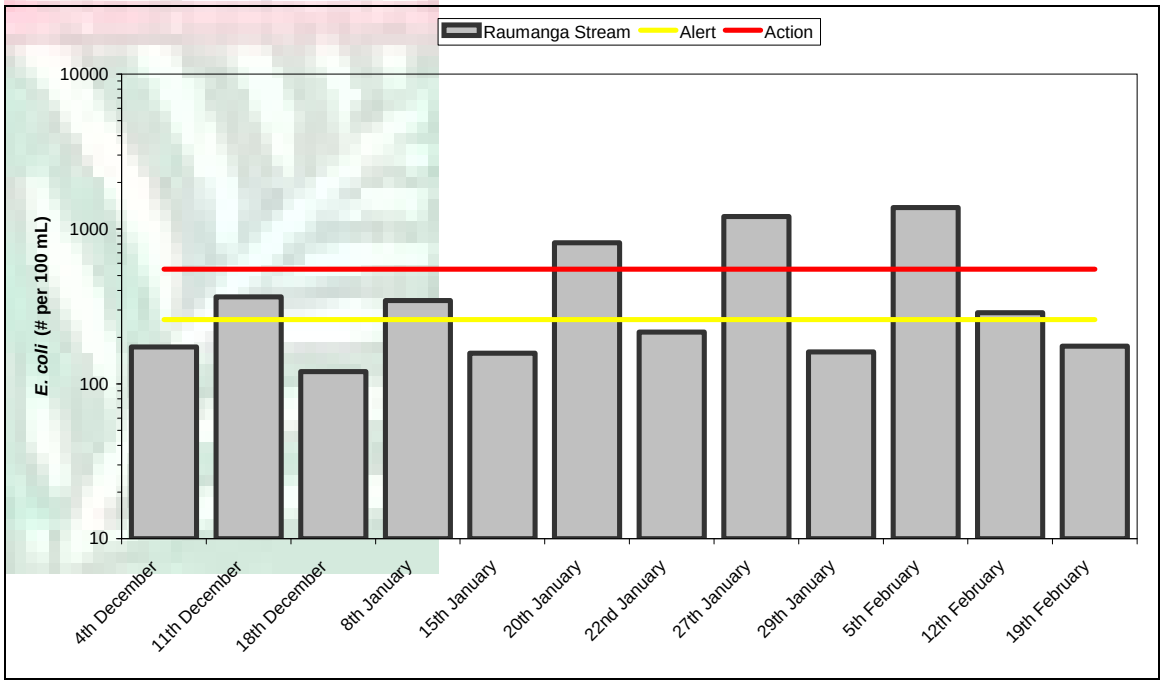

Figure 20 Results for the Raumanga Stream over the 2003-04 summer. Results from the 20th and 27th of January courtesy of the WDC

As Figure 21 shows, there is a likely correlation between rainfall and E. coli exceeding the action limits. Anything more than about 10mm in the preceding day appears to flush high numbers of E. coli into the Raumanga Stream, and the greater the rainfall, the greater the number of E. coli.

It appears that the Raumanga takes a couple of days to flush. Elevated E. coli results on the 8th of January for example, appears to have been caused by rain falling on the 5th, and similar circumstances could explain the levels observed on the 12th of February. An unexpected drop on the 19th of February may be due to the bulk of the E. coli having already been flushed through, as the most significant rainfall preceding it occurred on the 14th (five days earlier).

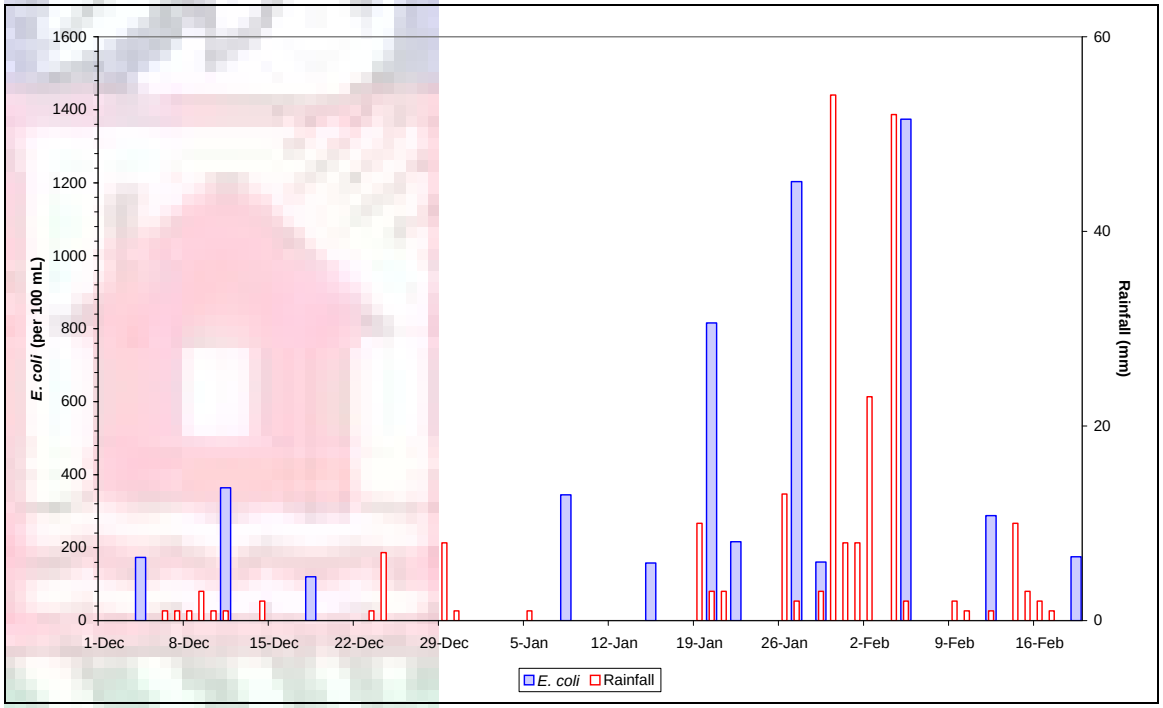

Figure 21 Rainfall and *E. coli* results for the Raumanga Stream

The probable relationship between rainfall and E. coli levels in the Raumanga Stream suggest that an interim SFRG of "poor" is perhaps overly conservative. In dry periods, the water quality of the Stream is generally adequate for recreational bathing, and therefore a "fair" grading may be more warranted. On the other hand, an historic alert compliance of only 40 % and an action compliance of 72 % suggest that a "true" grade probably lies somewhere in between "fair" and "poor". Whether or not a sign should be erected at the site is therefore not clear cut, and it may be that better education, especially at local schools, about the basic rules of swimming[4] in rivers is the best way to minimise the occurrence of bathing-related illnesses at the swimming hole.

[4] As outlined in the introduction of this document

5.11 MANGAKAHIA RIVER @ TOKIRI MARAE (TITOKI)

SIC: HIGH MAC: INSUFFICIENT DATA SFRG: N/A

The swimming hole below the Tokiri Marae is a popular swimming and recreational area for locals and campers, although no one was observed during sampling. The catchment is predominantly agricultural, with a mix of beef and dairy farming the predominant land uses. Local Iwi have recently undertaken the re-establishment of native bush on their land upstream of the swimming hole, in order to help restore the river's original pristine condition. There is no historical bacteriological data for this site.

Table 16 Collated results for the Tokiri Marae site

	2003-04 SURVEY
Median	174 *E. coli* per 100 mL
95th Percentile	6440 *E. coli* per 100 mL
Alert Compliance	60 %
Action Compliance	90 %

Water quality at the swimming hole below the marae was very good until mid to late January, after which time elevated levels persisted until the middle of February (Figure 22). In comparison to other sites in the Whangarei district, the Tokiri Marae site had the highest alert and action compliances, although this is tempered somewhat by a very high 95th percentile (6440 E. coli per 100 mL), as shown in Table 16.

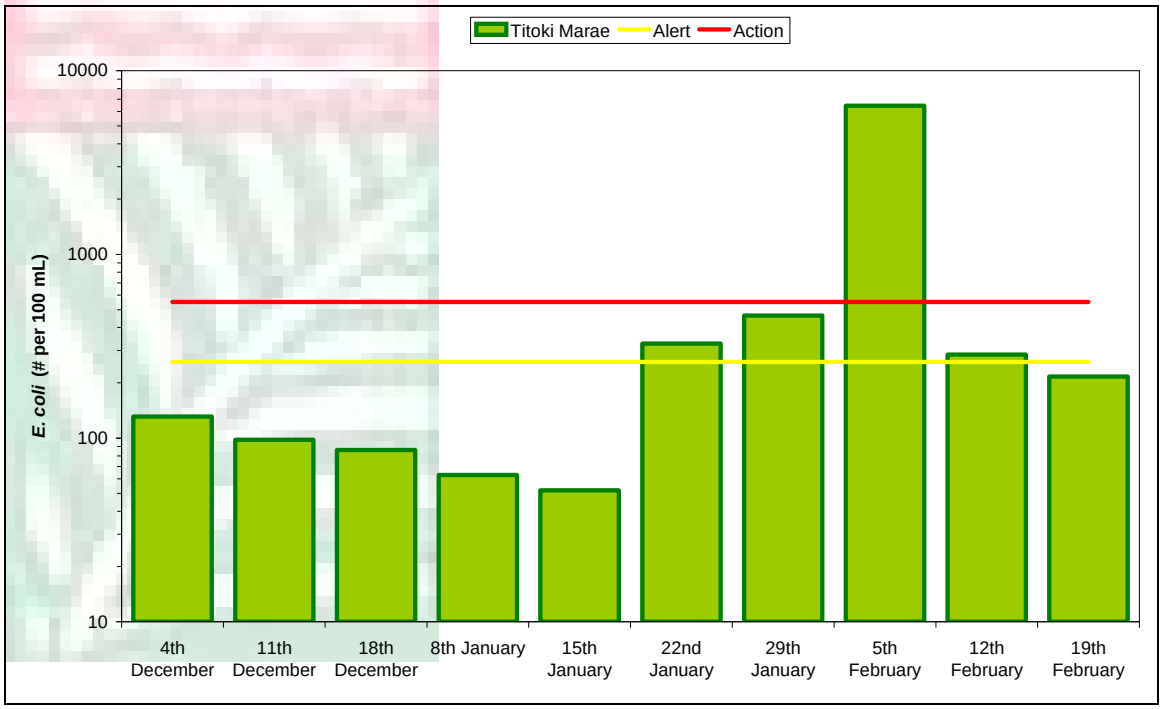

Figure 22 Results for the Tokiri Marae swimming hole collected over the summer of 2003-04

Rainfall appears to have caused the elevated E. coli detected in samples from the end of January through to the beginning of February, as shown in Figure 23. However, there is no clear correlation between E. coli and rainfall overall.

Sustained rainfall at the beginning of December did not cause an elevation of E. coli, and in fact, E. coli levels at the site were lower than in the sample collected a week earlier. A similar phenomenon occurred at the end of the summer, where E. coli continued to decline after the spike on the 5th February, even though sustained rainfall occurred between the 12th and 19th of that month.

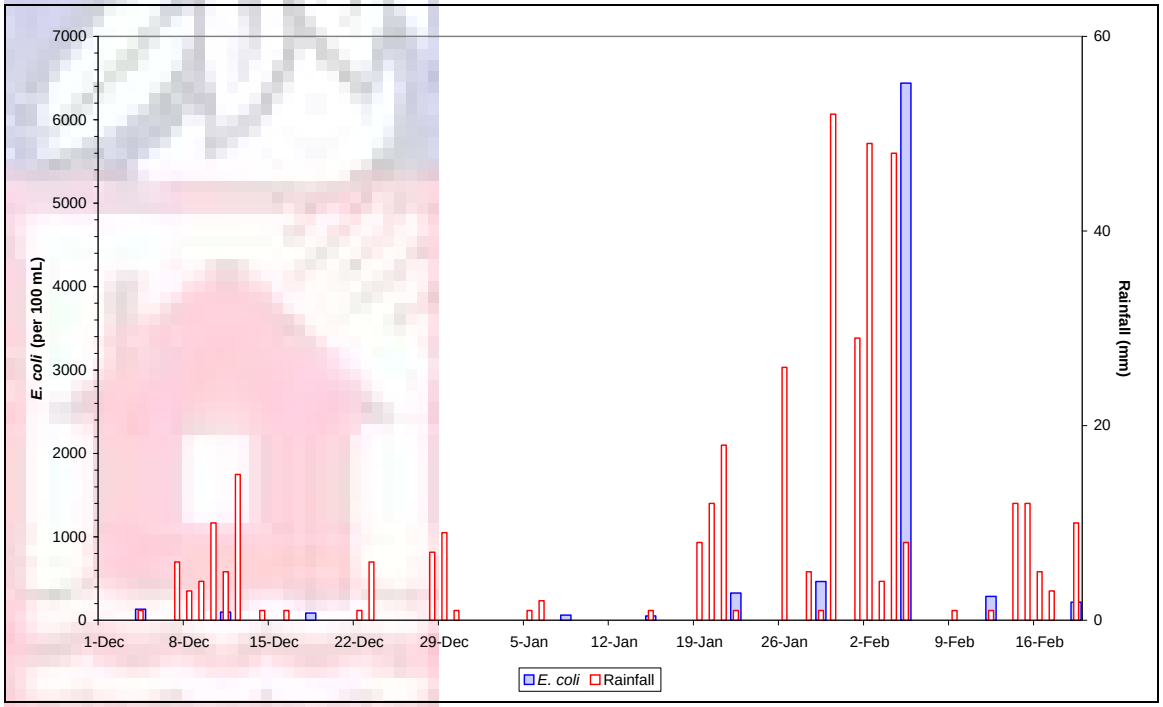

Figure 23 Rainfall and E. coli data for the Mangakahia River below the Tokiri Marae

One summer's worth of data is inadequate for any MAC or SFRG calculations. Informal observations suggest that, so long as people obey the basic rules of clarity, discolouration, and rainfall, then the health risks associated with freshwater recreation contact will be relatively low at the site.

5.12 MANGAKAHIA RIVER @ TWIN BRIDGES

SIC: MODERATE **MAC: D** **SFRG: POOR**

The Mangakahia River catchment is a mix of native forest (in the upper catchment), exotic forestry, beef and sheep farming (in the mid-catchment), and dairy farming (the lower catchment). The Twin Bridges lie within the middle part of the catchment, and therefore the upstream land-uses range from pristine indigenous forestry to moderately intensive beef farming. The Twin Bridges site is popular for both camping and swimming.

Table 17 Collated results for the Twin Bridges site

	2003-04 SURVEY	ALL SURVEYS
Median	295 *E. coli* per 100 mL	226 *E. coli* per 100 mL
95th Percentile	19765 *E. coli* per 100 mL	4993 *E. coli* per 100 mL
Alert Compliance	36 %	61 %
Action Compliance	64 %	75 %

The Twin Bridges site is one of the more pleasant sites to sample over summer, however water quality was exceptionally poor over the 2003-04 period. As listed in Table 17, water quality was worse than average across the board, and the 95th percentile for the summer was almost unbelievably high. Of particular concern were the results from the 22nd and 29th of January, at which *E. coli* were measured in the tens of thousands (Figure 24), suggesting the presence of an upstream source of contamination that requires urgent attention.

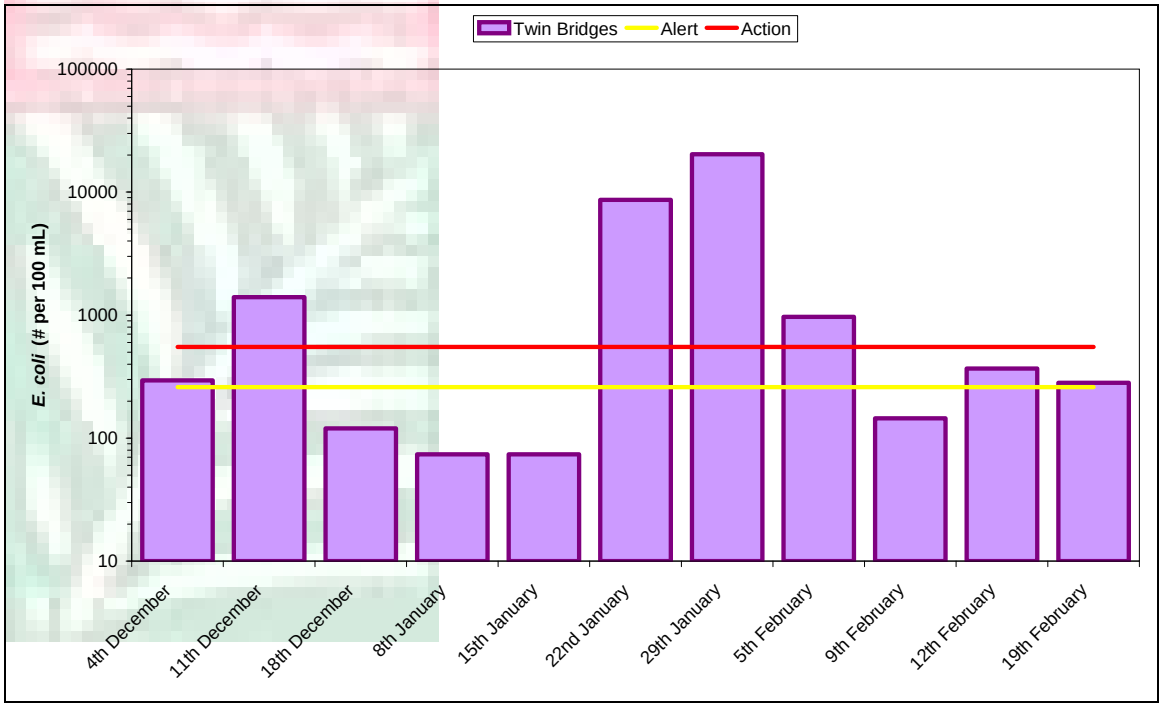

Figure 24 Results at the Twin Bridges site over the 2003-04 summer

Figure 25 details the evidence for a strong causal link between run-off and *E. coli* at the Twin Bridges. All results above the alert threshold of 260 *E. coli* per 100 mL occurred after or during rain, which suggests that agricultural or silvicultural (forestry) run-off is the most likely source of the contamination, given the nature of the upstream catchment.

While there is strong evidence for rainfall as the trigger of *E. coli* elevation, predicting the magnitude of such events is more difficult. The high levels of *E. coli* recorded on the 22nd of January are probably a result of "first flush", whereby a build-up of effluent and excrement over a dry period is washed into a river over a short period of time when heavy rainfall occurs and the parched soils cannot absorb the bulk of the rain. That a second spike occurred on the 29th of January either suggests that the "first flush" only mobilised a part of the total body of contaminants, and a "second flush" occurred or an isolated event (such as someone dumping effluent upstream) was responsible for the extremely high levels of *E. coli* observed.

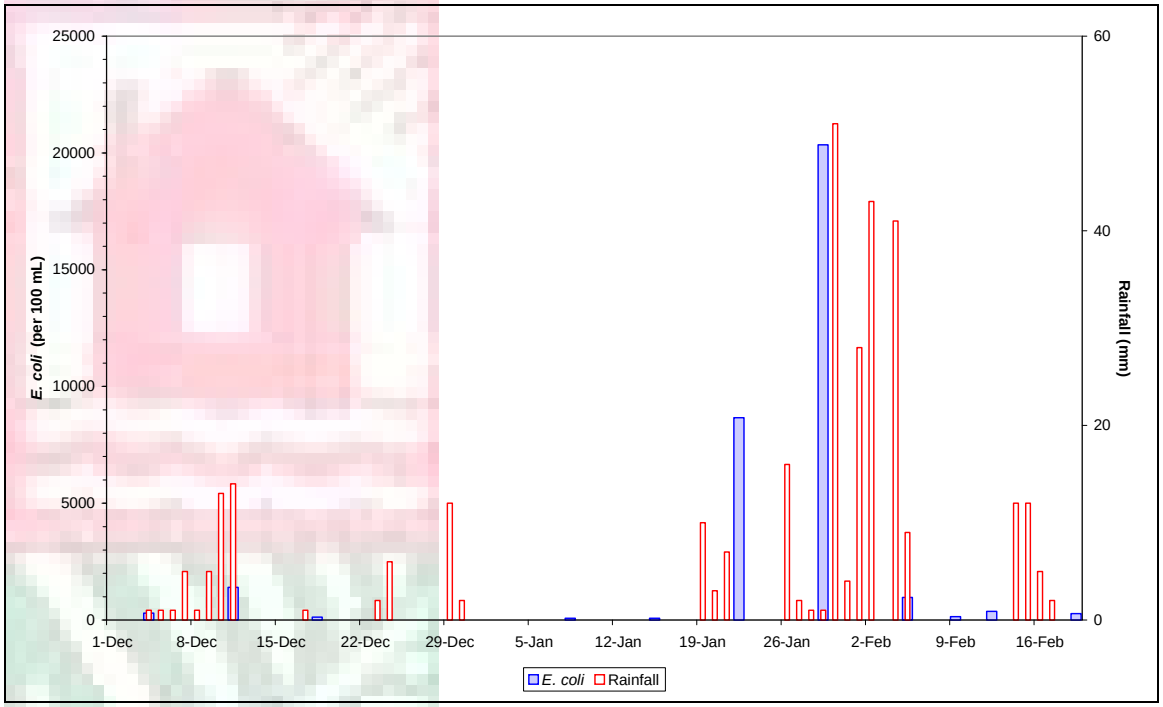

Figure 25 E. coli and rainfall at the Twin Bridges site

A SFRG of "poor" is perhaps overly harsh, given the strong correlation with rainfall at the site. However, until the causes of spikes such as those witnessed in January are isolated and remedied, it is unlikely that the 95th percentiles for the site (and therefore the MAC) will fall in the near future.

5.13 KAIHU RIVER

SIC: MODERATE MAC: D SFRG: POOR

The Kaihu River drains from a catchment that is a mix of native bush and agricultural farmland, with a number of dairy farms upstream of the sampling site. The NRC takes samples below major camping ground, which is extremely popular over the summer months. By the time the Kaihu River reaches the motor camp, the river has integrated both the Waima River and the Mangatu Stream.

Table 18 Collated results for the Kaihu River

	2003-04 SURVEY	ALL SURVEYS
Median	139 *E. coli* per 100 mL	86 *E. coli* per 100 mL
95th Percentile	12033 *E. coli* per 100 mL	4833 *E. coli* per 100 mL
Alert Compliance	70 %	71 %
Action Compliance	70 %	74 %

The compliance rates fro the Kaihu River were reasonably similar to previous years, however the median and 95th percentiles were much higher than average (Table 18). Similar to the Mangakahia River at the Twin Bridges site, particularly high levels of *E. coli* became prevalent from the 22nd of January through to early February, after which time levels fell below even the alert threshold (Figure 26). Results tended to be extreme at the site, samples contained either less than 150 *E. coli* per 100 mL or greater than 2500 *E. coli* per 100 mL.

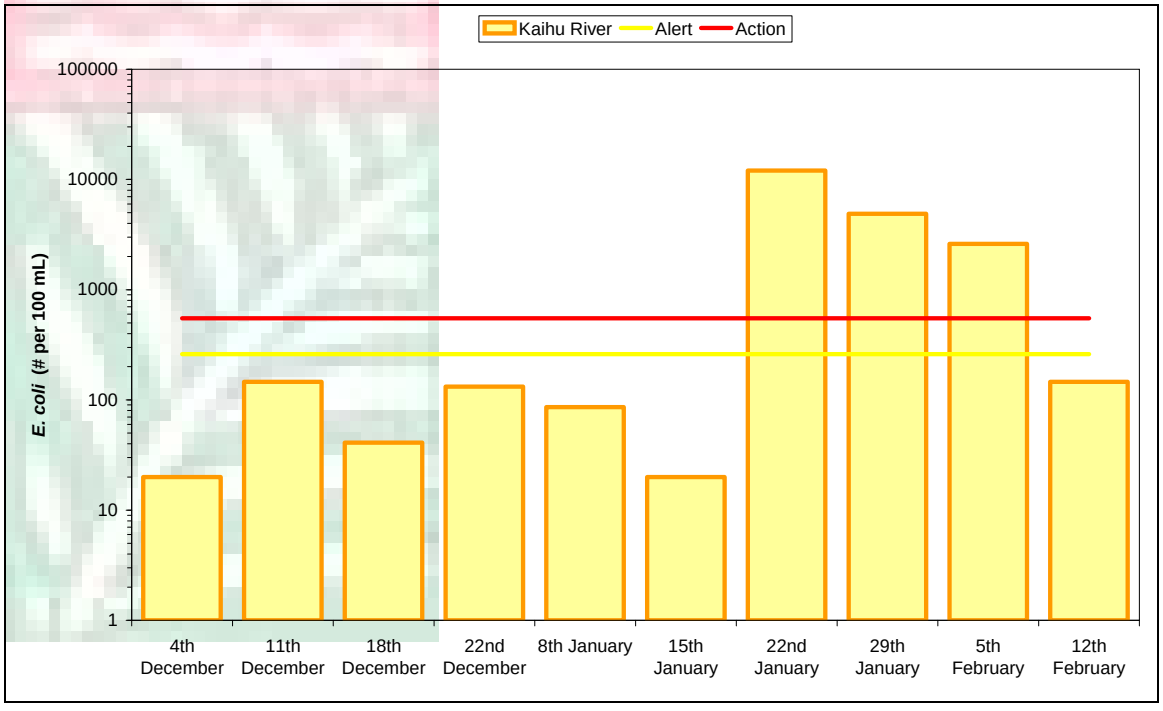

Figure 26 Results for the Kaihu River for the 2003-04 summer

The data collected for the 2003-04 summer (and presented as Figure 27) suggest that the Kaihu River is excellent for swimming in during dry periods, but after heavy rain may become extremely unsuitable (although this cannot be guaranteed). Rainfall is the likely cause of the series of high results between January 22nd and February 5th, which appear to follow a pattern in line with first flush principles.

No spike occurred on the 11th of December, when the catchment received a similar amount of rainfall as that later in the summer (Figure 27). A possible explanation is that the catchment requires a set amount of rainfall before the bacteriological by-products of agricultural farming is wash into the river. Another possibility is that consistent rainfall over previous months meant that no build up of animal excrement and effluent occurred, and therefore there was nothing to flush in early December.

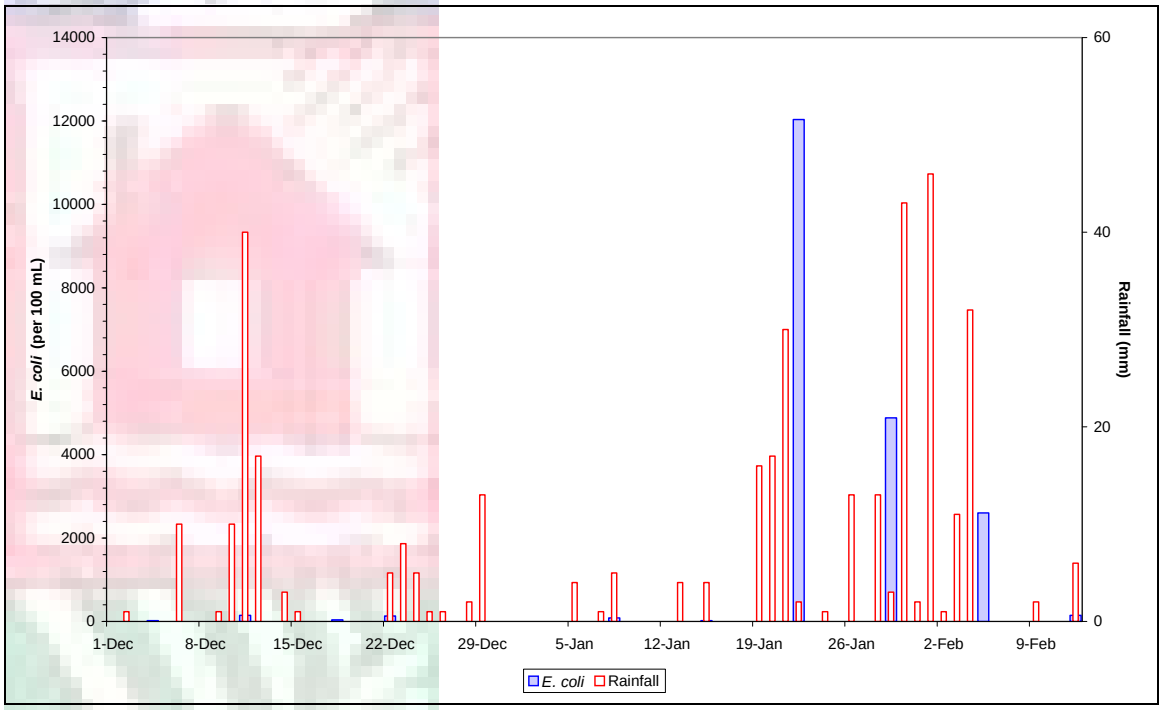

Figure 27 Rainfall and *E. coli* data for the Kaihu River

The NRC began sampling the Kaihu River as part of the freshwater recreational contact survey in the summer of 2000-01, and therefore will not receive an interim grading until the conclusion of next year's survey. There appears to be a link with rainfall, as significant rain events following prolonged dry-spells cause the river to become unsuitable for bathing, suggesting the river should perhaps grade as "good" or "fair". However, the high 95th percentiles recorded each summer mean that the river is likely to receive an overly conservative SFRG (probably "poor").

5.14 OMAMARI BEACH STREAM

SIC: LOW **MAC: INSUFFICIENT DATA** **SFRG: N/A**

The Omamari Beach Stream is a small stream created by the meeting of two tributaries, one derived from indigenous wetlands, the other from a mixed sheep and beef catchment. The Omamari Beach Stream itself is perhaps only a kilometre long, but a lot of local children swim in the stream and the Omamari Rate Payers Association have been concerned about the quality of the water for some time. This year was the first time the Omamari Beach stream has been monitored as part of the summer survey.

Table 19 Collated results for the Omamari Beach Stream

	2003-04 SURVEY
Median	103 *E. coli* per 100 mL
95th Percentile	504 *E. coli* per 100 mL
Alert Compliance	80 %
Action Compliance	100 %

The results presented as Table 19 and Figure 28 show that water quality was excellent at the site with two exceptions. *E. coli* on the 22nd of January just broke the alert threshold of 260 *E. coli* per 100 mL (262 *E. coli* per 100 mL, and approached the action threshold of 550 per 100 mL at the beginning of February.

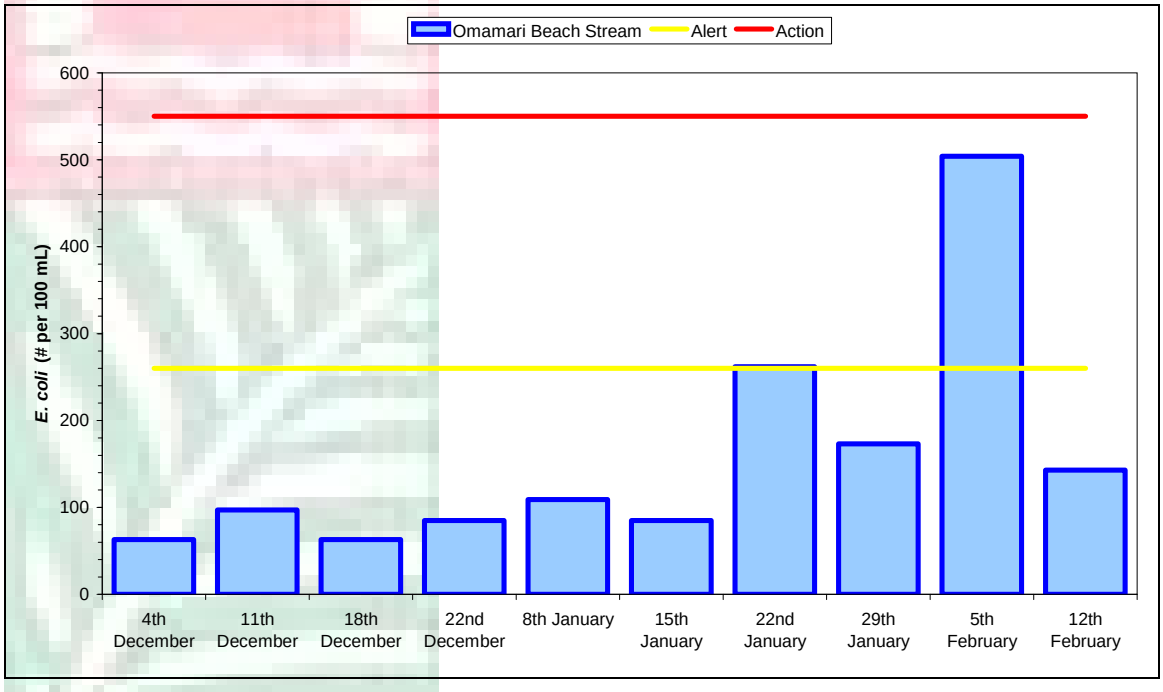

Figure 28 2003-04 results for the Omamari Beach Stream

The comparison between rainfall and *E. coli* suggests that sustained periods of rainfall greater than about 5 mm per day will cause elevated levels of *E. coli* in the stream. Stormwater is the most likely source of the contamination, with the high results coinciding with both sustained rainfall and an increased holiday population over the middle of summer.

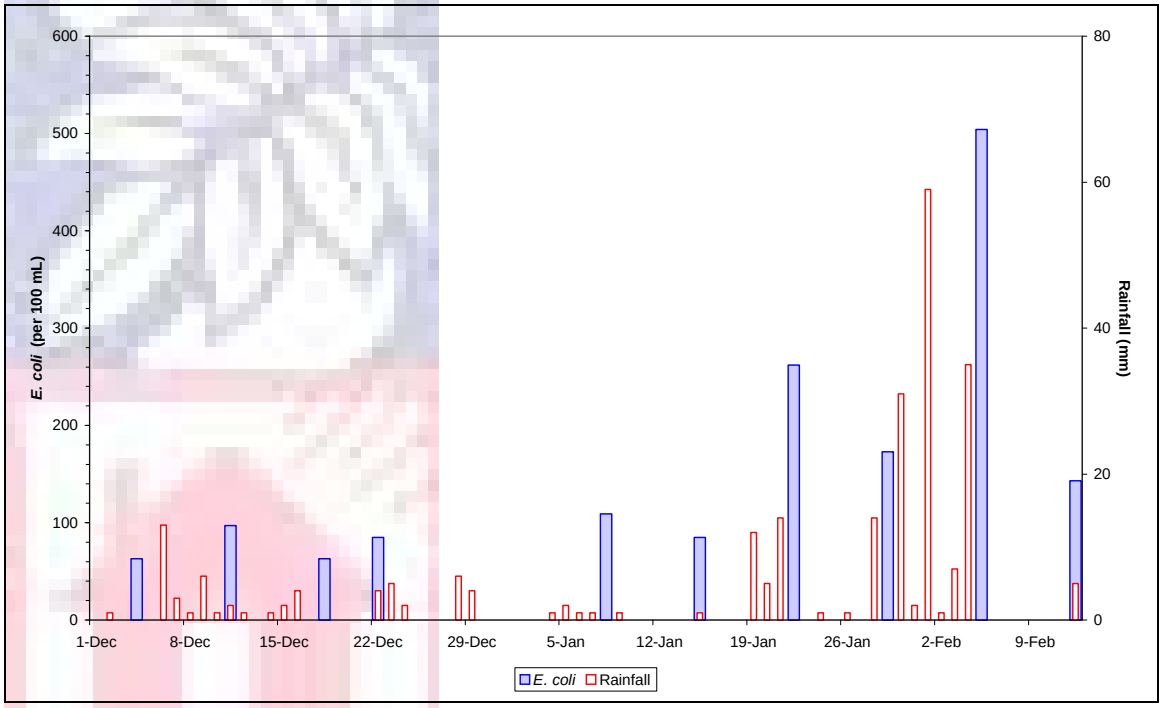

Figure 29 *E. coli* and rainfall data for the Omamari Beach Stream

Based on its first survey, the results are promising for the Omamari Beach Stream. The Omamari Beach Stream was the only stream or river at which *E. coli* levels did not breach the action threshold, suggesting that human impact on the stream is small compared to other sites. Future surveys will confirm whether it was simply a good year in terms of bacteriological monitoring (and that the stream is in fact subject to similar problems as those faced elsewhere), or if the Omamari Beach Stream is indeed in good condition. It is recommended that sampling continue at this site, with a view to make an interim grading after the conclusion of the summer of 2007-08.

5.15 LAKE TAHAROA

SIC: VERY LOW **MAC: B** **SFRG: VERY GOOD**

Lake Taharoa is the biggest of the four Kai Iwi lakes, an extremely popular area for both locals and tourists alike, situated approximately 25 km northwest of Dargaville. Thousands of people flock to the lake during summer and there are regularly enough tents at the camping ground to house 500 people. Like Lake Ngatu in the Far North, Lake Taharoa has no significant inputs or outputs, and rainfall is the major control on water levels. Without any major inputs, bacteriological contamination should be rare, even given the lake's heavy usage.

Table 20 Collated results for Lake Taharoa

	2003-04 SURVEY	ALL SURVEYS
Median	10 *E. coli* per 100 mL	10 *E. coli* per 100 mL
95th Percentile	109 *E. coli* per 100 mL	140 *E. coli* per 100 mL
Alert Compliance	100 %	97 %
Action Compliance	100 %	99 %

Results for the 2003-04 for Lake Taharoa were excellent. The highest result collected from the lake was only 109 *E. coli* per 100 mL, as shown on Figure 30, and therefore the lake achieved 100 % compliance with the MfE guidelines, slightly better than average (Table 20).

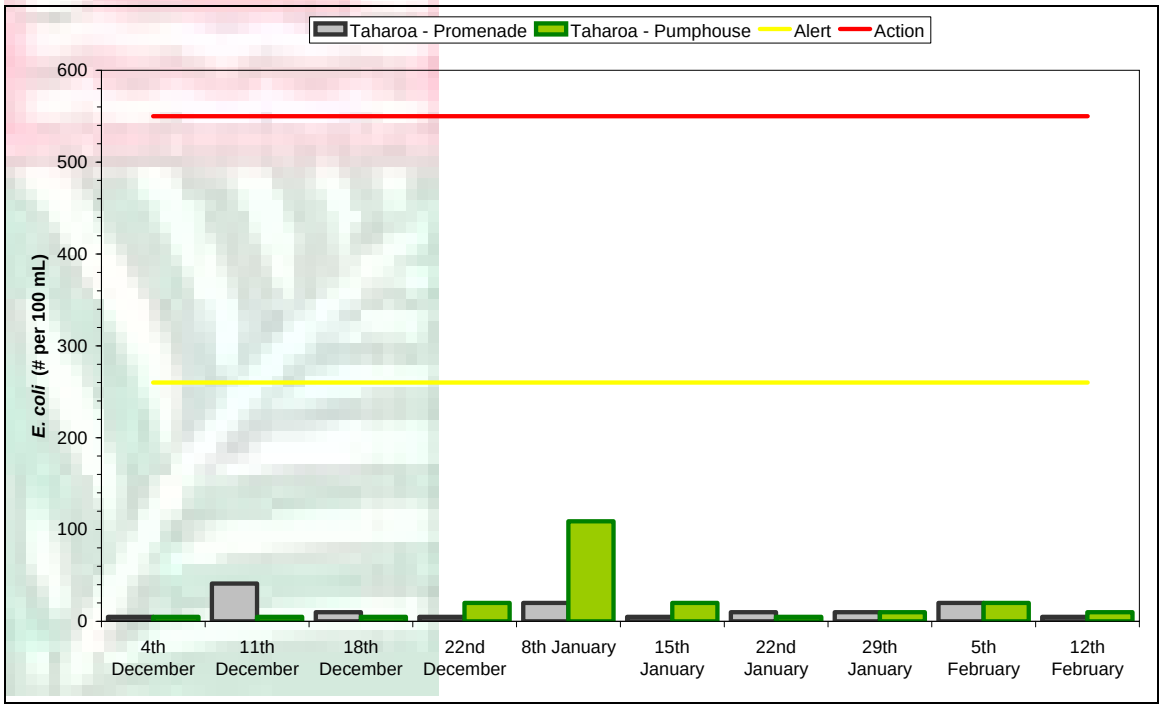

Figure 30 Results from Lake Taharoa over the 2003-04 summer

There is no obvious link between rainfall and *E. coli* levels at Lake Taharoa. As shown in Figure 31, very little rain fell before the spike recorded on the 8th of January, while prolonged rain had little effect, based on samples from the 5th of February. Isolating the cause for the spike is not possible, and could be anything from a contaminated sample through to birds defecating at the sampling site. Whatever the reason, when 109 *E. coli* per 100 mL constitutes a "spike", the implication is that people have not affected the health of Lake Taharoa at all (in terms of bacteriological quality at least).

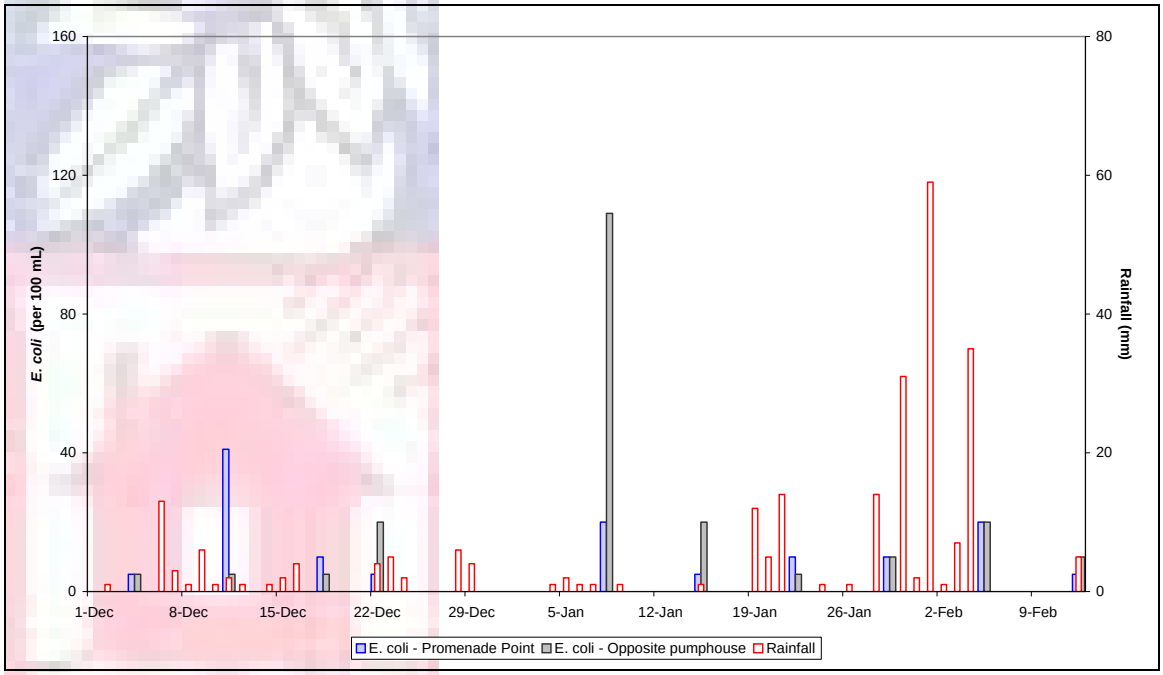

Figure 31 Rainfall and *E. coli* data for Lake Taharoa

The interim grade for Lake Taharoa is "Very Good", and therefore may not require sampling in the future, so long as the ambient environment at the lake is not drastically changed. However, with 73 data points collected over the last 5 summers, it is envisaged that Lake Taharoa, along with Lake Ngatu, will be able to be properly graded within the next few years, should sampling remain weekly. Such a feat unlikely for any other site unless the sampling regime is dramatically altered, and therefore it is recommended that sampling continue at Lake Taharoa until a dataset of 100 points collected over 5 years is achieved.

6 CONCLUSIONS FROM THE SURVEY

The 2003-04 freshwater recreational contact survey was the most comprehensive the NRC has conducted since the programme began in 1999. The regime still falls short of the proscribed MfE guidelines (that recommend 20 samples per site per summer), but with weekly sampling at least enough data is being collected that results can be compared with rainfall data, and problem sites identified.

The overall conclusion from the 2003-04 sampling was that most of the rivers throughout Northland are generally acceptable for swimming and other freshwater recreational activities during dry periods, but after heavy and/or prolonged rain, the waterways can become unsuitable for days afterwards. In a regional such as Northland, with a semi-tropical climate and a high annual rainfall, this means using 95th percentiles for the majority of sites result in grades that do not necessarily reflect the "true" state of Northland's freshwaters.

Exceptions to the rule are the Wairoa and Otiria Streams, which are both generally unsuitable for freshwater contact in all conditions. Otiria Stream is of the most concern, as E. coli levels were comfortably above the compliance thresholds over the entire summer.

The two lakes sampled are in much better health. Lakes are not as susceptible to rainfall as rivers and streams are, particularly the dune lakes of Northland, which do not have any significant surface inflows. However, as results collected at Lake Ngatu in the Aupouri peninsula show, even these lakes can be subject to occasional faecal contamination, and therefore sampling of Lakes Ngatu and Taharoa should continue.

7 RECOMMENDATIONS

Before each summer survey begins, it is customary for the NRC to meet with Northland's district councils and Northland Health to discuss any amendments or changes from previous years. Reports such as this one typically provide the foundation for these discussions, and it is therefore important to present several recommendations here:

7.1 FURTHER SAMPLING

The NRC has not collected enough data to make formal SFRGs for any of the 15 sites currently monitored. Therefore, it is not recommended that any of the sites be dropped from future surveys. The one possible exception to this might be the site below the Tokiri Marae, on the Mangakahia River. There was very little evidence that the site was used much over the sampling period, and therefore resources might be better spent on more popular locations. On the other hand, the sampling below the Marae is an opportunity to study recreational contact suitability of a river with a much bigger catchment than most of the other sites in the programme, and it might be interesting to determine whether the "fully-flushed" system explanation for results from the site do in fact hold true.

Instead of dropping any sites, there is still probably room for the survey to expand, to include further sites such as Hikurangi Lake, just north of Whangarei. Hikurangi Lake is a very popular place for freshwater recreation, even if there are growing concerns about water quality at the site.

7.2 EDUCATION

Northland Health has distributed brochures detailing the simple ways in which people can determine how safe a body of water is for swimming (attached as Appendix One), but whether their message is getting across remains to be seen. Northland Health's campaign would be greatly aided if the regional and district councils became more involved, by also distrusting the pamphlets and discussing the principles of safe bathing as part of their own educational programmes. Individually, each organization can only do so much, and an integrated approach could make a real difference.

Schools need to be the primary target in any education campaign, because children are both the most numerous users of inland swimming holes and one of the more at-risk groups. It may also be necessary to begin to erect more signs at Northland's most popular sites, not necessarily warning of the dangers of contact recreation, but instead providing advice on when it is best to swim, and when the swimming holes should be avoided.

8 REFERENCES

Ministry for the Environment (2002). **Freshwater Microbiology Research Programme: Pathogen Occurrence and Human Health Risk Assessment Analysis.** *Ministry for the Environment and Ministry of Health, Wellington, New Zealand.*

Ministry for the Environment (2003). **Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas.** *Ministry for the Environment and Ministry of Health, Wellington, New Zealand.*

Northland Health (2003). **Freshwater Swimming and Avoiding Getting Sick.** *Public Health Unit, Northland Health, Whangarei, New Zealand.*

9 APPENDIX ONE

Public Health Unit

FRESHWATER SWIMMING AND AVOIDING GETTING SICK

A large number of disease-causing pathogens ("bugs") are found in the faeces ("poos") of humans and animals. Sadly many rivers in Northland are at times polluted by human and/or animal faeces.

What sort of sickness is caused by swimming in polluted rivers?

It used to be thought that only "tummy bugs" were caught from swimming in water polluted by faeces (poos). Recent studies show that other illnesses such as "colds", influenza, skin, eye and ear infections can also be caught through contact with water polluted by faeces.

Where does the human and animal faecal pollution come from?

There are three main sources of faecal pollution of waterways:

- Human sewage – one of the main sources of human sewage pollution in Northland is failing septic tanks. It is estimated that over 50% of septic tanks are not working properly in Northland. Other sources of human sewage pollution include broken or leaky pipes and sewage overflows.

- Stormwater - rainwater collected from roofs, driveways, roads, and other sealed surfaces is piped directly into waterways without treatment. It can contain waste from domestic animals.

- Farm animals - farm run-off, especially that from dairy farms, can add significantly to the contamination of waterways. Farm run-off has the same potential for causing illness in swimmers as contamination by human sewage. Wild birds can also pollute waterways with bird droppings.

How can you tell if a river is polluted by human or animal sewage?

One of the main ways is to consider how the land is used upstream. It is much more likely that a river has faecal pollution if there is a lot of farming or there is a community with septic tanks upstream.

Please see overleaf for a quick easy way for checking out water quality. The Northland Regional Council (0800 002 004) also has information on some of the rivers in Northland.

Checking out swimming water quality

Here is a quick checklist you can use to help you decide whether to swim in a river or not. Circle the score box of the statement that best describes the river or lagoon that you are considering swimming in. Add up the score at the end.

RAINFALL

score		
5	There has been heavy rain in the last 3 days	DO NOT SWIM HERE
4	There has been heavy rain in the last 7 days	
2	There has been some rain in the last 3 days	
0	There has been no recent rain	

WHAT IS THE LAND USE UPSTREAM FROM THE SWIMMING SITE?

score		
5	Town/city area, communities with septic tanks or intensive dairy farming	DO NOT SWIM HERE
4	Country area with sheep or cattle farming	
2	Forestry	
0	Native bush	

ARE THERE ANY STOCK OR BIRDS (20 PLUS) AT THE SWIMMING SITE?

score		
4	Yes, they have access to the waterway	DO NOT SWIM HERE
2	Yes, they are close to the edge of the waterway but do not have access	
2	No, but there are fresh droppings near the waterway	
0	No, there are no animals present	

AT WHAT DEPTH CAN YOU SEE YOUR FOOT CLEARLY

score	
4	Ankle depth (10cm)
3	Calf depth (35cm)
2	Knee depth (50cm)
1	Greater than knee depth

WHAT IS THE RIVER BOTTOM LIKE?

score	
3	Muddy
2	Sandy
1	Stony

WHAT IS THE SCORE?

11+	Poor water quality – the risk of catching a disease is high
7 to 10	Medium water quality – there is medium risk of catching a disease
1 to 6	Good water quality – the risk of catching a disease is low

Acknowledgment: Hawkes Bay Regional Council