RECREATIONAL BATHING WATER QUALITY

AT NORTHLAND'S FRESHWATER BATHING SITES

SUMMER 2007-08

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NORTHLAND REGIONAL COUNCIL

EXECUTIVE SUMMARY

- Eighteen popular swimming sites at some of Northland's rivers, lakes and streams were sampled over a twelve week period, from the start of December 2007 through to the end of February 2008.

- 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 Lake Waro was excellent over the entire 2007-08 survey.

- Results for the rivers and streams were variable. The samples from the Kaihu River, Waipapa in Puketi Forest and Waipoua River sites met the guidelines for most of the sampling period, however samples taken from Otamure Bay Stream, Whananaki, and Waitaua Stream above the Whangarei Falls sites 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 two summers. The process has tended to be conservative and have overstated the health risks at some sites.

- A faecal source tracking investigation was carried out at several ongoing problematic sites to assist with identifying the source of contamination in 2008. The results showed that the contamination was not of human origin for all sites sampled and identified the likely source to be stock and/or water fowl at many of the sites.

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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 which contains large numbers of organisms capable of causing illness. These organisms, called pathogens, include such "bugs" as giardia (*Giardia lamblia),* and campylobacter *(Campylobacter jejuni)*.

The most common sources of pathogenic contamination are human sewage, stormwater and rural run-off (Jarman, 2002a). Human sewage is perhaps of most concern, particularly because it should be the easiest to remedy by fixing broken or leaking pipes, maintaining septic tanks and minimising sewage system overflows. The effects of stormwater and rural run-off are not as easy to mitigate. No matter what the source is though, the potential for causing illness is the same (Jarman, 2002a).

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

1.1 Health risks

Swimming in contaminated water can lead to skin, eye or ear infections, or gastrointestinal or respiratory illnesses (Jarman, 2002a). Ingestion is the most common pathway for pathogens, but inhalation has been identified as a major route as well, particularly for activities such as water-skiing (MfE 2002).

The effects of recreational bathing related illnesses can be quite unpleasant. Campylobacteriosis, for example, can cause fever, severe abdominal pain, nausea and diarrhoea, with symptoms lasting up to ten days (Jarman, 2002b). Depending on the type of disease and the severity of the infection, hospitalisation may be necessary. In 2001, 26% of patients infected with shigellosis required some time in hospital (Jarman, 2002b)[1].

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, if every swimmer got sick, the risks become unacceptable. The maximum acceptable risk falls somewhere in between; some people may get sick,

[1] Both Campylobacteriosis and Shigellosis, along with a host of other bathing-related illnesses, are common in Northland (Jarman, 2002b).

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 using our waterways for contact recreation, 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[2] 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.

[2] 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[3] 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.

[3] 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 from 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 below shows 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

♠ Implies non-sewage source of faecal contamination, and this needs to be verified.
♣ Unexpected results, which require further investigation (either SIC or MAC needs to be reassessed).

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 as 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 addition 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 cooperative 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* is 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).

The Northland Regional Council collected 13 samples per site over the course of the 2007/2008 summer, with the exception of a few sites, which had the odd sampling occasion missed due to staff availability. One sample was collected weekly from each site from 26 November 2007 to 21 February 2008. Each sample was collected following the methods in the '*Microbiological Water Quality Guidelines for Freshwater and Marine Recreational Bathing Areas'* (MfE, 2002).

Each sample was analysed for *E. coli* and total coliforms using Colilert™. Temperature was noted at each site using a handheld YSI meter and turbidity was measured in the laboratory. All laboratory sample analysis was carried out following the procedures in the '*Standard Methods for the Examination of Water and Wastewater*' (APHA, 1998).

5 SAMPLING 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 sampled in the annual surveys at the beginning of each summer, choosing sites based on popularity, and/or because of a specific request from the public if there is a suspected human health risk associated with microbiological contamination.

Eighteen freshwater sites were sampled weekly in the 2007/2008 summer, as shown in table 5 (below). This includes four new sites that were added in either 2006 or 2007 and excludes the eight sites removed before the 2007/2008 summer (see below for more information).

Table 5: Details of the sites used in the 2007-08 Survey

Water body	Location	Site number	District
Otamure Bay Stream	Otamure Bay, Whananaki	108859	Whangarei
Lake Waro	Hikurangi	107272	
Waitaua Stream	Whangarei Falls	105972	
Raumanga Stream	Raumanga reserve	103246	
Kaikou River	Pipiwai	108919	
Langs Beach Stream	Middle of Langs Beach	100686	
Waiharakeke stream	At Lucas Road, Moerewa	108921	Far North
Waipapa River	Puketi Forest	103248	
Waipapa River	Waipapa Landing	105706	
Kerikeri River	Kerikeri Stone Store	101530	
Waitangi River	Lily Pond Reserve	104830	
Tirohanga Stream	Tirohanga Road	102252	
Kapiro Stream	Purerua Road	102838	
Waipoua River	DOC camping site	108613	
Mangakahia River	Twin Bridges	105973	
Otaua Stream	Kaikohe	108510	
Kaihu River	Motor camp	102221	Kaipara
Omamari Beach Stream	Omamari Beach	102305	

5.1 Sites Removed

Following a review of the recreational bathing data and programme after the 2006-2007 summer, eight freshwater sites were removed from the monitoring programme either because they have indicated consistently good or poor microbiological water quality.

The four freshwater sites shown in table 6 (below) were removed from the programme because they have had consistently poor water quality over the last four summers. However, all of these four sites and others were sampled for several weeks towards the end of summer as part of the faecal source tracking investigation (refer to section 7).

Table 6: Sites removed from the recreational bathing water quality sampling programme prior to the 2007/2008 summer as historically they have consistently high bacterial levels

Site description	Site number	District	Grade
Ocean Beach Stream	102077	Whangarei	Very poor
Langs Beach Stream (southern end by toilets)	100686	Whangarei	Very poor
Wairoa Stream (Ahipara)	105053	Far North	Very poor
Otiria Stream	105376	Far North	Very poor

The four freshwater sites shown in table 7 (below) were removed from the programme as they have had consistently low bacterial levels over the last four years, making them

suitable for swimming most of the time. However, bacterial levels can still become elevated after heavy rain. We recommend that you do not swim after heavy rain, if the water is dirty or if there is a warning sign erected.

Table 7: Sites removed from the recreational bathing sampling programme prior to the 2007/2008 summer as historically they have consistently good microbial water quality

Site description	Site number	District	Grade
Lake Ngatu at launch site	100402	Far North	Good
Lake Ngatu at southern end	100401	Far North	Very good
Lake Taharoa at pump house	105434	Kaipara	Very good
Lake Taharoa at Promenade Pt	100452	Kaipara	Very good

5.2 Sites added

The five sites shown in table 8 (below) have been added to the recreational bathing programme since the last freshwater recreational bathing report was written (NRC 2006). These were added to the programme as they are all popular swimming spots that have been identified by the public, district councils or Northland Health, which have been confirmed by the Northland Regional Council to have sufficient risks in the catchment that good affect microbiological water quality.

Table 8: Sites added to the recreational bathing sampling programme prior to 2007/2008

Water body	Location	Site number	District
Otamure Bay Stream	Otamure Bay, Whananaki	108859	Whangarei
Kaikou River	Pipiwai	108919	Whangarei
Langs Beach Stream	Middle of Langs Beach	104539	Whangarei
Waiharakeke stream	At Lucas Road, Moerewa	108921	Far North
Waipapa River	Puketi Forest	103248	Far North

The 18 sites sampled in 2007/2008, plus the eight sites removed from the programme are shown in figure 1 (right).

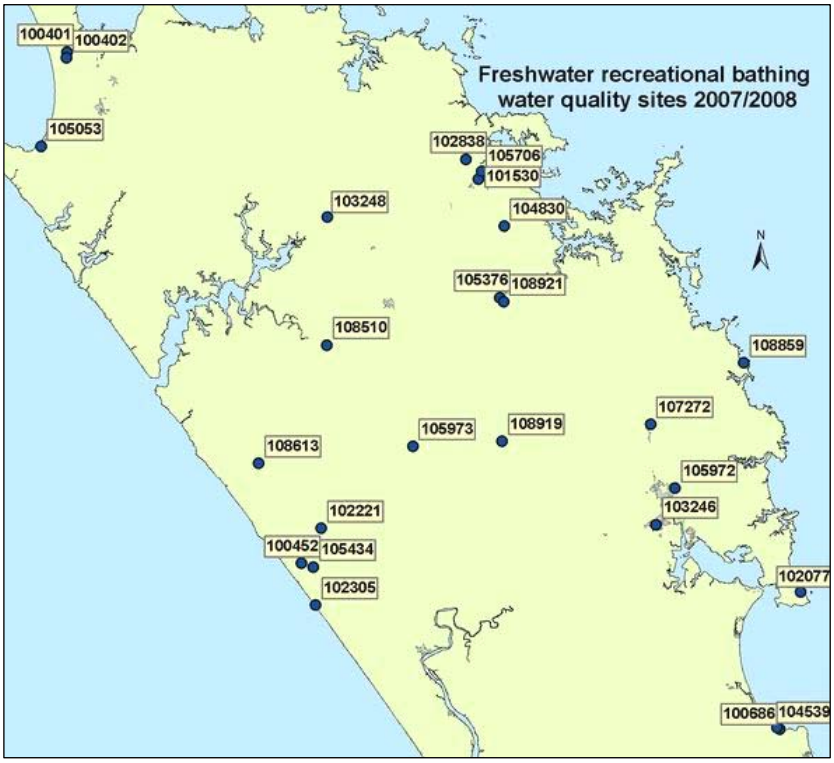

Figure 1: Freshwater recreational bathing sites in Northland, including all sites sampled in 2007/2008 and those removed from the programme.

6 RESULTS & INTERPRETATIONS

The *E. coli* results for each site sampled in 2007/2008 are summarised below, including a comparison with historical results, compliance with the alert and action thresholds from the Microbiological Water Quality Guidelines (MFE 2002), and correlation with rainfall.

The information for each site includes the likely sources of bacterial contamination and the most recent Sanitary Inspection Category (SIC), Microbiological Assessment Category (MAC) and Suitability for Recreation Grade (SFRG). The sites that were part of the faecal source tracking investigation also have a brief summary of the key findings from this research for each site, with more detailed information presented in section 7.

6.1 Otamure Bay Stream

SIC: High **MAC: D** **SFRG: Very poor**

Otamure Bay Stream has a relatively small catchment. It is predominately low intensity agricultural land use, with a few houses/holiday homes on septic tanks in the catchment. There is a reasonably wetland area, just upstream of the swimming hole which is frequented by water fowl including Brown Teal. This site was sampled for the first time in 2006/2007 and was added to the freshwater bathing monitoring programme due to concerns over water quality for recreational users. It is a popular swimming spot as it is adjacent to the DOC camping ground at Otamure Bay.

This summer's results are similar to what was found in the 2006/2007 summer, with a median and 95th percentile well above the guidelines, as shown in table 9 (below).

Table 9: Collated results for Otamure Bay Stream for 2007/2008 compared to previous years

	2007/2008 survey	Last two surveys
Median	1374 *E. coli* per 100 mL	1223 *E. coli* per 100 mL
95th Percentile	*4858 E. coli* per 100 mL	*15644 E. coli* per 100 mL
Alert Compliance	0%	0%
Action Compliance	7%	11%

This site had consistently high *E. coli* results over the 2007-08 summer, exceeding the alert level on all 13 sampling occasions and the action level on 12 occasions, as shown in figure 2 (below). A warning sign was erected at this site by Whangarei District Council.

It is still unclear whether rainfall and, in turn surface run-off, are major influencing factors for microbiological levels in the Otamure Bay Stream. It appears that the rainfall on 21 January 2008 caused a spike in *E. coli* when the stream was sampled on the same day, whereas bacterial levels were nowhere near as high on 10 December 2007 when there was several days of heavy rain prior to sampling, as shown in figure 3 (below). It could be that as the catchment is so small, it does not take long for the elevated bacterial levels to reach the sampling site after rainfall. Regardless of the effects of rainfall and surface run-off, there is contamination at this site from a frequent or constant source such as stock or water fowl defecating in the water, or a septic tank discharge.

Investigative sampling was carried out at this site in 2006/2007 and 2007/2008. This showed that the source of elevated bacterial levels was not human sewage, but could be water fowl (ducks) and herbivores (stock). For more information refer to section 7 – Faecal Source Tracking Investigation.

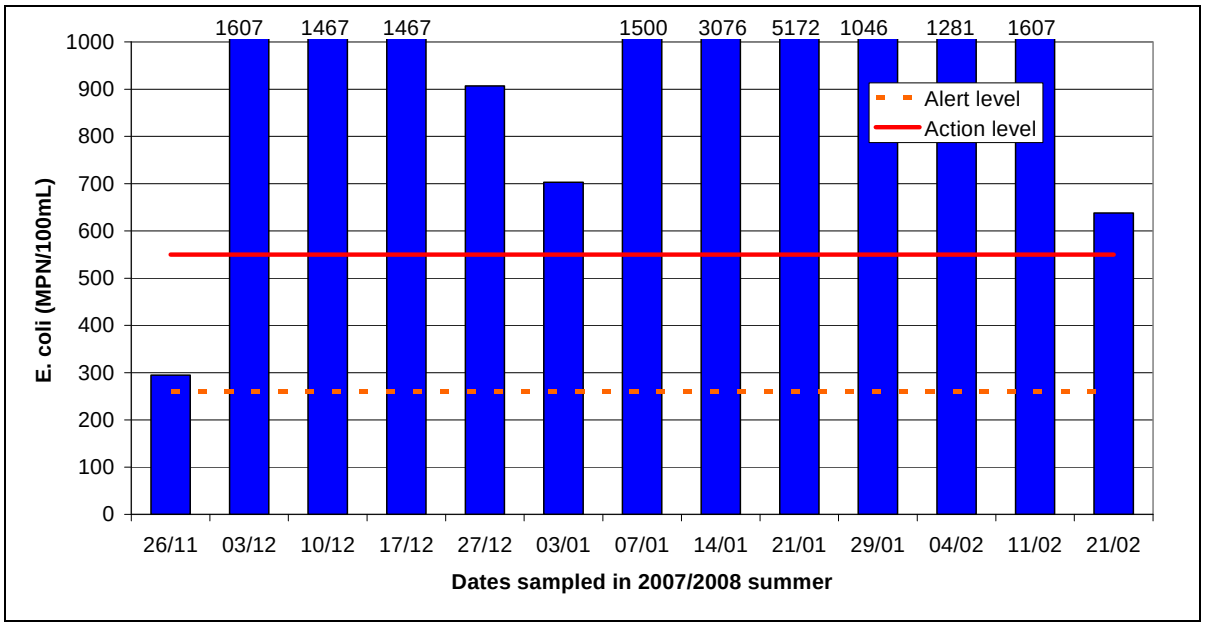

Figure 2: Results from the 2007-08 freshwater recreational contact sampling for Otamure Bay Stream, Otamure Bay.

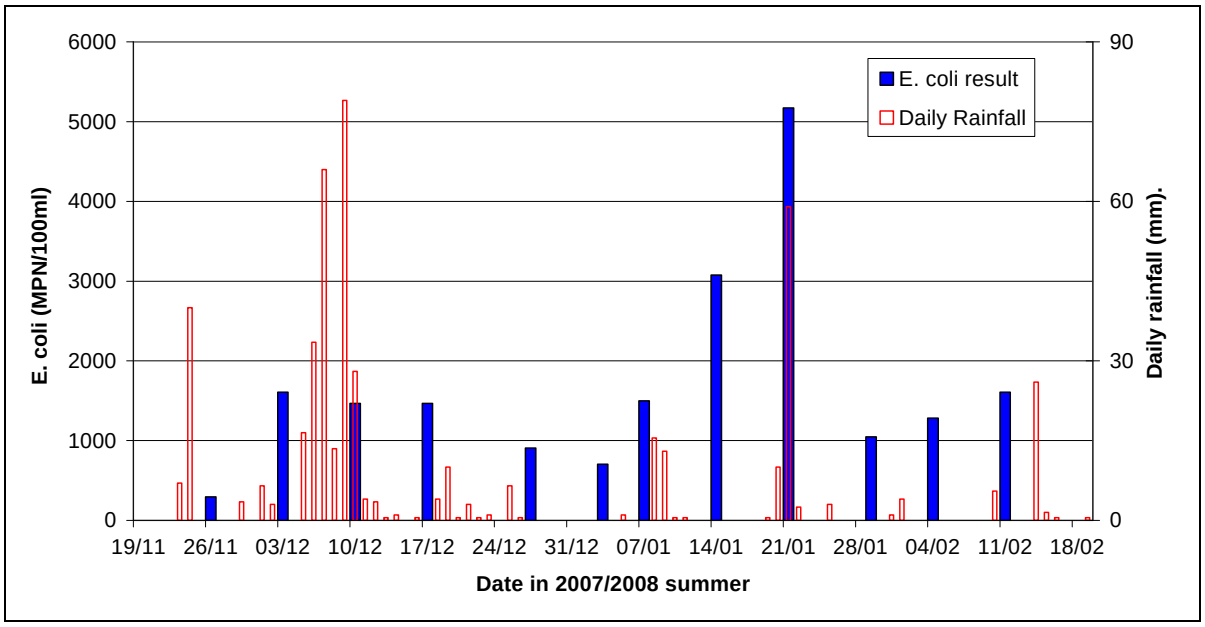

Figure 3: Rainfall and *E. coli* data for Otamure Bay Stream over the 2007/2008 summer

With two years data now available for this site, there is sufficient data to calculate an interim suitability for recreation grade (SFRG). With a Sanitary Inspection Category (SIC) of “high” and a Microbiological Assessment Category (MAC) of ‘D’, it is not surprising the SFRG grade for this site is “very poor”. This suggests that this site is not suitable for recreational use the majority of the time.

6.2 Lake Waro at Hikurangi

SIC: High MAC: D SFRG: Very poor NB: Good/fair are more accurate grades for this site.

Lake Waro is a small man-made lake with a small catchment area, located north of Hikurangi. It is a popular swimming spot for local children in summer months. It has no contributing permanent flowing streams or drains. The catchment is predominately low intensity beef farming, with a few houses that have septic tanks. Water fowl are commonly seen on the lake, so there is a risk of bacteriological contamination from birds excreting into the water. Lake Waro was sampled for the first time in the 2004/2005 summer and was added to the freshwater bathing monitoring programme due to concerns over water quality for recreational users. Bacterial levels were high in the 2005/2006 summer due to a large population of water fowl that frequent the lake.

The median, 95th percentile and compliance rates were improved in 2007/2008 compared to the results for the last four years, as shown in table 10 (below). It appears that the problems with elevated bacterial levels in Lake Waro in the 2005/2006 summer seem to have been averted, most likely due to the relocation of many of the water fowl that used the lake (NRC 2006).

Table 10: Collated results for the Lake Waro site

	2007-08 Survey	Last Four Surveys
Median	31 *E. coli* per 100 mL	86 *E. coli* per 100 mL
95th Percentile	*237 E. coli* per 100 mL	*1033 E. coli* per 100 mL
Alert Compliance	100%	78%
Action Compliance	100%	85%

The *E. coli* levels in Lake Waro were below the alert threshold on all sampling occasions in the 2007/2008 summer. It is likely that the microbiological water quality in Lake Waro is suitable for recreational use the majority of the time.

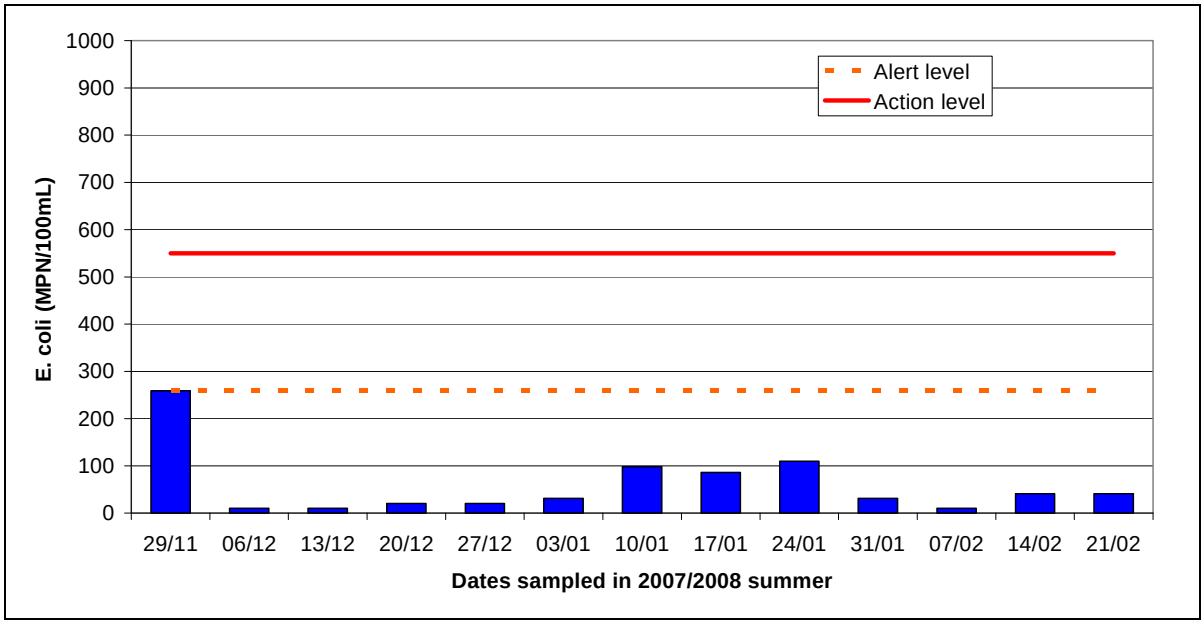

Figure 4: Results from the 2007/2008 freshwater recreational contact sampling for Lake Waro, Hikurangi

A comparison of rainfall and *E. coli* showed no clear relationship between rainfall and bacteriological water quality in Lake Waro, which is consistent with Lakes Taharoa and Ngatu.

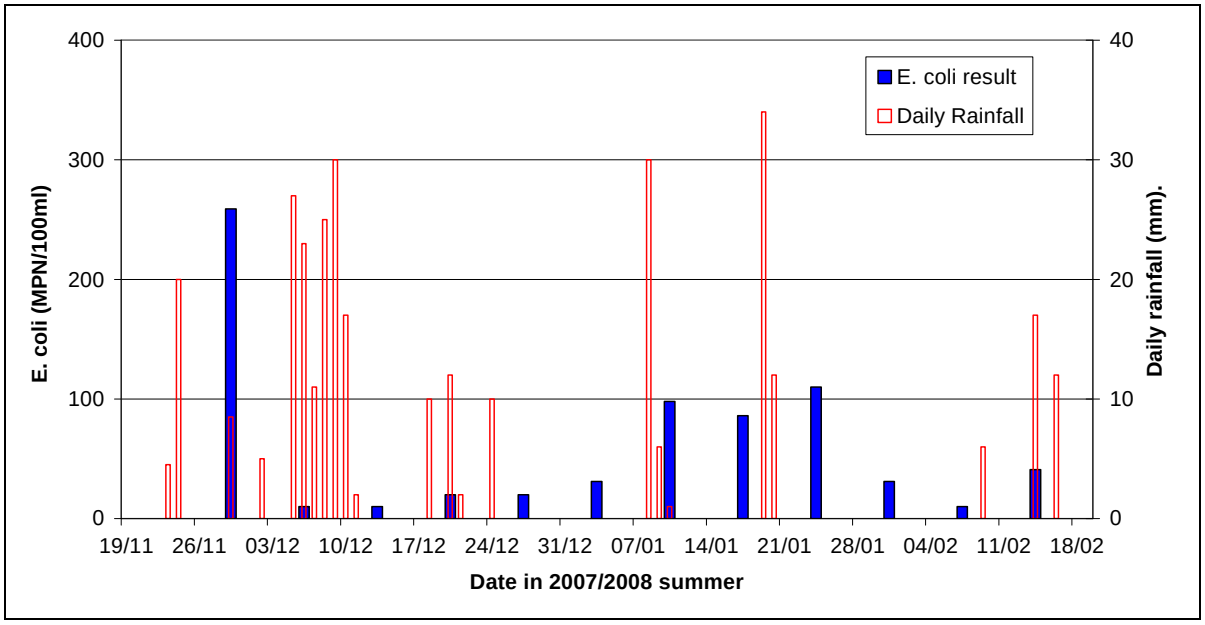

Figure 5: Rainfall and *E. coli* data for Lake Waro over the 2007-08 summer

Unfortunately due to the high results in the 2005/2006 summer, the MAC remains in the 'D' category and the SFRG remains as "very poor" for this site. However, it should be noted that the microbiological water quality has remained consistently good for the last two summers since the water fowl population was reduced. If the bacterial levels remain low for the next two summers, the SFRG is likely to improve to "good" or "fair".

6.3 Waitaua Stream at Whangarei Falls

SIC: High **MAC: D** **SFRG: Very poor**

Waitaua Stream originates North of Whangarei, flows around the edge of an urban area on the East of Whangarei and eventually becomes the Hatea (Hotea) River. Unlike most of the sites sampled during the recreational bathing surveys, the Whangarei Falls site is largely unaffected by agriculture. While the upper catchment does contain some mixed beef farming, the catchment is predominately 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 by Whangarei District Council. In spite of the warning sign, children are frequently observed swimming at the site during sampling, and it can be assumed that usage is heavy throughout summer. The bacterial levels in Waitaua Stream at Whangarei Falls were worse in the 2007/2008 summer compared to the last four summers, with a higher median and lower compliance with the guidelines, as shown in table 11 (below).

Table 11: Collated results for the Waitaua Stream at Whangarei Falls.

	2007-08 survey	Last five surveys
Median	624 *E. coli* per 100 mL	403.5 *E. coli* per 100 mL
95th Percentile	*2315 E. coli* per 100 mL	*2618E. coli* per 100 mL
Alert Compliance	15%	28%
Action Compliance	23%	61%

Microbiological water quality was generally very poor for the entire summer, with it only being suitable for bathing on two sampling occasions (less than the alert threshold).

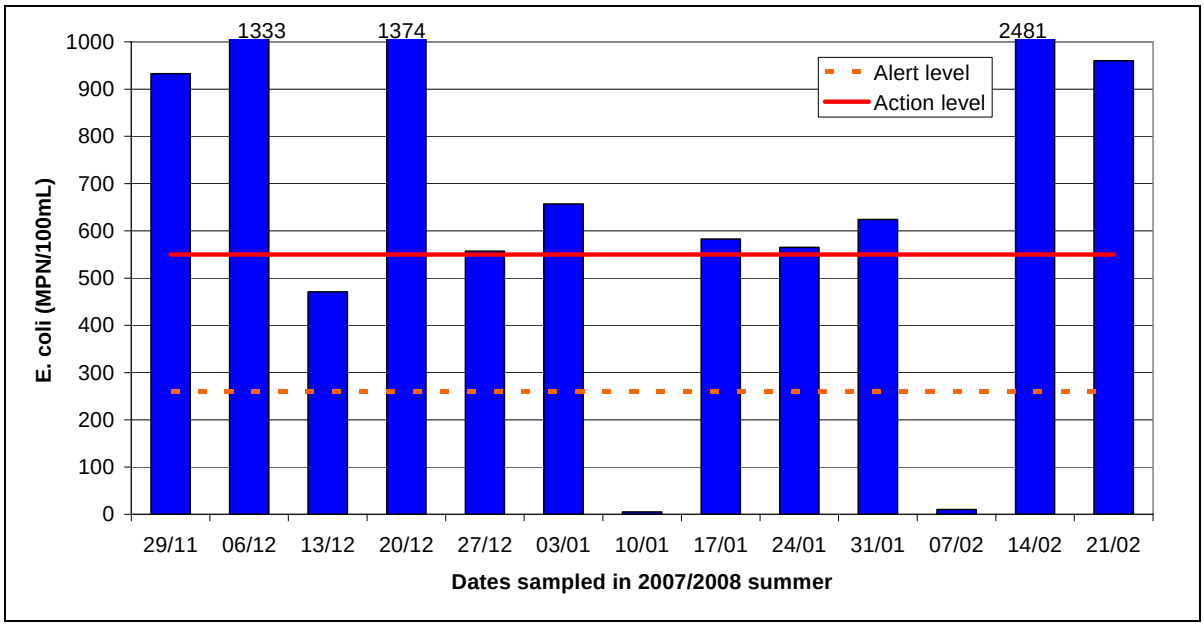

Figure 6: Results from the 2007/2008 freshwater recreational contact sampling for Whangarei Falls on the Waitaua Stream.

Although, in general, bacterial water quality is consistently poor in Waitaua Stream irrelevant of rainfall, it seems that rainfall causes bacterial levels to rise even further, such as on 6 December 2007 and 14 February 2008 as shown in figure 7 (below). This is consistent with the previous year's results (NRC 2006).

This indicates that there could be several factors influencing water quality in Waitaua Stream, including those that are not related to rainfall such as leakage from poorly maintained septic tanks, stock access or water fowl, and those such as stormwater discharges and agricultural run-off. As this site has had consistently poor water quality over the last five years, investigation was carried out here in 2008 to try to identify the source of the bacterial contamination. It was identified that the source was not humans, but is likely to be herbivores (stock) and water fowl (ducks). For more information refer to section 7 – Faecal Source Tracking Investigation.

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 guideline. The interim Suitability for Recreation Grade for Waitaua Stream has been calculated as "very poor" with a Hazen 95th percentile of 2618 *E. coli* for the last five seasons. This is a realistic grading for Waitaua Stream when compared to other Northland freshwater bathing sites, as it is often not suitable for swimming (only suitable 28% of the time over the last five summers) and has an extremely high median and 95th percentile.

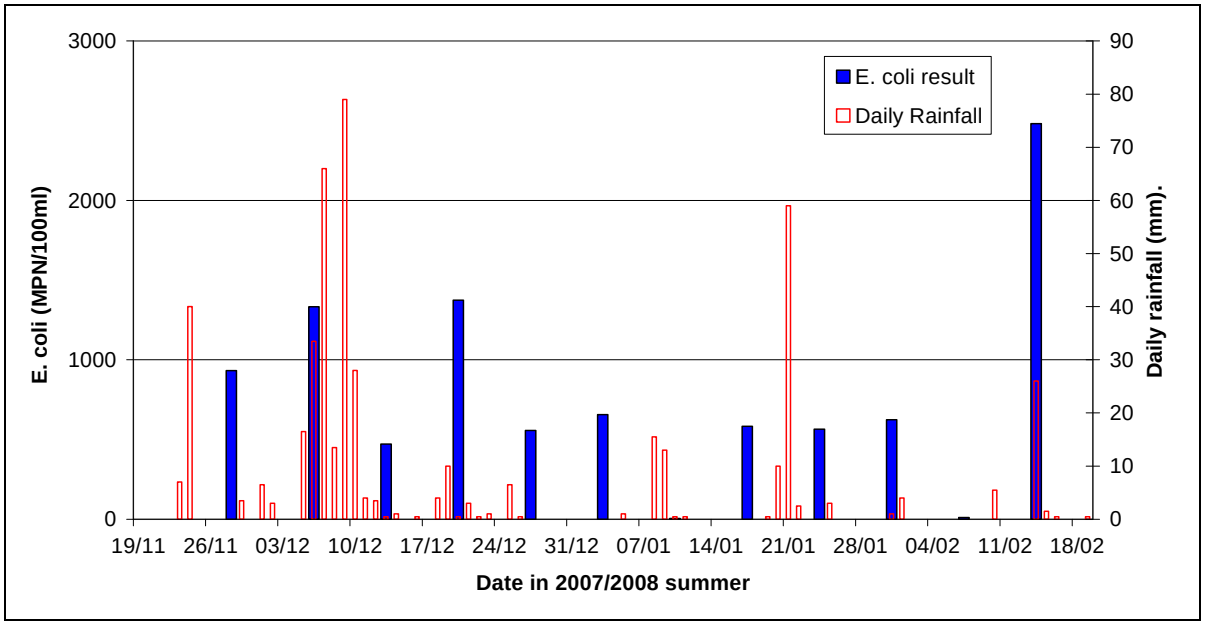

Figure 7: Rainfall and *E. coli* data for Waitaua Stream at Whangarei Falls over the 2007/08 summer

6.4 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 stream.

The results from the Raumanga Stream swimming hole were worse for the 2007/2008 summer compared with previous summers, with a higher median, higher 95th percentile and lower compliance rates, as shown in table 12 (below).

Table 12: Collated results for the Raumanga Stream

	2007-08 Survey	Last Five Surveys
Median	529 *E. coli* per 100 mL	278 *E. coli* per 100 mL
95th Percentile	*7034 E. coli* per 100 mL	*3533 E. coli* per 100 mL
Alert Compliance	15%	44%
Action Compliance	53%	67%

As shown in figure 8 (below), the *E. coli* results breached the action threshold six times over the 2007/2008 summer months, and exceeded the alert level on a further five occasions.

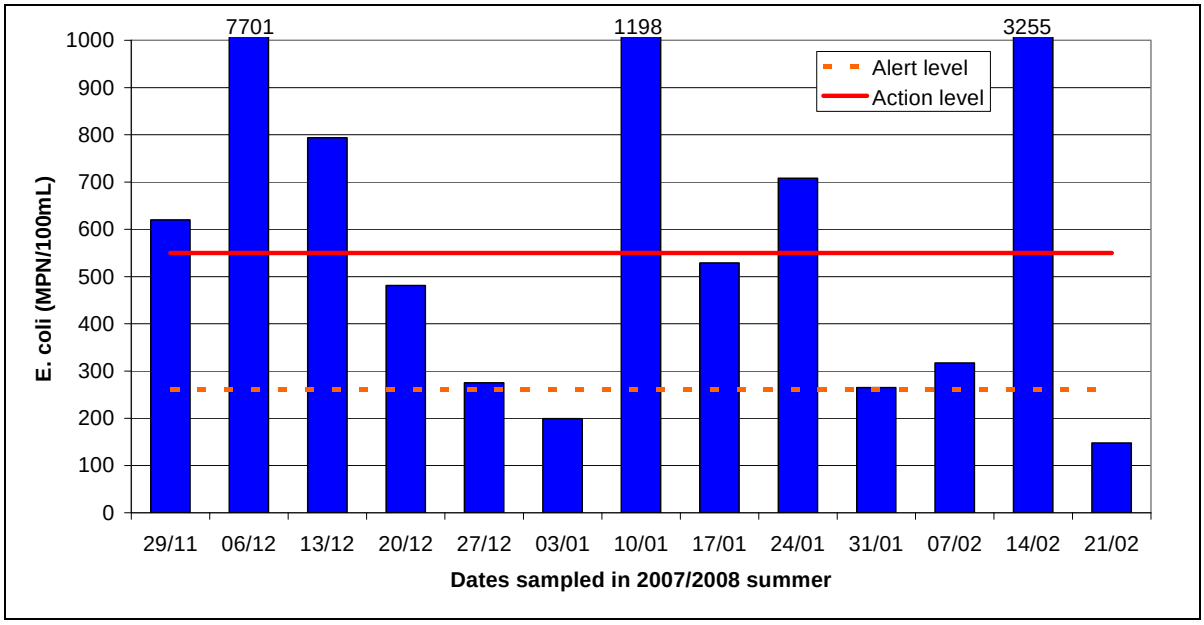

Figure 8: Results from the 2005-06 freshwater recreational contact sampling for Raumanga Stream

The results from this and previous summers suggest that bacterial levels in Raumanga Stream are affected by rainfall with extreme spikes of *E. coli* on days of heavy rainfall such as 6 December 2007, as shown in figure 9 (below). Therefore, the majority of bacterial contamination in Raumanga Stream is most likely related to sources associated with rainfall events such as agricultural run-off and stormwater.

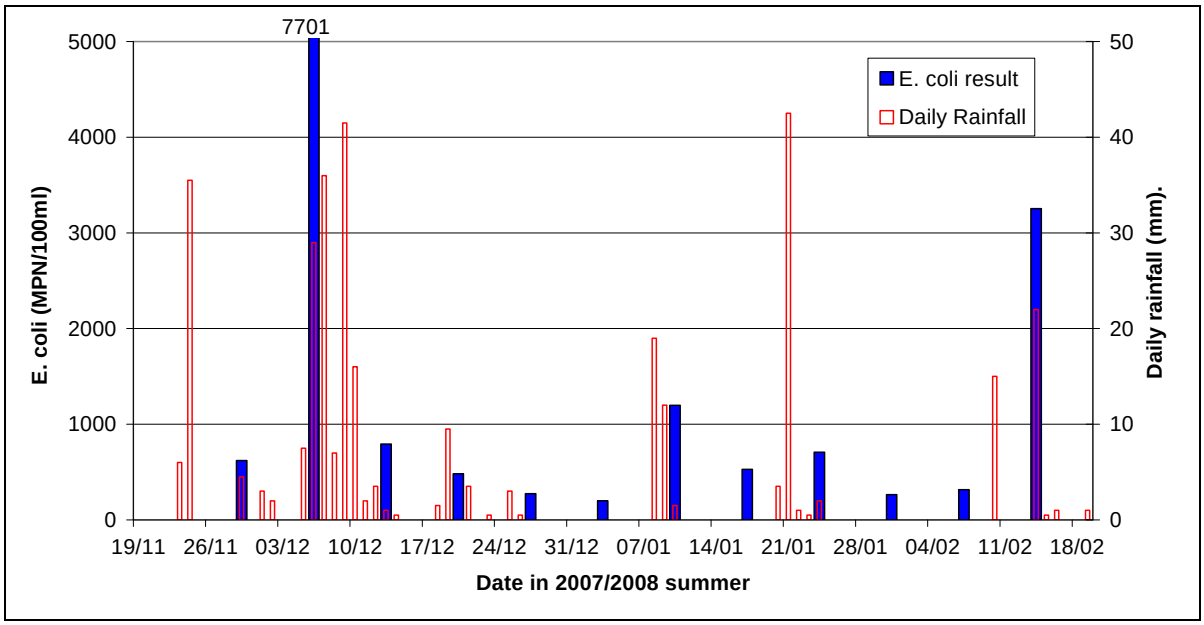

Figure 9: Rainfall and *E. coli* results for the Raumanga Stream over the 2007-08 summer

The probable relationship between rainfall and *E. coli* levels in the Raumanga Stream that causes extremely high *E. coli* spikes during rainfall events is causing the 95th percentile to be very high (3533 *E. coli*/100 mL for the last five summers). This, and the historic alert compliance of only 44% and an action compliance of 67%, suggests that the interim SFRG grade of "poor" for Raumanga Stream is realistic.

Whether or not a sign should be erected at this site is not clear-cut, and it may be that 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.

6.5 Kaikou River

SIC: Moderate **MAC: D** **SFRG: Poor**

The Kaikou River is frequently used for swimming by the Pipiwai community, especially during summer. This site was added to the programme in 2006/2007 at the request of Northland Health and the local community, particularly as there had been concerns with failing or inadequate onsite wastewater systems in the area. The dominant land use in the catchment is agricultural and pine forestry. The potential sources of faecal contamination are onsite wastewater systems (septic tanks) and run-off of faecal material from agricultural land use.

Microbiological water quality was worse in 2007/2008 compared to 2006/2007, with a higher medium, 95th percentile and compliance rates, as shown in table 13 (below).

Table 13: Collated results for the Kaikou River

	2007-08 Survey	Last Two Surveys
Median	413 *E. coli* per 100 mL	309 *E. coli* per 100 mL
95th Percentile	21339 *E. coli* per 100 mL	9927 *E. coli* per 100 mL
Alert Compliance	38%	44%
Action Compliance	61%	68%

As shown in figure 10 (below), the *E. coli* results breached the action threshold five times over the 2007/2008 summer, and exceeded the alert level on a further three occasions.

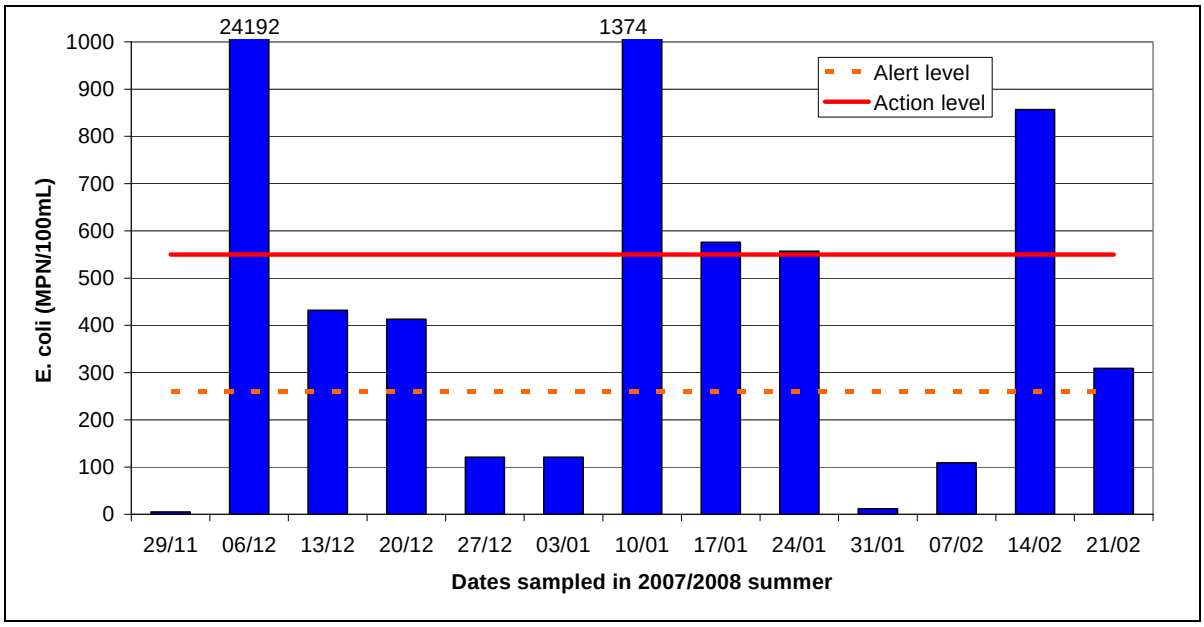

Figure 10: Results from the 2007-08 freshwater recreational contact sampling for Kaikou River, Pipiwai.

[4] As outlined in the introduction of this document.

The results from the last two summers suggest that bacterial levels in Kaikou River are affected by rainfall with extreme spikes of *E. coli* on days of heavy rainfall such as 6 December 2007 and 10 January 2008, as shown in figure 11 (below).

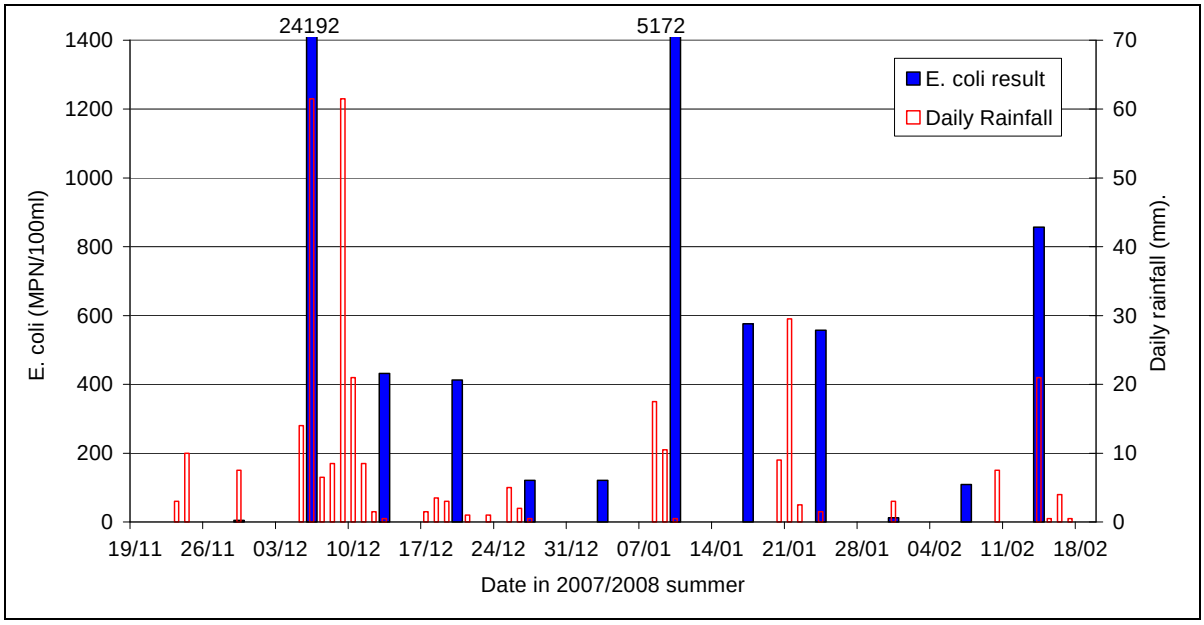

Figure 11: Rainfall and *E. coli* data for Kaikou River over the 2007-08 summer

With two years data now available for this site, there is sufficient data to calculate an interim suitability for recreation grade (SFRG). With a SIC assessment of "moderate" and a Microbiological Assessment Category (MAC) of 'D', it is not surprising the SFRG grade for this site is "poor". This suggests that this site is not suitable for recreational use on many occasions, particularly after heavy rain.

6.6 Langs Beach Stream (middle of beach)

SIC: N/A **MAC: N/A** **SFRG: N/A**

The stream in the middle of Langs Beach was added to the recreational water quality monitoring programme in 2007/2008 due to a request from the Whangarei District Council and Northland Health and because the other stream near the public toilets (site 100686) was removed from the programme.

This small stream flows on to the middle of Langs Beach and has a predominately native forest and shrub catchment with small areas of beef farming. Similarly to Ocean Beach Stream and the other Langs Beach Stream site, this is a popular spot for young children to paddle in. The most likely sources of bacteriological contamination include agricultural run-off, feral animals and poorly maintained septic tanks.

The microbiological water quality results for the 2007/2008 summer for the stream in the middle of Langs Beach are poor, with a high median and 95th percentile (both well above the action threshold) and low compliance rates, as shown in table 14 (below).

Table 14: Collated results for the Langs Beach Stream (middle of beach)

	2007-08 Survey
Median	842 *E. coli* per 100 mL
95th Percentile	5541 *E. coli* per 100 mL
Alert Compliance	15%
Action Compliance	31%

Of the 13 sampling occasions in 2007/2008, nine exceeded the action threshold with a further two exceeding the alert threshold, as shown in figure12 (below).

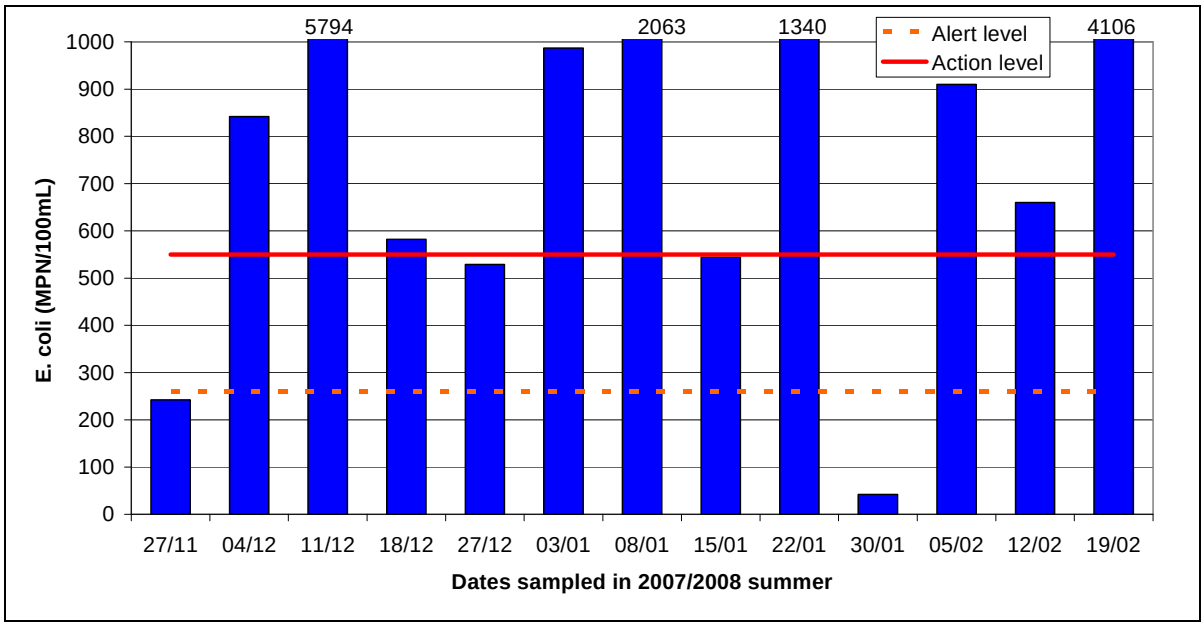

Figure 12: Results from the 2007-08 freshwater recreational contact sampling for the Stream in the middle of Langs Beach.

Although the extreme spikes in *E. coli* are related to rainfall events, there also appears to be a relatively high background level of contamination at this site which is consistent with the findings for other small streams that flow onto beaches.

There is insufficient data to calculate a MAC category and, in turn, SFRG grading for this site, but with just this first year of results it appears that this site is also going to have continually high bacterial levels which is consistent with other small streams that flow onto beaches. Research to date (see section 7) has not been able to provide conclusive results on the source of the contamination that we are detecting in these beach streams. More research will be done into these types of sites in the future. This site will remain in the recreational bathing water quality monitoring programme at least until enough data is collected to calculate an interim SFRG grade.

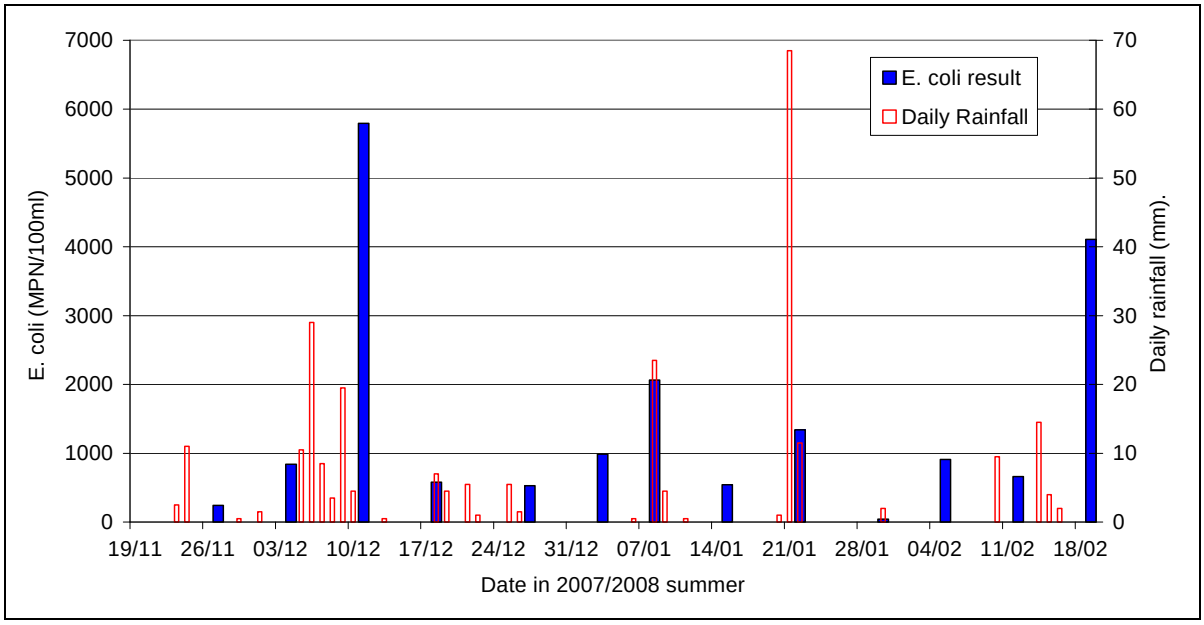

Figure 13: Rainfall and *E. coli* data for the stream in the middle of the Langs Beach over the 2007-08 summer

6.7 Waiharakeke Stream at Lucas Road

SIC: High **MAC: D** **SFRG: Very poor**

This is a popular swimming spot for local children, especially as the nearby Otiria Stream swimming hole is consistently unsuitable for swimming. Similarly to Otiria Stream this site has a mix of forestry and farming in the upstream catchment. This site was added to the recreational bathing programme in 2005/2006 at the request of the community and Northland Health.

Like the results from 2006/2007, Waiharakeke Stream had generally poor microbiological water quality in the 2007/2008 summer, with a high median, 95th percentile and low compliance rates, as shown in table 15 (below).

Table 15: Collated results for the Waiharakeke Stream

	2007-08 Survey	Last Two Surveys*
Median	556 *E. coli* per 100 mL	419 *E. coli* per 100 mL
95th Percentile	4475 *E. coli* per 100 mL	3352 *E. coli* per 100 mL
Alert Compliance	23%	32%
Action Compliance	46%	55%

* Note the site was moved to a new location from 2006/2007 onwards and therefore the results from 2005/2006 are excluded from this analysis

E. coli levels exceeded the action threshold on seven of 12 sampling occasions and exceeded the alert threshold on a further three occasions, as shown in figure 14 (below). Note: No sample was collected on 4 February 2008.

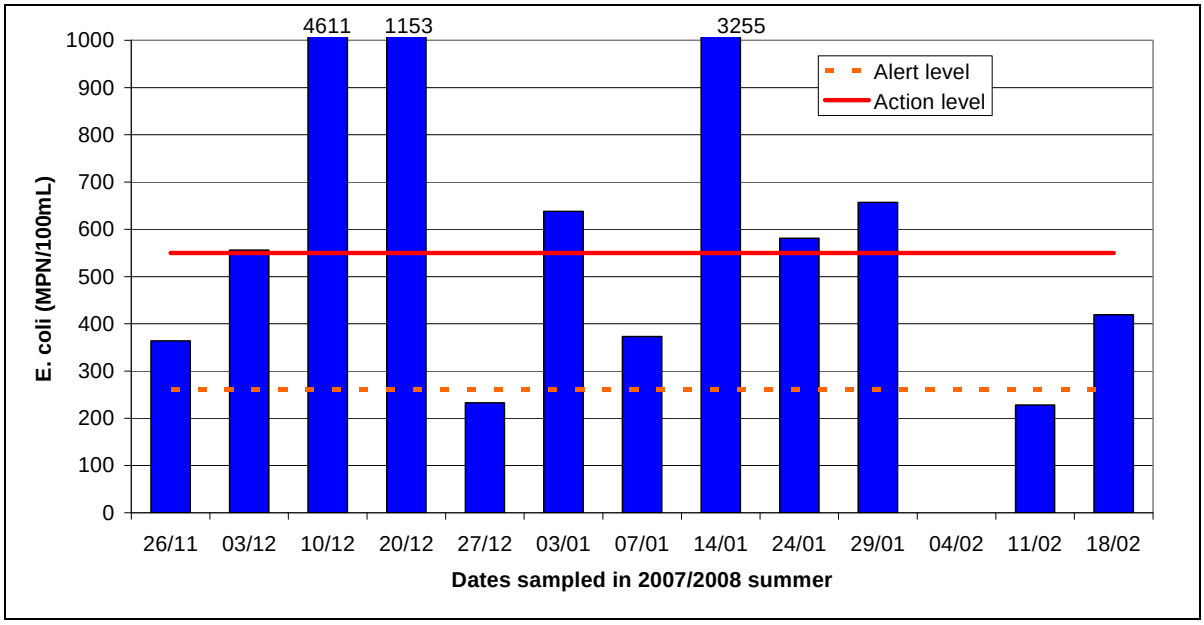

Figure 14: Results from the 2007/2008 freshwater recreational contact sampling for Waiharakeke stream at Lucas Road

It appears that there is a relationship between rainfall and *E. coli* in Waiharakeke Stream, with extreme spikes in *E. coli* occurring several days after heavy or prolonged rainfall, as shown in figure 15 (below).

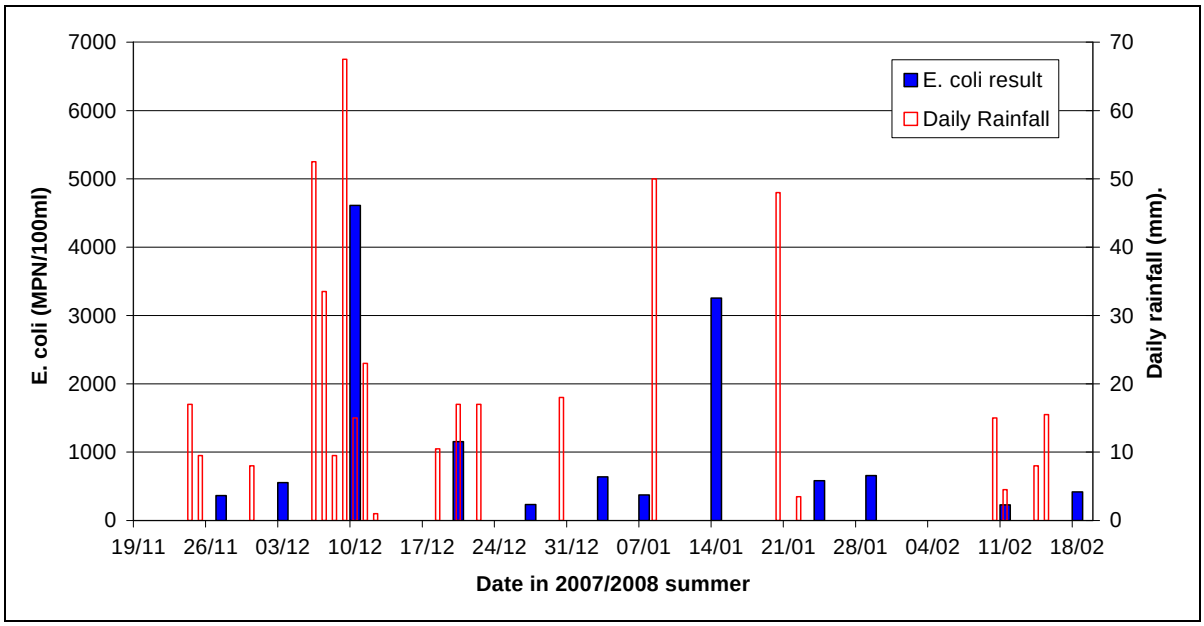

Figure 15: Daily rainfall and *E. coli* data for Waiharakeke stream at Lucas Road over the 2007/2008 summer

With two years data now available for this site, there is sufficient data to calculate an interim suitability for recreation grade (SFRG). With a Sanitary Inspection Category (SIC) of “high” and a Microbiological Assessment Category (MAC) of ‘D’, it is not surprising the SFRG grade for this site is “very poor”. This suggests that this site is not suitable for recreational use the majority of the time.

6.8 Waipapa River at Puketi Forest

SIC: low **MAC: D** **SFRG: Followup** NB: The grade is likely to be Fair for this site.

This site is located by the DOC camping ground in Puketi Forest and is a very popular picnic, camping and swimming spot. It has a predominately native forest catchment, so therefore you would expect consistently good water quality. It was added to the sampling programme in the 2006/2007 summer.

Like the results from 2006/2007, Waipapa River at Puketi Forest had generally good microbiological water quality in the 2007/2008 summer, with a low median and relatively high compliance rates, as shown in table 16 (below). The median is well below the alert threshold of 260 *E. coli*/100mL.

Table 16: Collated results for the Waipapa River at Puketi Forest.

	2007/2008 survey	Last two surveys
Median	82 *E. coli* per 100 mL	90 *E. coli* per 100 mL
95th Percentile	1132 *E. coli* per 100 mL	1354 *E. coli* per 100 mL
Alert Compliance	77%	83%
Action Compliance	92%	91%

The bacterial levels at the Waipapa River in Puketi forest site were good over the majority of the 2007/2008 sampling period with the action threshold exceeded on one sampling occasion and alert threshold exceeded on a further two occasions, as shown in figure 16 (below), all of which were related to rainfall events as shown in figure 17 (below).

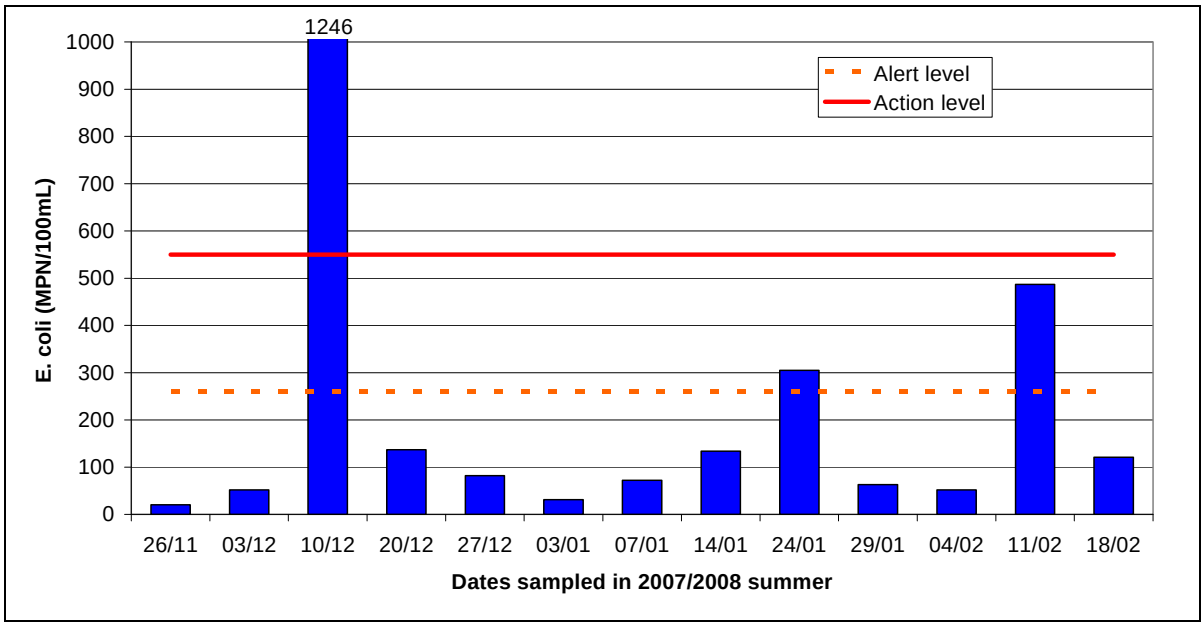

Figure 16: *E. coli* results from the 2007/2008 freshwater recreational contact sampling for Waipapa River at Puketi Forest.

With two years data now available for this site there is sufficient data to calculate an interim suitability for recreation grade (SFRG). However, the SIC assessment category of "low" contradicts the MAC result of 'D' giving an interim SFRG grade of irreconcilable follow up. Spikes after heavy rainfall have created a "D" MAC category, while levels are well below the alert threshold the rest of the time. Without the spikes associated with rainfall events the

SFRG grade for this site would be better described as “fair”. Therefore, it is recommended that any public description of the site should explain this particular discrepancy.

However, this does highlight that people should be aware that even rivers in relatively pristine native forest catchments are susceptible to contamination as a result of rainfall.

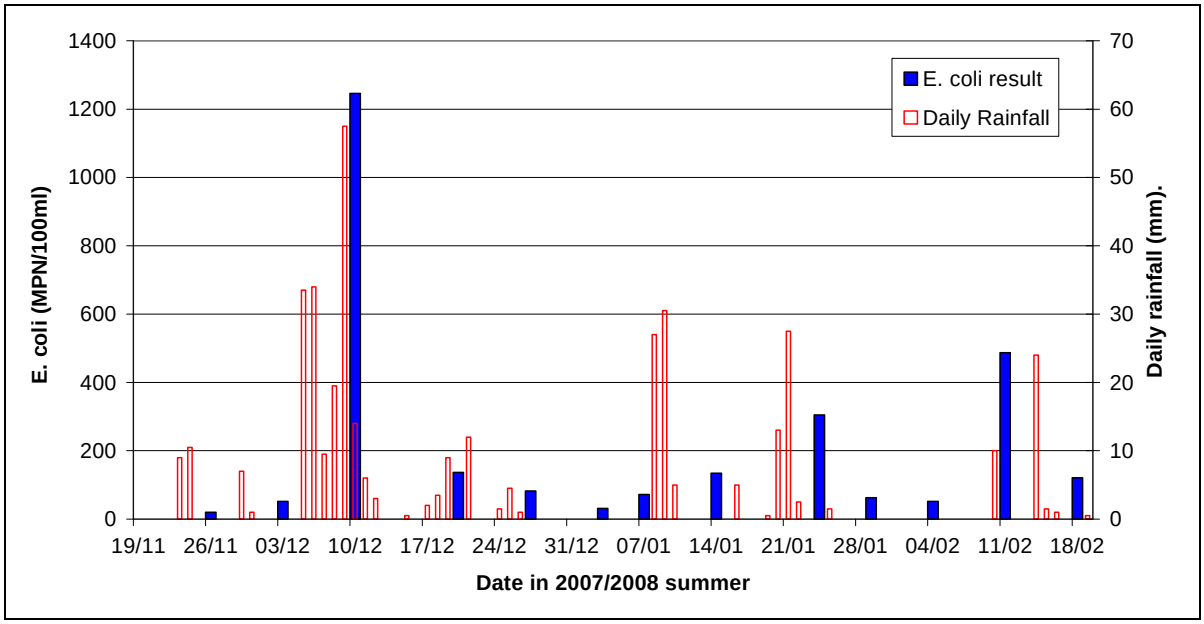

Figure 17: Daily rainfall and *E. coli* data for the Waipapa River at Puketi Forest site over the 2007/2008 summer

6.9 Waipapa River at Waipapa Landing

SIC: Moderate **MAC: D** **SFRG: Poor** NB: Fair is a more accurate grade for this site.

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 River has been a popular site for water users and picnickers.

The results for 2007/2008 were similar to the previous four summers, with a median below the alert threshold and similar compliance rates, as shown in table 17 (below). The high 95th percentile in 2007/2008 is due to the extreme spike in *E. coli* on 10 December 2007, which is a result of the heavy and prolonged rainfall received prior to sampling.

Table 17: Collated results for the Waipapa River at Waipapa Landing

	2007/2008 survey	Last five surveys
Median	74 *E. coli* per 100 mL	121 *E. coli* per 100 mL
95th Percentile	3539 *E. coli* per 100 mL	1017 *E. coli* per 100 mL
Alert Compliance	85%	83%
Action Compliance	92%	93%

The Waipapa River site was suitable for recreational bathing for the majority of the 2007/2008 summer, however levels exceeded the action threshold of 550 *E. coli* per 100

mL on one occasion and the alert threshold on one further occasion, as shown in figure 18 (below).

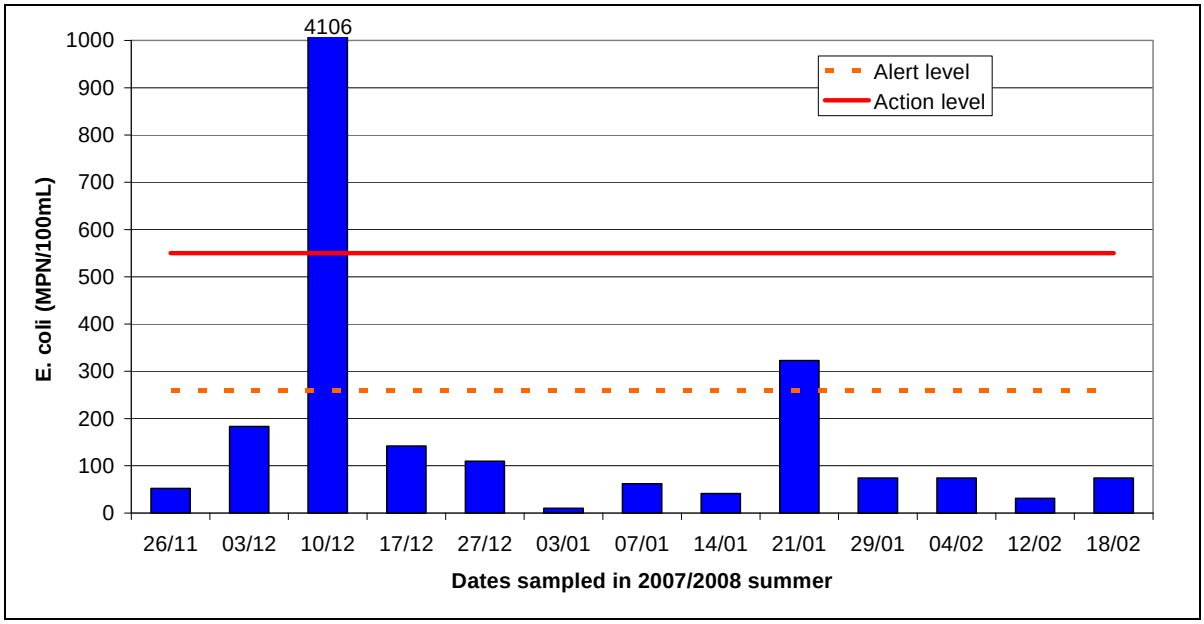

Figure 18: Results from the 2007/2008 freshwater recreational contact sampling for Waipapa River at Waipapa Landing

Bacterial levels in Waipapa River in the 2007/2008 summer were strongly related to rainfall, as shown in figure 18 (below). This is consistent with previous summers.

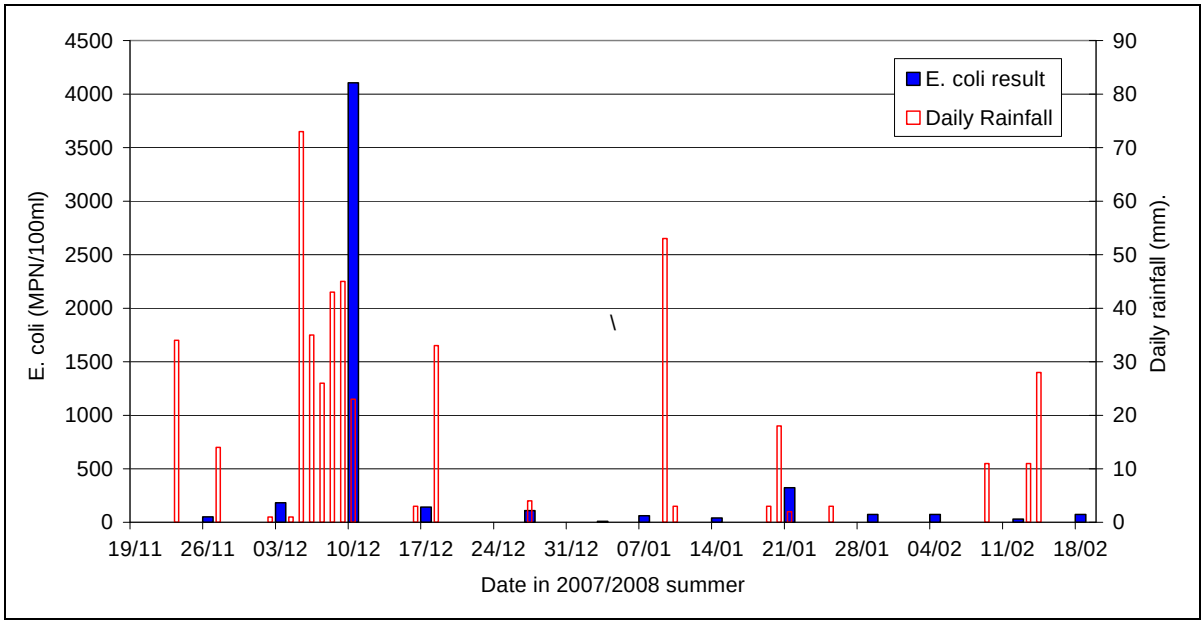

Figure 19: Rainfall and *E. coli* data for Waipapa Stream over the 2007-08 summer

As suggested in the last report (NRC 2006), an interim SFRG of "poor" is not an accurate reflection of the state of the Waipapa River. Spikes after heavy rainfall have created a 'D' MAC category, but for the bulk of the summer the water quality is good and with a SIC assessment of "moderate", a grade of "fair" would be a better assessment of the situation at Waipapa Landing. 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 for more than 5% of the sampling occasions can potentially fail (i.e. be categorised as poor or very poor), even if for the rest of the time water quality is very good.

6.10 Kerikeri River

SIC: High **MAC: D** **SFRG: Very poor**

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 and feral animals in bush remnants, are the main potential sources of pathogenic bacteria into the basin. Stormwater discharges and sewage reticulation system failures may also have a significant influence.

The microbiological water quality at the Kerikeri River site was fairly good over the 2007/2008 summer and similar to the previous four summers, as shown in table 18 (below).

Table 18: Collated results for the Kerikeri River

	2007-08 Survey	Last Five Surveys
Median	175 *E. coli* per 100 mL	187 *E. coli* per 100 mL
95th Percentile	6277 *E. coli* per 100 mL	4274 *E. coli* per 100 mL
Alert Compliance	54%	61%
Action Compliance	76%	78%

E. coli levels exceeded the action threshold on three of 13 sampling occasions and the alert threshold on a further three occasions, as shown in figure 20 (below).

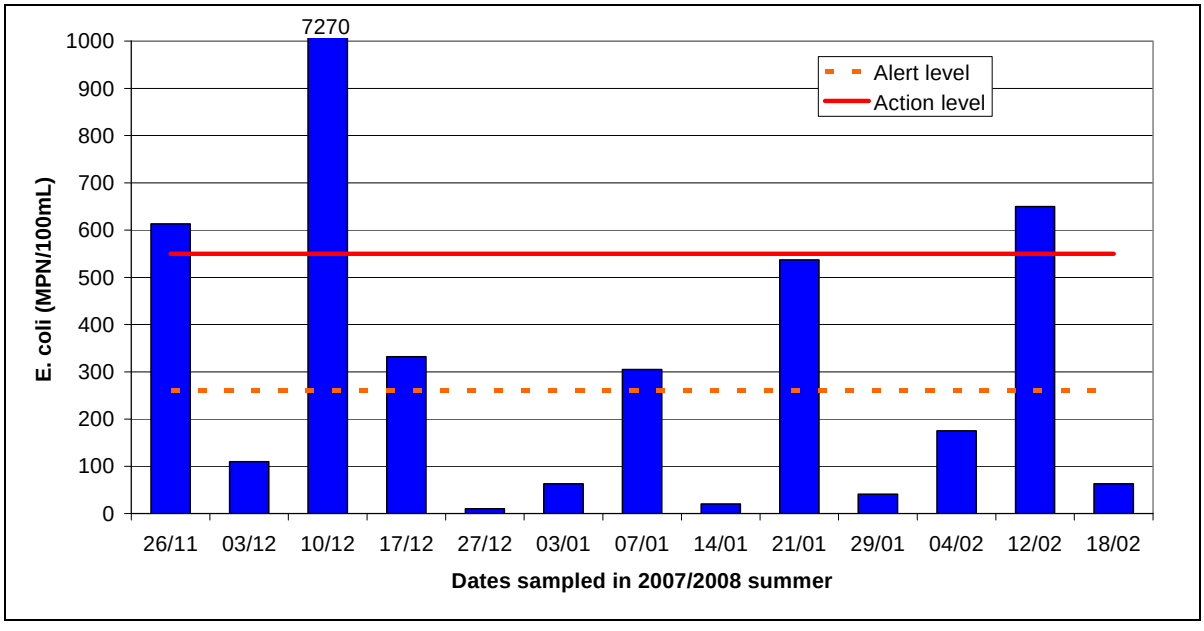

Figure 20: Results from the 2007-08 freshwater recreational contact sampling for Kerikeri River

Like most other freshwater sites in Northland, there was an extreme spike in *E. coli* levels on 10 December 2007 as a result of prolonged and heavy rainfall in the week preceding sampling as shown in figure 21 (below).

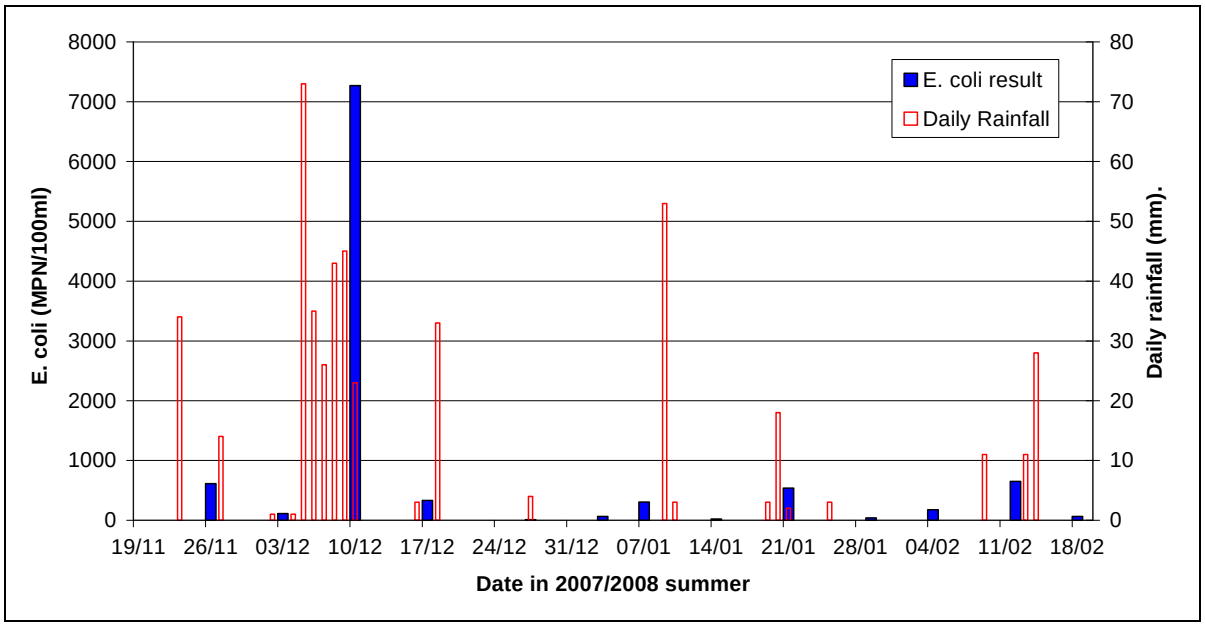

Figure 21: Rainfall and *E. coli* levels for the Kerikeri River over the 2007-08 summer

Like many of our river bathing sites in Northland, the results for Kerikeri River produce a MAC category of 'D'. This, coupled with a SIC assessment result indicating there is a "high" risk of faecal contamination, means the interim SFRG grade for the Kerikeri River site at Stone Store remains "very poor".

6.11 Waitangi River at Lily Pond

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 at a popular swimming hole known as Lily Pond. Upstream agricultural land use and increasing lifestyle block developments significantly impact upon this stony bottomed and fast flowing river.

The 2007/2008 results are slightly worse than previous years for Waitangi River at Lily Pond, with a higher median and 95th percentile and much lower compliance rates, as shown in table 19 (below).

Table 19: Collated results for the Waitangi River

	2007/2008 Survey	Last Five Surveys
Median	292 *E. coli* per 100 mL	240 *E. coli* per 100 mL
95th Percentile	3725 *E. coli* per 100 mL	1977 *E. coli* per 100 mL
Alert Compliance	31%	54%
Action Compliance	69%	86%

The action threshold was exceeded on four of 13 sampling occasions and the alert threshold was exceeded on a further five occasions, as shown in figure 22 (below).

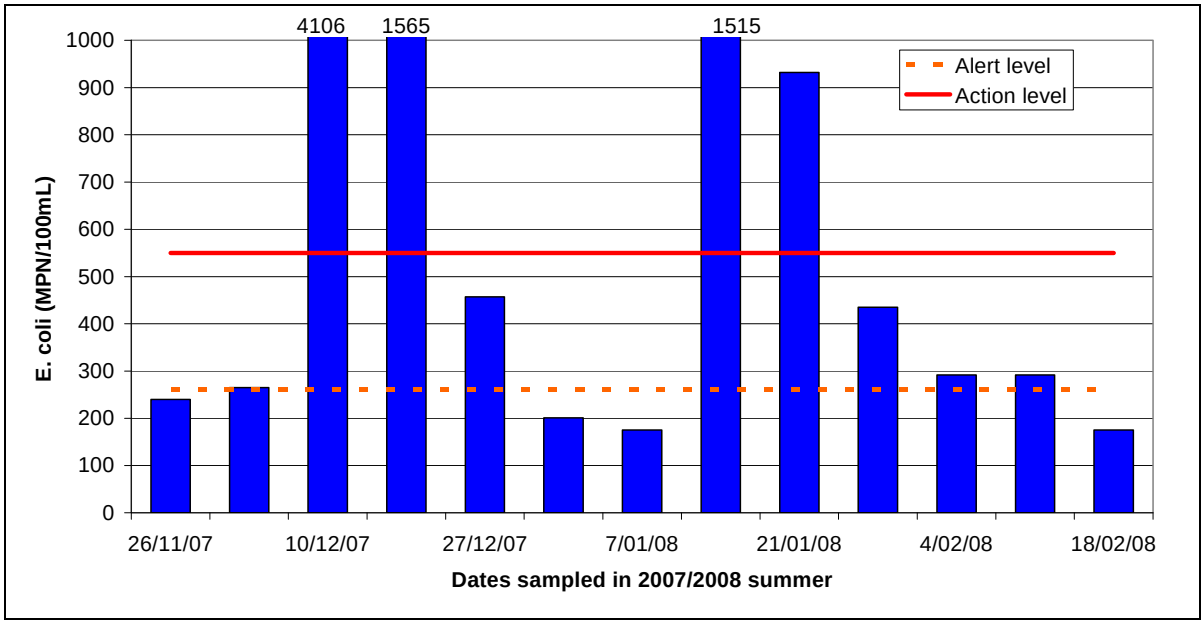

Figure 22: Results from the 2007-08 freshwater recreational contact sampling for Waitangi River

Surface runoff as a result of rainfall appears to be causing elevated *E. coli* levels, as breaches of the alert and action thresholds occur when it has rained prior to sampling, as shown in figure 23 (below).

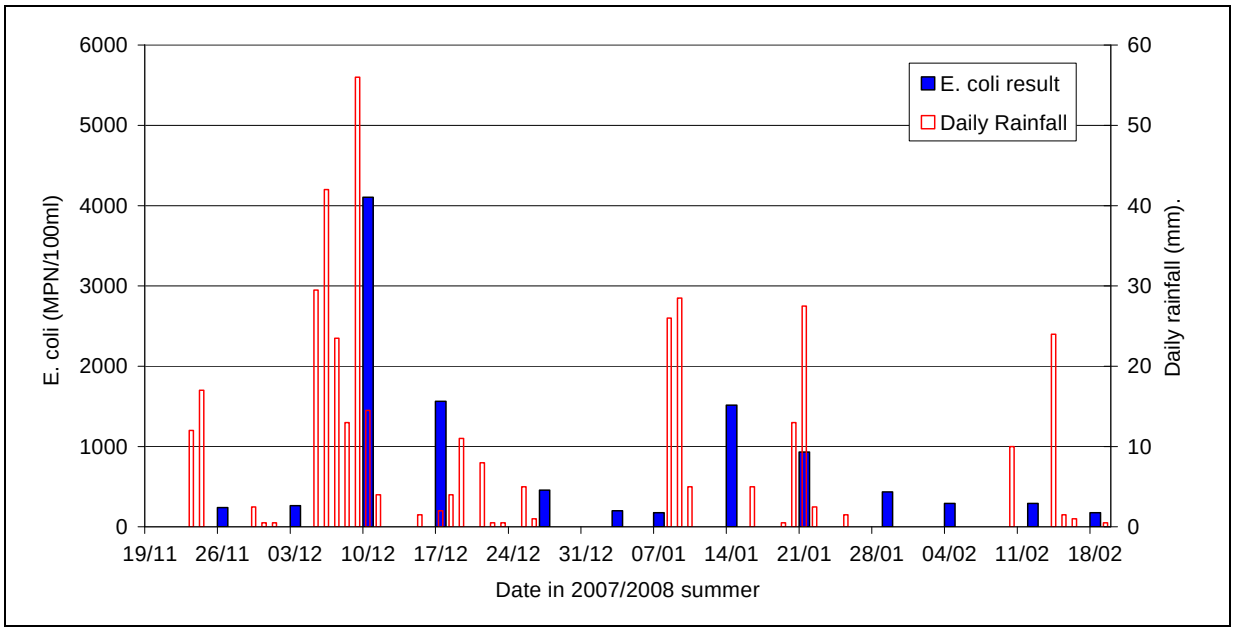

Figure 23: Rainfall and *E. coli* levels for Waitangi River over the 2007-08 summer

With a historical compliance rate of only 54% with the alert threshold and a Hazen 95th Percentile of 1977 *E. coli*/ per 100 mL it is not surprising the Waitangi River site has a MAC assessment category of 'D' and in turn a interim SFRG grading of "very poor". It was suggested in the 2004/2005 report that a grading of "poor" would be fairer for this site, however the results from the last three years do not support this suggestion. There has been an increase in the number of exceedences of the guideline levels each summer, suggesting that a SFRG grade of "very poor" is probably appropriate for this site unless there is an improvement in water quality.

6.12 Tirohanga Stream

SIC: Moderate **MAC: D** **SFRG: Poor**

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.

The microbiological water quality results for 2007/2008 are similar to the last four summers, as shown in table 20 (below).

Table 20: Collated results for the Tirohanga Stream

	2007-08 Survey	Last Five Surveys
Median	231 *E. coli* per 100 mL	259 *E. coli* per 100 mL
95th Percentile	1013 *E. coli* per 100 mL	1379 *E. coli* per 100 mL
Alert Compliance	62 %	52 %
Action Compliance	84 %	85 %

In general, the bacteriological quality of the water in Tirohanga Stream was good in the 2007/2008 summer, with *E. coli* levels below the alert threshold of 260/100 mL on eight of the 13 sampling occasions, as shown in figure 24 (below).

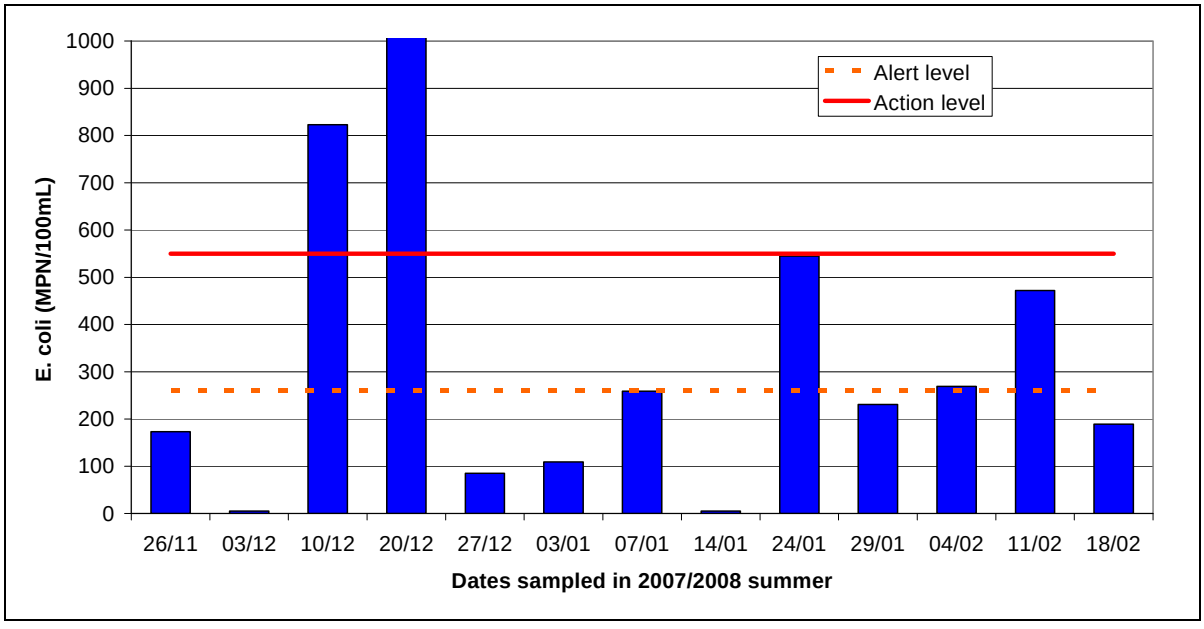

Figure 24: Results from the 2007-08 freshwater recreational contact sampling for Tirohanga Stream

There appears to be a clear relationship between rainfall and elevated *E. coli* levels in Tirohanga Stream for the 2007/2008 summer. The good news is there was no contamination events in 2007/2008 that were not related to rainfall as were reported in the 2005/2006 summer (NRC 2006).

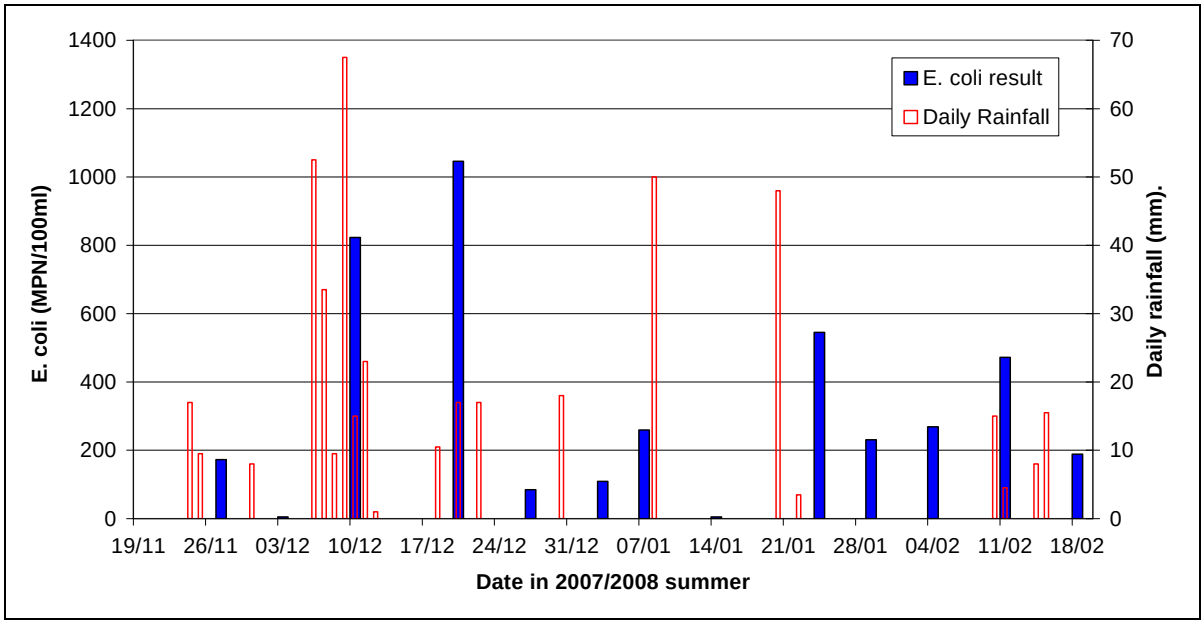

Figure 25: Rainfall and *E. coli* levels in Tirohanga Stream over the 2007-08 summer

With a Hazen 95th percentile of 1379 *E. coli* per 100 mL for the last five survey results, the Tirohanga Stream has a MAC category of 'D' and has a SFRG interim grade of "poor". In the 2004/2005 report it was suggested that the grade is likely to improve to "fair" as more data is obtained (NRC 2005), but as the microbiological water quality remains variable at this site, the grade is still "poor". With this site only having microbiological water quality that is safe for swimming about half the time (compliance with alert threshold of 52%), a grade of "poor" is warranted for this site.

6.13 Kapiro Stream at Purerua Road Bridge

SIC: Moderate **MAC: D** **SFRG: Poor**

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 Purerua 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.

The microbiological results for 2007/2008 were similar to the previous four summers, as shown in table 21 (below).

Table 21: Collated results for the Kapiro Stream

	2007/2008 Survey	Last Five Surveys
Median	272 *E. coli* per 100 mL	246 *E. coli* per 100 mL
95th Percentile	2397 *E. coli* per 100 mL	1233 *E. coli* per 100 mL
Alert Compliance	46 %	47 %
Action Compliance	76 %	85 %

Bacterial levels in Kapiro Stream exceeded the action threshold on three of 13 sampling occasions and the alert threshold on a further five occasions in the 2007/2008 summer, as shown in figure 26 (below).

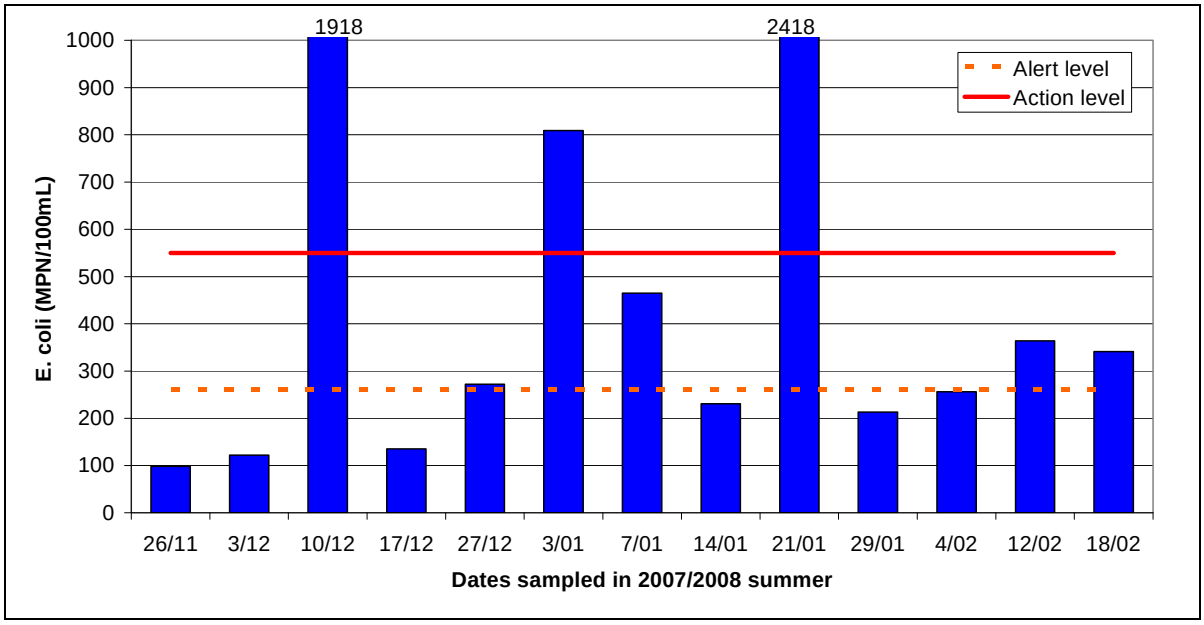

Figure 26: *E. coli* results from the 2007/2008 recreational contact survey for Kapiro Stream

The results from this summer show quite a strong relationship between *E. coli* and rainfall, with spikes in *E. coli* usually associated with heavy and/or prolonged rainfall prior to sampling, as shown in figure 27 (below). Therefore the likely source of contamination at this site is agricultural run-off during rainfall. There is a small spike in *E. coli* on 3 January 2008 which is not associated with a rainfall event. The cause of this contamination is unclear.

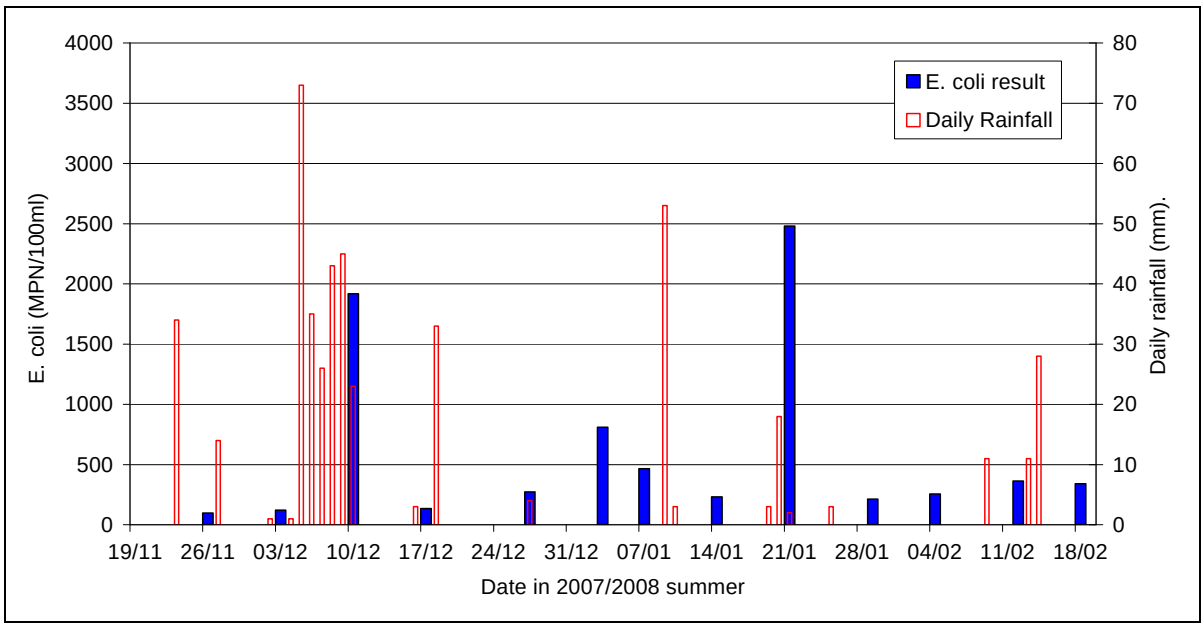

Figure 27: Rainfall and *E. coli* data for Kapiro Stream over the 2007-08 summer

With a SIC assessment of “moderate” susceptibility to faecal contamination and a MAC category of ‘D’ the interim SFRG grade for the Kapiro Stream site is “poor”. As the bacterial water quality has got worse at his site, it is unlikely that this grade will improve as suggested in the last report (NRC 2006).

6.14 Waipoua River

SIC: Low **MAC: D** **SFRG: Followup** NB: The grade is likely to be Fair for this site.

This site is situated near the DOC camping ground in Waipoua Forest and is a very popular picnic, camping and swimming spot. It has a predominately native forest catchment, so therefore you would expect consistently good water quality. It was added to the programme in the 2005/2006 summer.

Microbiological water quality was slightly worse in 2007/2008 compared to the two previous summers, with a higher median and 95th percentile and lower compliance rates, as shown in table 22 (below).

Table 22: Collated results for the Waipoua River

	2007/2008 Survey	Last Three Surveys
Median	74 *E. coli* per 100 mL	52 *E. coli* per 100 mL
95th Percentile	7001 *E. coli* per 100 mL	3965 *E. coli* per 100 mL
Alert Compliance	84 %	89 %
Action Compliance	84 %	91 %

Water quality in the Waipoua River was good over the 2007/2008 season. The action and alert thresholds were breached on two of 13 occasions, as shown in figure 28 (below), both of which were as a result of rainfall, as shown in figure 29 (below).

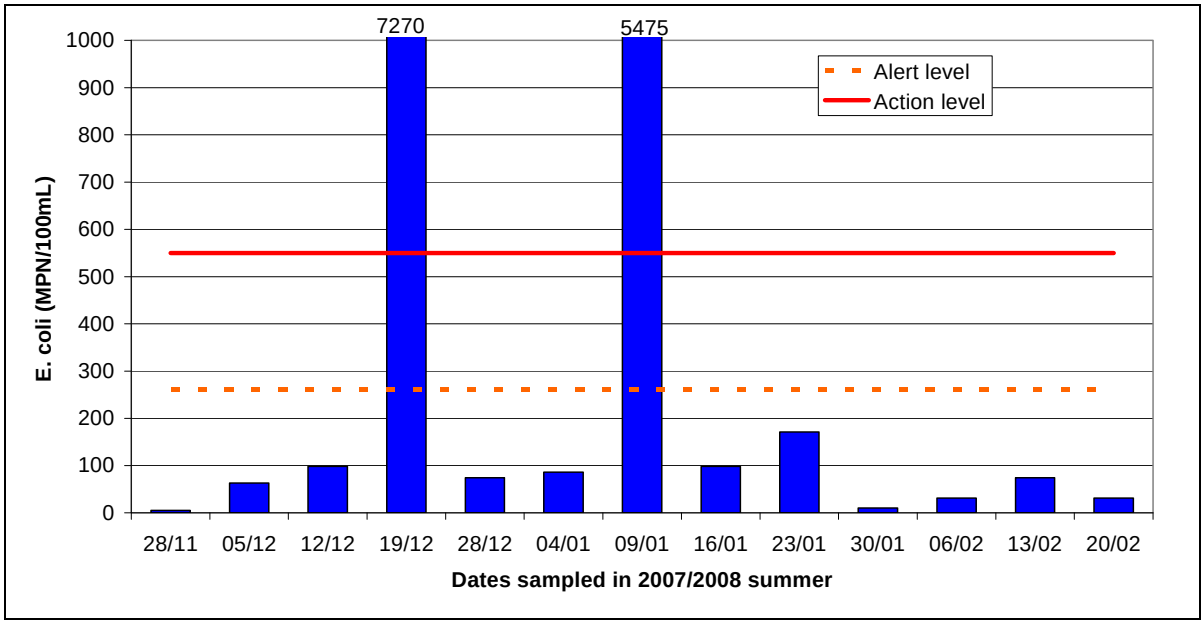

Figure 28: Results from the 2007-08 freshwater recreational contact sampling for Waipoua River.

Similarly to Waipapa River in Puketi Forest, Waipoua River had an interim SFRG grade of 'follow-up' because the SIC category contradicts the MAC result. Spikes after heavy rainfall have created a 'D' MAC category, while levels are well below the alert threshold the rest of the time. Without the spikes associated with rainfall events the SFRG grade for this site would be better described as "fair".

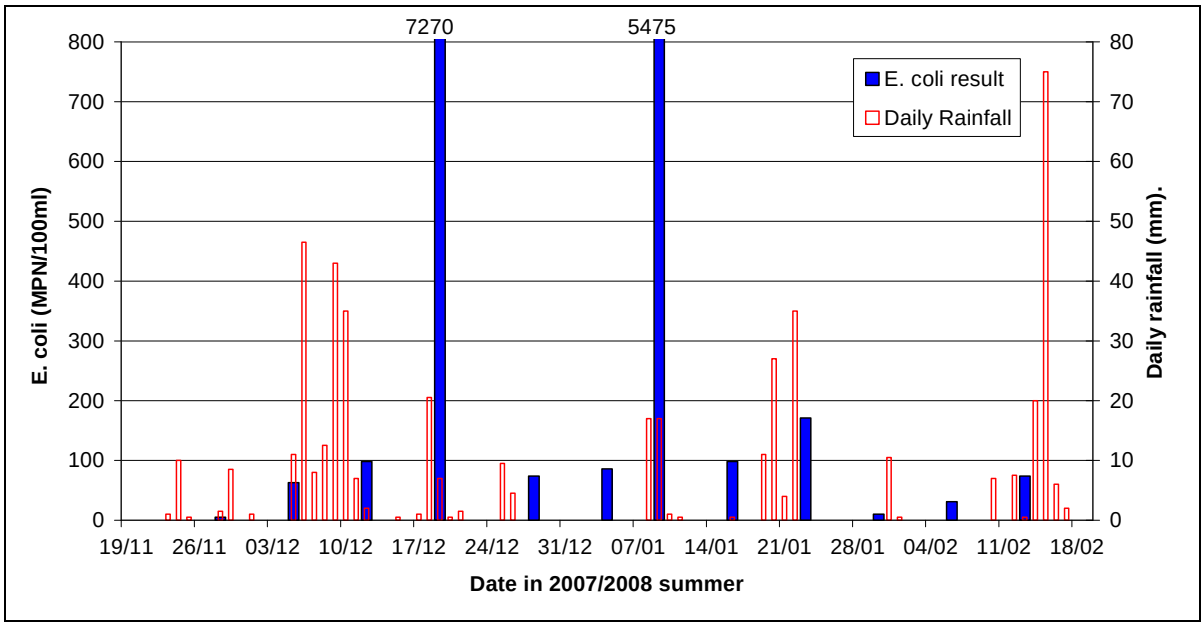

Figure 29: Rainfall and *E. coli* data for Waipoua River over the 2007-08 summer

6.15 Mangakahia River at Twin Bridges

SIC: Moderate **MAC: D** **SFRG: Poor**

The Mangakahia River catchment upstream of Twin Bridges is a mix of native forest, exotic forestry and moderately intensive sheep and beef farming. The Twin Bridges is a popular spot for picnics, camping and swimming, however there are no public toilets available.

Microbiological water quality for the 2007/2008 summer was similar to the previous four summers for Mangakahia River at Twin Bridges, as shown in table 23 (below). However, there was a much higher 95th percentile for the 2007/2008 results due to two extremely high spikes in *E. coli*.

Table 23: Collated results for Mangakahia River at Twin Bridges

	2007-08 Survey	Last Five Surveys
Median	231 *E. coli* per 100 mL	246 *E. coli* per 100 mL
95th Percentile	23543 *E. coli* per 100 mL	14823 *E. coli* per 100 mL
Alert Compliance	62 %	53 %
Action Compliance	69 %	71 %

There were four exceedences of the action threshold and one further exceedence of the alert threshold at this Mangakahia River site for the 13 sampling occasions in 2007/2008, as shown in figure 30 (below).

There is a link between run-off as a result of rainfall and *E. coli* at the Twin Bridges site, as shown in figure 31 (below). However, there is also several extreme spikes in *E. coli* that are not associated with rainfall events such as on 4 January and 9 January 2008. This could be as a result of stock access to the river, and/or stock effluent and septic tank discharges.

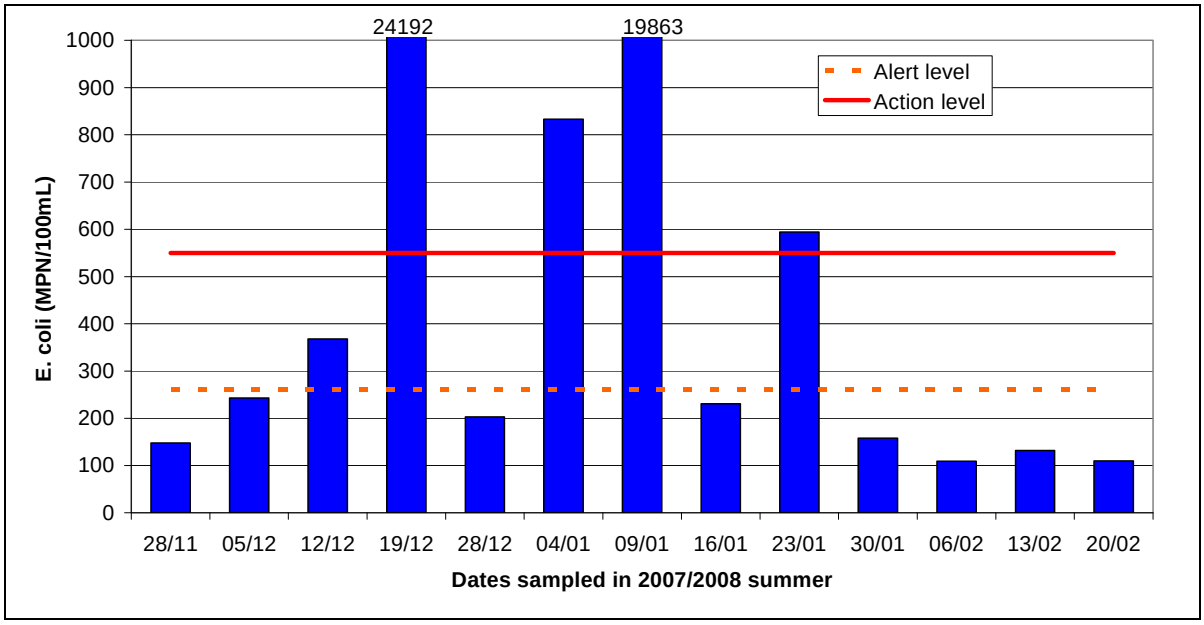

Figure 30: Results from the 2007/2008 freshwater recreational contact sampling for Mangakahia River at Twin Bridges

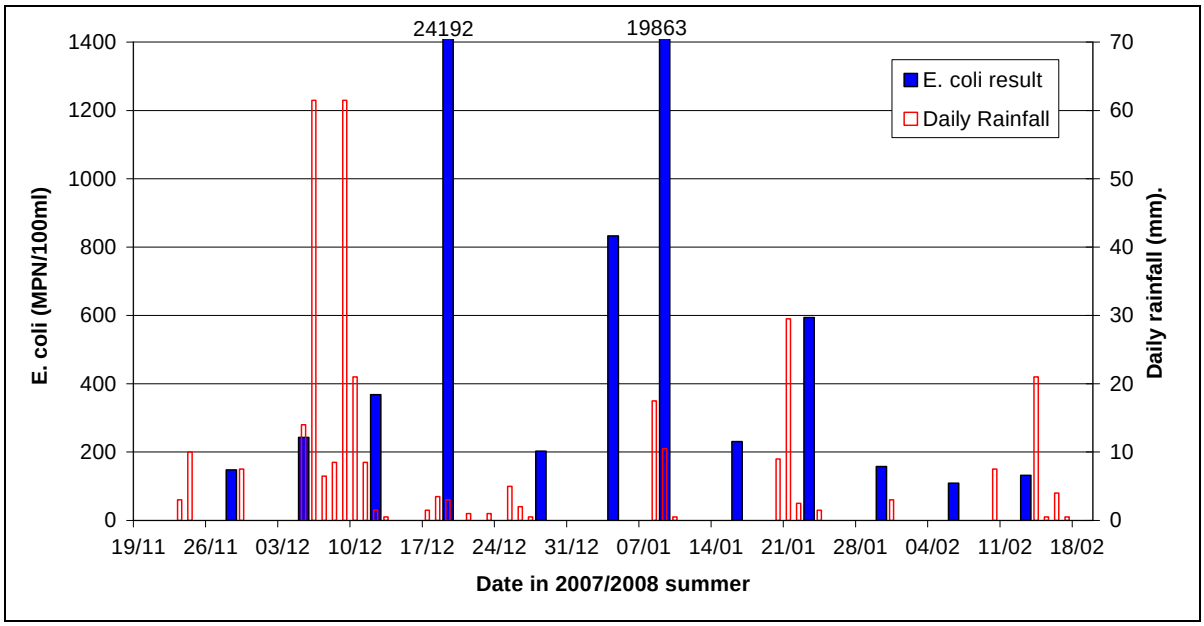

Figure 31: Rainfall and *E. coli* levels at twin bridges (Mangakahia River) over the 2007-08 summer

Like many of our river bathing sites in Northland, the results for Mangakahia River produce a MAC category of 'D'. This, coupled with a SIC assessment result indicating there is a "moderate" risk of faecal contamination, means the interim SFRG grade for the Mangakahia River site, Twin Bridges, remains "poor".

6.16 Otaua Stream

SIC: High **MAC: d** **SFRG: Very poor**

The Otaua Stream swimming hole on Otaua Road west of Kaikohe added to the sampling programme in 2004/2005 due to its popularity and concerns over water quality after an outbreak of gastroenteritis in the community in November 2004 (Tahi Morton *pers. comm*.). The site is located just up the road from a marae and has predominantly agricultural land use in its upstream catchment. There would be contamination risks associated with agricultural run-off and poorly maintained septic tanks in the rural areas upstream of the swimming hole.

Microbiological water quality was similar in Otaua Stream in 2007/2008 to the three previous summers, as shown in table 24 (below).

Table 24: Collated results for Otaua Stream, Kaikohe

	2007/2008 Survey	Last Four Surveys
Median	271 *E. coli* per 100 mL	281 *E. coli* per 100 mL
95th Percentile	4831 *E. coli* per 100 mL	4943 *E. coli* per 100 mL
Alert Compliance	50 %	46 %
Action Compliance	75 %	70 %

The action threshold was exceeded on three of 12 sampling occasions and the alert threshold was exceeded on a further two occasions, as shown in figure 32 (below).

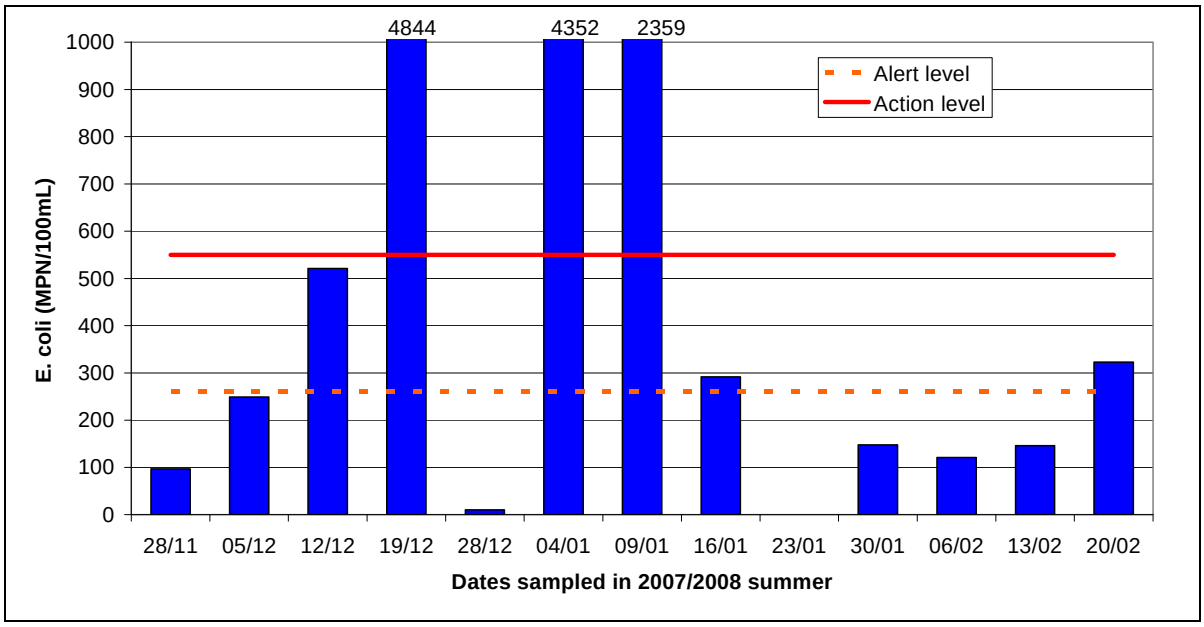

Figure 32: Results from the 2007-08 freshwater recreational contact sampling for Otaua Stream swimming hole. Note: No sample was analysed for 23 January 2008.

Similarly to Mangakahia River, there is a link between run-off as a result of rainfall and *E. coli* in the Otaua Stream; however with an extreme spike in *E. coli* on 4 January 2008 that is not associated with a rainfall event, as shown in figure 33 (below). This contamination could be as a result of stock access to the river, and/or stock effluent and septic tank discharges.

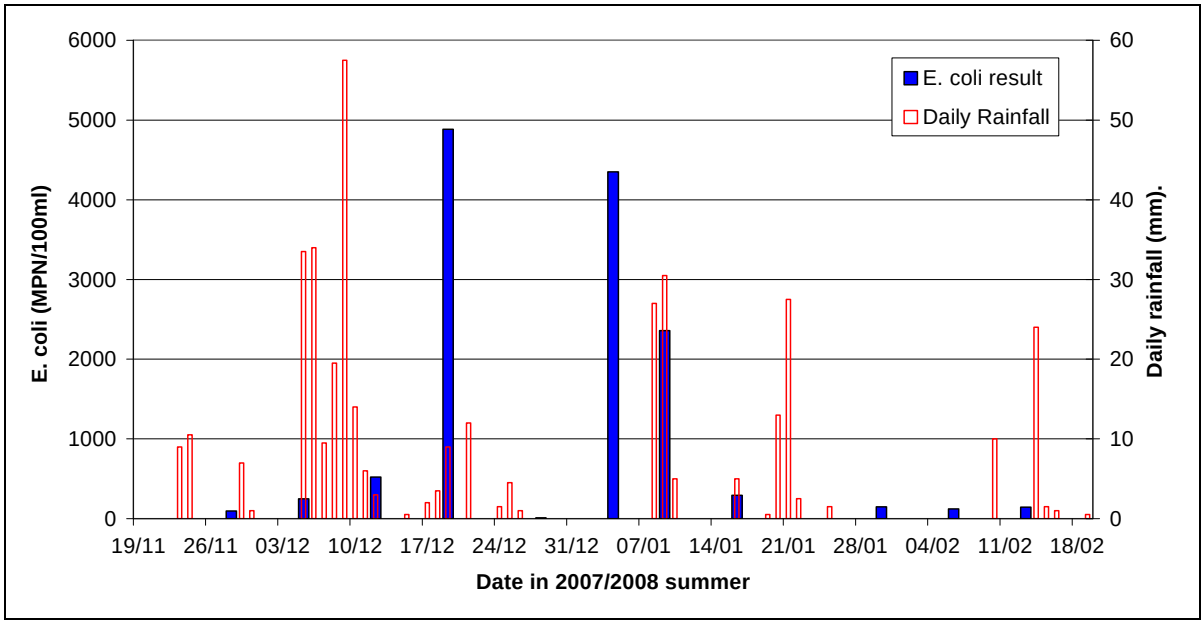

Figure 33: Rainfall and *E. coli* levels for Otaua Stream over the 2007-08 summer

With a SIC assessment category of "high" and MAC category of 'D', the interim SFRG grade for Otaua Stream is "very poor", which is a realistic grade for the microbiological water quality at this site.

6.17 Kaihu River

SIC: high MAC: D SFRG: Very poor NB: Fair/poor are more accurate grades for this site.

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 Northland Regional Council takes samples below the camping ground, which is extremely popular over the summer months. By the time the Kaihu River reaches the motor camp, the river includes both the Waima River and Mangatu Stream.

Microbiological water quality was similar in Kaihu River in 2007/2008 to the four previous summers, as shown in table 24 (below).

Table 25: Collated results for the Kaihu River

	2007/2008 Survey	Last Five Surveys
Median	86 *E. coli* per 100 mL	115 *E. coli* per 100 mL
95th Percentile	9663 *E. coli* per 100 mL	5846 *E. coli* per 100 mL
Alert Compliance	77 %	79 %
Action Compliance	84 %	82 %

The water quality at the Kaihu River was good for the majority of the summer. The action threshold was breached twice and the alert threshold once, as shown in figure 34 (below), all of which were related to rainfall events, as shown in figure 35 (below).

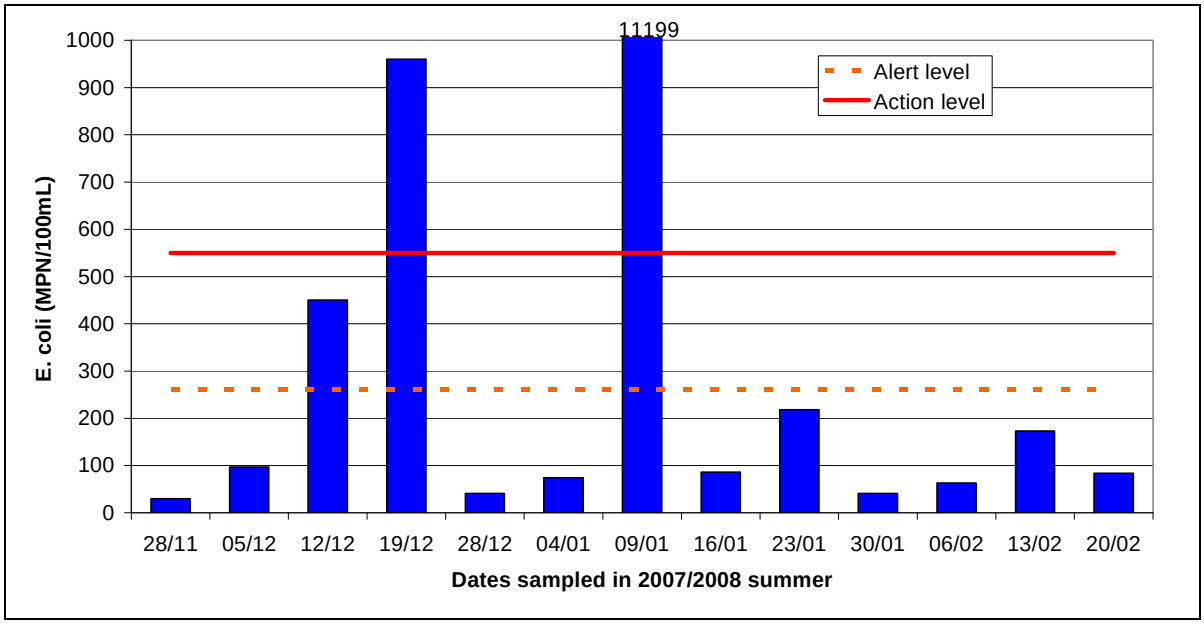

Figure 34: Results from the 2007-08 freshwater recreational contact sampling for Kaihu River

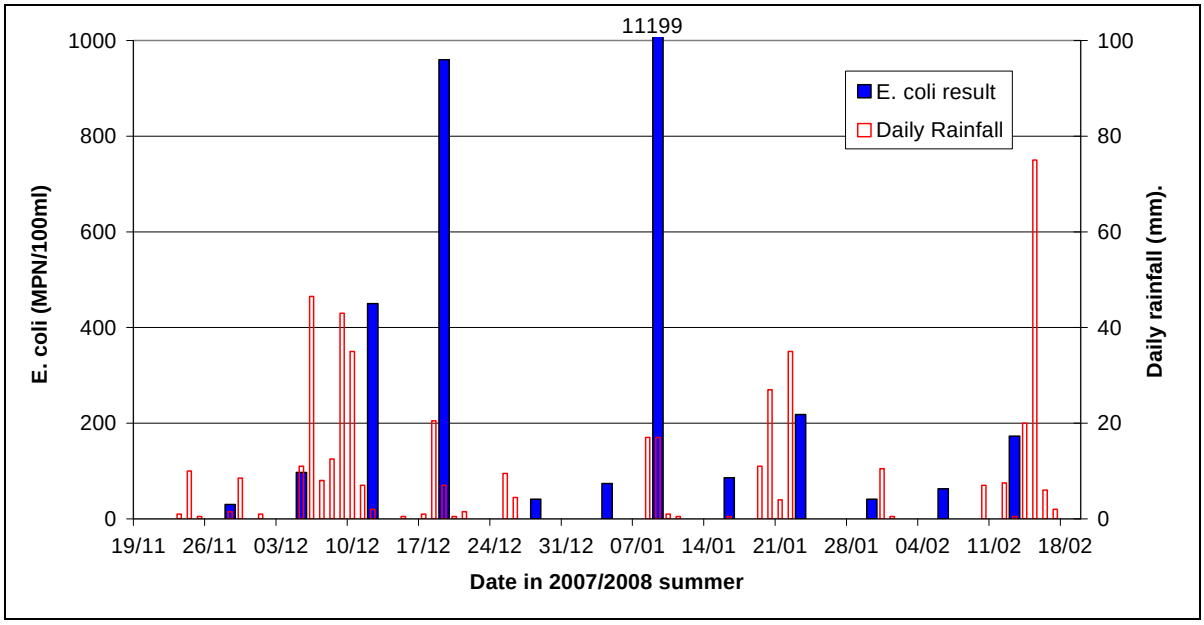

Figure 35: Rainfall and *E. coli* data for the Kaihu River over the 2007-08 summer

The interim SFRG grade, based on a MAC of 'D' due to the high 95th percentile and a SIC assessment of "high" due to the intensive agricultural land use in the immediate catchment, calculates to be "very poor". However, the median and compliance rates suggest that water quality is suitable for swimming the majority of the time and that a grading of either "poor" or "fair" is probably more accurate of the situation at the Kaihu River swimming hole, as long as the basic rules discussed in section 2 of this report are followed.

6.18 Omamari Beach Stream

SIC: Low **MAC: D** **SFRG: Follow up** NB: The SIC is likely to be Moderate and the SFRG Poor for this site.

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 farming and exotic forestry catchment. The Omamari Beach Stream is only a small stream, 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. There is a risk of contamination from poorly maintained septic tanks, however the risk would be low as there are not many houses in Omamari.

The microbiological water quality in the Omamari Beach Stream was slightly worse in the 2007/2008 summer compared to the previous four summers, as shown in table 26 (below).

Table 26: Collated results for the Omamari Beach Stream

	2007-08 Survey	Last Five Surveys
Median	218 *E. coli* per 100 mL	173 *E. coli* per 100 mL
95th Percentile	2087 *E. coli* per 100 mL	1207 *E. coli* per 100 mL
Alert Compliance	62 %	69 %
Action Compliance	69 %	81 %

The action guideline level was exceeded four times and the alert level once further, as shown in figure 36 (below). The median, however, was still below the alert level of 260 *E. coli* per 100 mL.

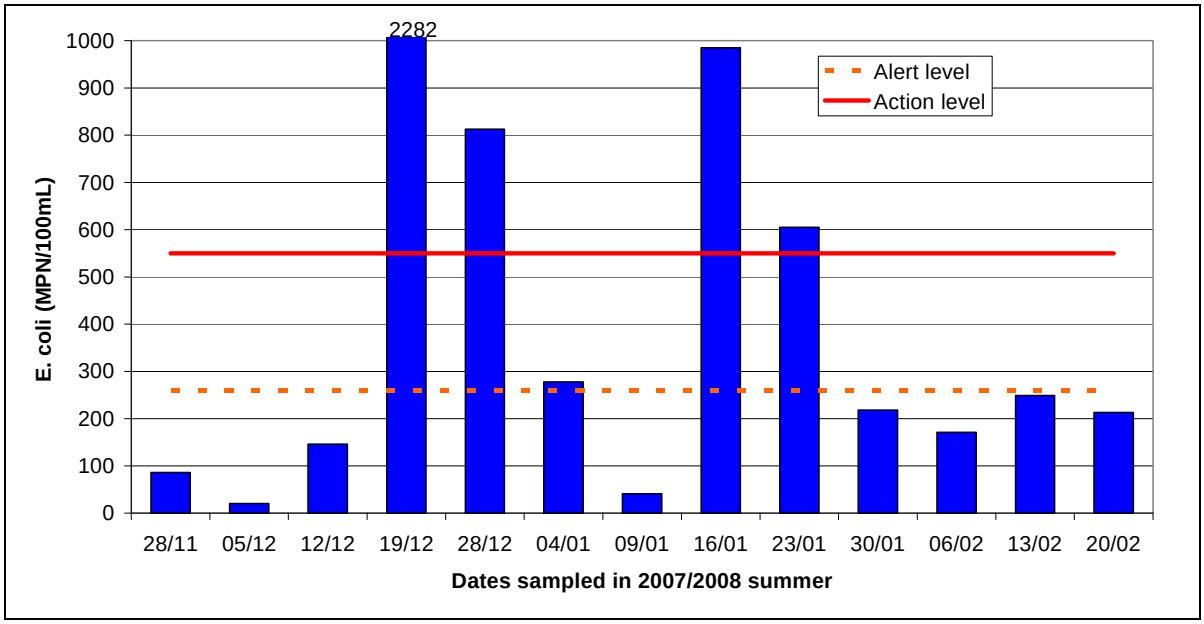

Figure 36: Results from the 2007-08 freshwater recreational contact sampling for Omamari Beach Stream

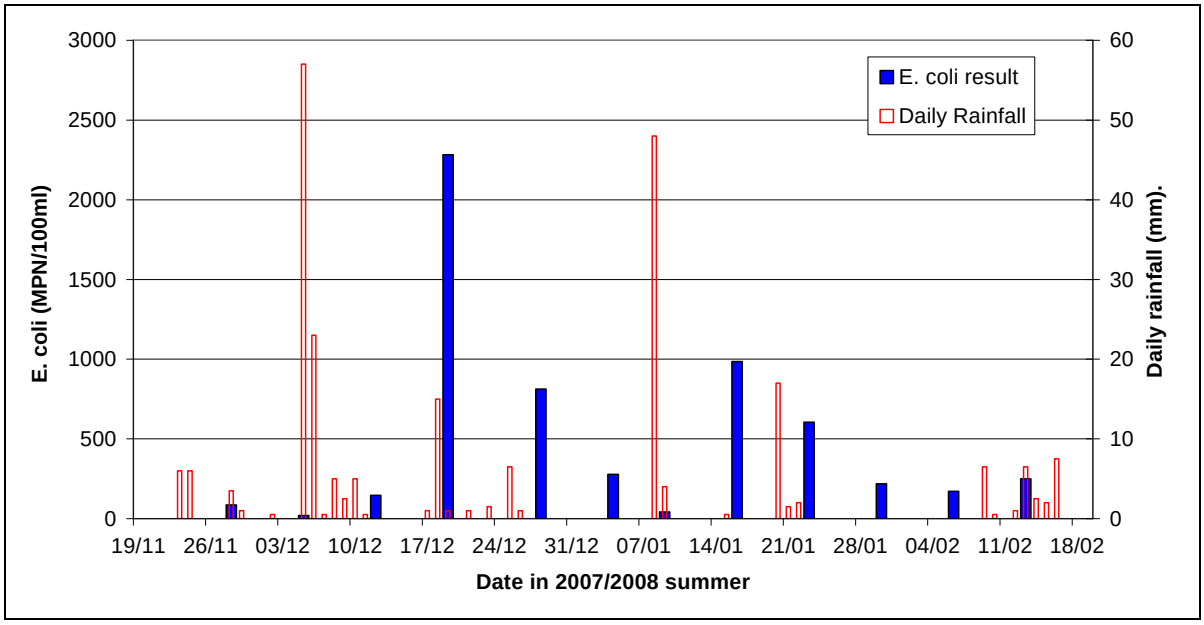

Figure 37: Rainfall and *E. coli* levels in Omamari Beach Stream over the 2007-08 summer

The interim SFRG for Omamari Beach Stream could not be calculated because the SIC assessment of "low" contradicts with the MAC of 'D', giving a grade of "follow up". As suggested in the last report (NRC 2006), a "low" risk of this site being unsuitable for swimming is likely to be too conservative and it is more likely to be "moderate", which would give an interim grade of "poor".

6.19 Ocean Beach Stream

SIC: High **MAC: D** **SFRG: Very poor**

Ocean Beach Stream is only small, flowing out onto Ocean Beach on the coastal side of Whangarei Heads, with a predominately sheep and beef farming catchment and some native forest in the headwaters. It is a popular stream for children to paddle in, but it has had consistently high *E. coli* levels over the last four years. Therefore it was removed from the sampling programme before the 2007/2008 summer and a permanent warning sign was erected by Whangarei District Council. The most likely sources of bacteriological contamination include agricultural run-off, poorly maintained septic tanks and faecal material from ducks and seagulls.

Ocean Beach Stream was sampled on four occasions in the 2007/2008 summer, the results of which were added to the previous three summers results and are shown in table 27 (below). The microbiological water quality in Ocean Beach Stream is still very poor, with all four sampling occasions in 2007/2008 exceeding the action threshold, as shown in figure 38 (below).

Table 27: Collated results for Ocean Beach Stream

	Last Four Surveys
Median	985 *E. coli* per 100 mL
95th Percentile	10864 *E. coli* per 100 mL
Alert Compliance	26%
Action Compliance	36%

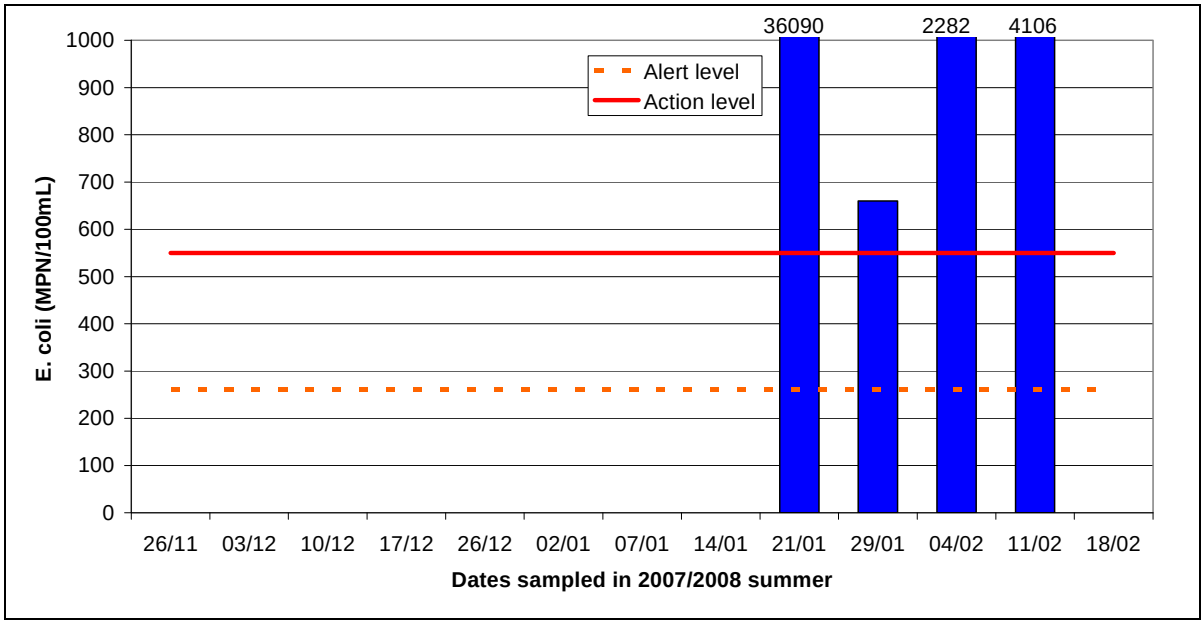

Figure 38: Results from the 2005-06 freshwater recreational contact sampling for Ocean Beach Stream

The extreme spike in *E. coli* on 21 January 2008 is associated with a heavy rainfall event, however the background levels of *E. coli* in Ocean Beach Stream are high regardless of rainfall, as shown in figure 39 (below).

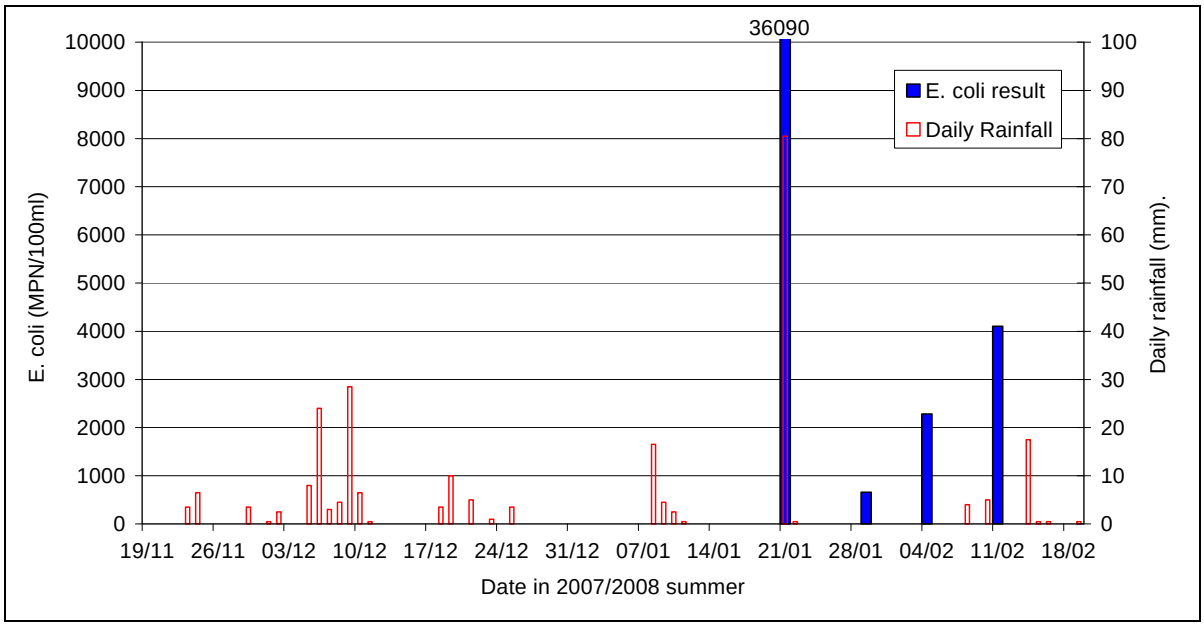

Figure 39: Rainfall and *E. coli* data at Ocean Beach Stream site over the 2005-06 summer

As the bacterial levels were constantly elevated in Ocean Beach Stream irrelevant of rainfall, the possible sources of contamination are stock access further upstream, water fowl or leaking septic tanks. Ocean Beach Stream was investigated in February and March 2008, refer to section 7 for more information.

The interim SFRG grade for Ocean Beach Stream, with a SIC of “very high”, and MAC category of ‘D’ (including the four results from 2007/2008) remains as “very poor”. This is an

accurate indication of the unsuitability of this site for recreational use. Therefore a permanent sign has been erected and will remain until results fall below guidelines.

6.20 Langs Beach Stream (below public toilets)

SIC: High **MAC: D** **SFRG: Very poor**

This small stream flows on to the southern end of Langs Beach and has a predominately native forest and shrub catchment with small areas of beef farming. Similarly to Ocean Beach Stream, Langs Beach Stream is a popular spot for children to paddle in, but it has had consistently high *E. coli* levels over the last four years. Therefore it was removed from the sampling programme before the 2007/2008 summer and a permanent warning sign was erected by Whangarei District Council. The most likely sources of bacteriological contamination include agricultural run-off, feral animals, poorly maintained septic tanks, or a leak from the public toilets upstream of the site.

The stream by the public toilets at the southern end of Langs Beach was sampled on five occasions in the 2007/2008 summer, the results of which was added to the previous three summers results and are shown in table 28 (below).

Table 28: Collated results for Langs Beach Stream by the public toilets

	Last Four Surveys
Median	1145 *E. coli* per 100 mL
95th Percentile	4118 *E. coli* per 100 mL
Alert Compliance	15%
Action Compliance	34%

The microbiological water quality in Langs Beach Stream by the public toilets is still poor, with two sampling occasions in 2007/2008 exceeding the action threshold, as shown in figure 40 (below). However as both of these spikes in *E. coli* are associated with rainfall events, as shown in figure 41 (below), there could be a slight improvement in microbiological water quality at this site. Therefore it is recommended that this site be added back into the sampling programme for the 2008/2009 summer.

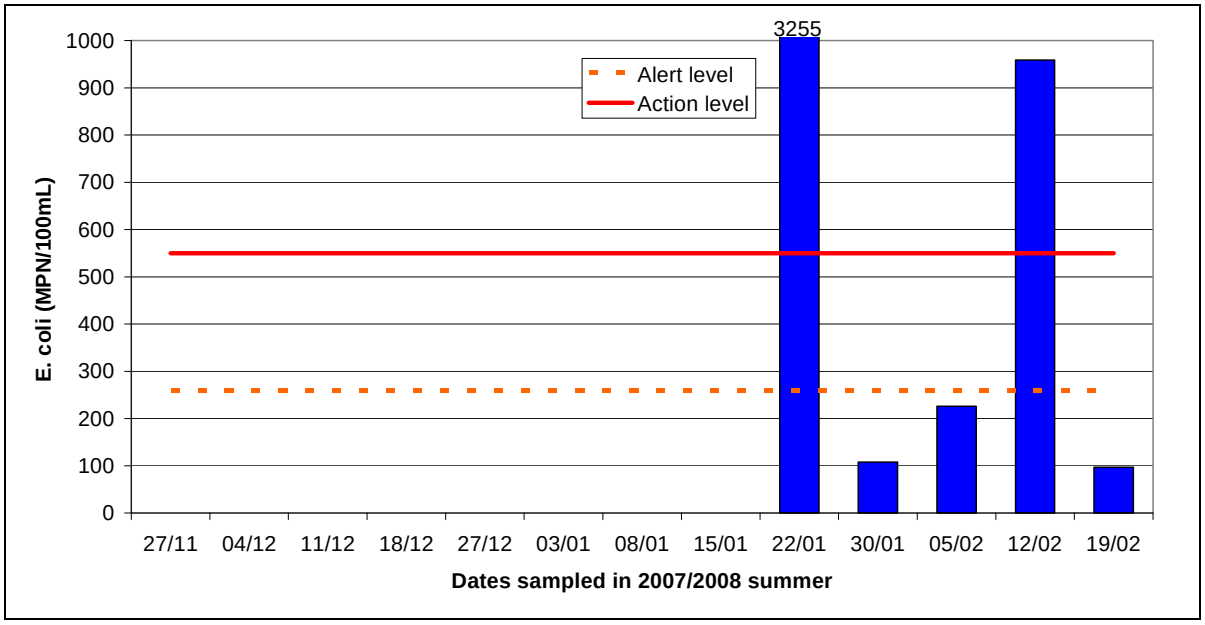

Figure 40: Results from the 2005-06 freshwater recreational contact sampling for Langs Beach Stream

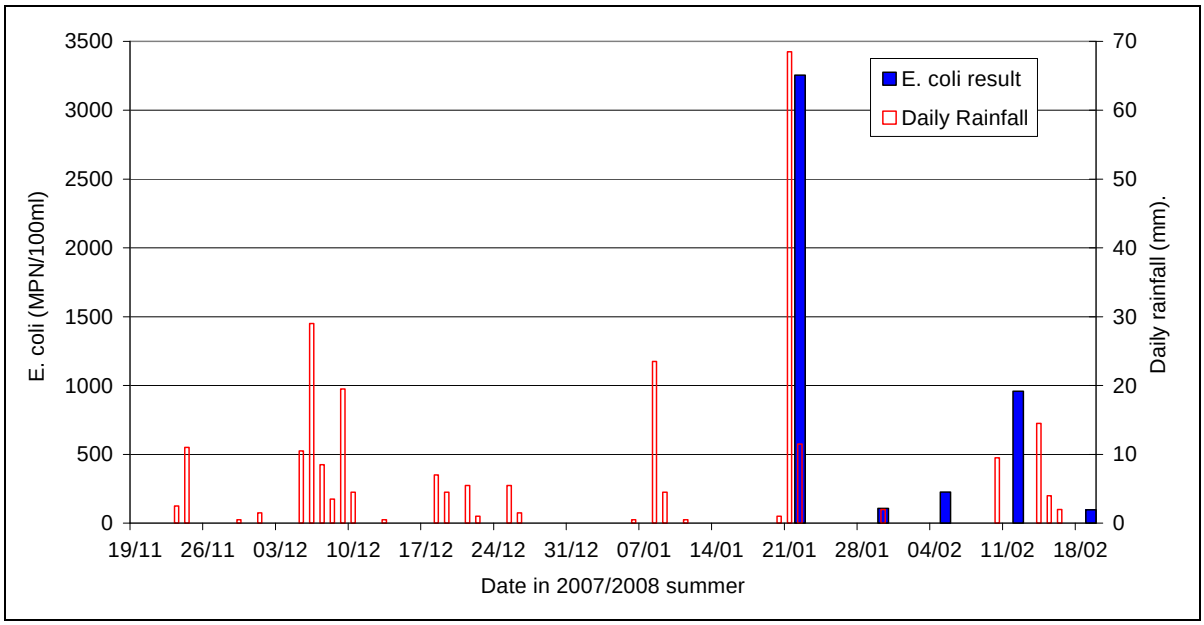

Figure 41: Rainfall and *E. coli* data for the Langs Beach Stream site over the 2005-06 summer

Similarly to Ocean Beach Stream, this site was also investigated in 2008 – refer to section 7 for more information.

The interim SFRG grade for Langs Beach Stream below the toilets, with a SIC of "very high", and MAC category of 'D' (including the five results from 2007/2008) remains as "very poor".
This is an accurate indication of the unsuitability of this site for recreational use. Therefore a permanent sign has been erected and will remain until results fall below guidelines.

6.21 Otiria Stream below the falls

SIC: Very high **MAC: D** **SFRG: Very poor** (NB: Based on 2006/2007 assessment)

The Otiria Waterfall is a popular swimming hole for people from Moerewa, but the water quality at the site is particularly poor. Due to the consistently high bacterial levels found at this site, a permanent warning sign has been erected by Far North District Council for several years and the site was removed from the monitoring programme for the 2007/2008 summer.

However a review of existing information for the Otiria Stream catchment has been carried out (NRC 2008) and the Otiria site was one of the nine recreational bathing sites investigated in 2008 (refer to section 7). As part of the investigation the Otiria Stream was sampled on three occasions in 2008, two of which exceeded the action threshold and the other exceeded the alert threshold. With these three results included there would be no change in the interim SFRG reported in 2005/2006 and 2006/2007 (above) of "very poor".

The water quality review for Otiria Stream (NRC 2008), which incorporated the results from the investigation presented in section 7, found the potential sources of bacterial contamination are:

- Diffuse surface run-off from agricultural land of animal waste from sheep and cattle, and direct stock access to waterways
- Microbial activity in catchment wetlands
- Diffuse surface run-off from indigenous or exotic forest land cover of animal waste from wild animals such as pigs, deer, possums, goats, mustelids and rats
- Faecal contamination from water fowl in wetland and stream areas

For more information refer to the detailed report from the review available on the Northland Regional Council website at the following link:

http://www.nrc.govt.nz/Resource-Library-Summary/Research-and-reports/Rivers-and-streams/

6.22 Wairoa Stream at Ahipara

SIC: Very high **MAC: D** **SFRG: Very poor** (NB: Based on 2006/2007 assessment)

Wairoa Stream is located just east of the Ahipara Township at the southern end of Ninety-Mile Beach. Similarly to Otiria Stream, due to the consistently high bacterial levels found in Wairoa Stream, a permanent warning sign has been erected by Far North District Council for several years and the site was removed from the monitoring programme for the 2007/2008 summer.

However, the Wairoa Stream site was one of the nine recreational bathing sites investigated in 2008 (refer to section 7). As part of the investigation the Wairoa Stream was sampled on two occasions in 2008, both of which exceeded the action threshold. With these two results included there would be no change in the interim SFRG reported in 2005/2006 and 2006/2007 (above) of “very poor”.

The investigation ruled out human influence as the source of faecal contamination on these two occasions which indicates that the likely sources are stock (herbivores in particular ruminants) and water fowl. Refer to section 7: Faecal Source Tracking Investigation for more information.

7 FAECAL SOURCE TRACKING INVESTIGATION

An investigation was carried out at several freshwater recreational bathing sites that have consistently high bacterial levels with the support of Environmental Science and Research (ESR) and Envirolink (Devane et al. 2008) to try to establish the source of elevated bacterial levels. As part of this investigation samples were collected from the following nine sites on three fortnightly occasions in February and March 2008:

- Raumanga Stream (site 103246)
- Above Whangarei Falls (site 105972)
- Langs Beach Stream below the toilets (site 100686)
- Langs Beach Stream in the middle of the beach (site 104539)
- Ocean Beach Stream (site 102077)
- Otamure Bay Stream (site 108859)
- Waiharakeke Stream (site 108921)
- Wairoa Stream at Ahipara (site 105053)
- Otiria Stream below falls, near Moerewa (site 105376)

7.1 Methods used by ESR

The samples were tested using a range of scientific techniques by ESR to assist in identifying the source of bacterial contamination, including faecal sterols, fluorescent whitening agents and polymerase chain reaction (PCR) markers.

Faecal Sterols

Sterols are lipids that relate to both plants and animals such as cholesterol or the plant sterol, stigmasterol. The sterol profile in faeces depends on the animal's diet, internally produced sterols and the bacteria in the animal's gut. Consequently analysis of the sterol composition of animal faeces can generate distinctive faecal sterol fingerprints. Therefore, the ratio of different sterols in a water sample can be used to narrow down the potential source(s) of bacterial contamination to either humans, herbivores (animals whose main diet consists of vegetation – members of the ruminant group are a subset of herbivores and include cattle, sheep, deer and goats), and plant decay and/or run-off from vegetation.

Fluorescent Whitening Agents

Fluorescent whitening agents (FWAs) are common ingredients of washing powders and only one is used in New Zealand. In most households the effluent from toilets is mixed with grey water from washing machines and therefore FWAs are usually linked to human faecal contamination in both septic tanks and community wastewater systems.

PCR Markers

Polymerase chain reaction (PCR) markers basically show the difference between closely related bacteria using DNA sequencing. In some cases this bacteria is highly host specific (i.e. only associated with the faecal material of one animal or animal group). Therefore the type of animal that the bacteria are from can sometimes be identified using PCR markers. PCR markers for the following host groups were used in this investigation: human, ducks (wildfowl), ruminants (includes sheep, cattle, deer and goats), possums and pigs, as well as a general indicator for faecal contamination.

7.2 Key findings

The key findings from this research are:

- None of the samples from any of the sites showed the source of bacteria to be humans.
- There were several sites which showed one of the sources of faecal contamination to be herbivores, in particular ruminants on one or more sampling occasions, including Whangarei Falls, Langs Beach Streams (at both the south end below toilets and in the middle of the beach), Otamure Bay Stream, Waiharakeke Stream, Wairoa Stream at Ahipara and Otiria Stream.
- The results from some sites suggested a source of faecal contamination could be water fowl, including Raumanga Stream, Whangarei Falls, Langs Beach Stream (middle beach only), Otamure Bay Stream, Waiharakeke Stream, Wairoa Stream at Ahipara and Otiria Stream. However the tools for identifying bird faecal contamination need more development, as it is currently only based on ducks and therefore some sites which did not show birds as a source could still in fact be contaminated by gulls.
- There are preliminary (unconfirmed) results that suggest pigs could be a source of faecal contamination at Langs Beach Stream (middle only) and Otiria Stream. The tools for identifying faecal contamination from pigs need further development.
- There are preliminary (unconfirmed) results that suggest that plant decay or runoff from vegetation could be contributing to the high bacterial levels in the two Langs Beach Streams (below toilets and middle of beach). This requires further work.
- There are also preliminary (unconfirmed) results that suggest possums could be a source of faecal contamination at Whangarei Falls, Ocean Beach Stream, Waiharakeke, Wairoa and Otiria Streams. The tools for indentifying faecal contamination from possums need further development.

7.3 Summary of results

The sources of bacterial contamination at each site confirmed by this investigation are summarised in the table below with a tick.

Site	Human	Herbivores	Water fowl	Unconfirmed results
Raumanga Stream	**x**	**?**	✓	**x**
Whangarei Falls	**x**	✓	✓	**?** (possum)
Langs Beach Stream (below toilets)	**x**	✓	**X**	**?** (plant decay or runoff)
Langs Beach Stream (middle of beach)	**x**	✓	✓	**?** (plant decay or runoff and pig)
Ocean Beach Stream	**x**	**?**	**?**	**?** (possum)
Otamure Bay Stream	**x**	✓	✓	**x**
Waiharakeke Stream	**x**	✓	✓	**?** (possum)
Wairoa Stream (Ahipara)	**x**	✓	✓	**?** (possum)
Otiria Stream	**x**	✓	✓	**?** (possum and pig)
Ruahuia Stream	**x**	**?**	**x**	**x**
Mangere Stream	**x**	**x**	✓	**x**

Note: The results marked with a question mark were either very weak results, questionable or unconfirmed results (i.e. in most cases the tools used by ESR need more development).

Although this investigation has found no evidence of faecal contamination from humans at the nine sites analysed on the three occasions, it should be highlighted that this does not mean that there is no risk of human faecal pollution reaching these waterways. Nor does it mean that there is no human health risks associated with the elevated bacterial levels in these waterways. If the source of faecal contamination is mainly herbivores and wild fowl,

the faecal material from these animals can still contain pathogens that can cause illness in humans such as *Campylobacter* sp. and *Salmonella* sp.

For more information refer to the detailed report available on the Council's website at the following link:

http://www.nrc.govt.nz/Resource-Library-Summary/Research-and-reports/Rivers-and-streams/Faecal-Source-Tracking-at-Recreational-Bathing-Locations-in-Northland/

8 SUMMARY TABLE

When looking at a summary of the freshwater bathing sites ranked by their median *E. coli* results over the last five surveys, as shown in table 27 (below), a few things become clear:

- It becomes apparent which sites are probably unrealistically graded using the MfE guidelines to be worse than what they actually are such as Kaihu River, which has bacteriological water quality more similar to sites graded as "fair" or "poor" rather than "very poor".

- It highlights how restrictive the MfE guidelines can be and possibly how they are not realistic for Northland with our semi-tropical weather conditions and therefore unpredictable rainfall in summer months. As the MAC assessment is based on the Hazen 95th percentile, it typically only takes one elevated *E. coli* result caused by rainfall to give a 95th percentile above 550 *E. coli* per 100 mL and therefore a MAC assessment of 'D'. As shown in Table 27, all the sites have percentiles exceeding the 550 *E. coli* per 100 mL threshold, which immediately means they can only be graded as "poor" or "very poor" (Refer to Table 1 and 3).

Table 27: Showing median and 95th percentile for *E. coli* per 100 mL based on the last five surveys at all ongoing sites with their interim SFRG grade. Note: Sites are ranked by their median *E. coli* counts.

Location	Site	Median	95th percentile	Interim SFRG
Waipoua River at DOC HQ	108613	52	3965.45	Follow up (fair)
Lake Waro	107272	86	1032.75	Very poor (good/fair)
Waipapa Stream at Puketi	103248	90	1354.3	Follow up (fair)
Kaihu River	102221	115	5846.4	Very poor (fair/poor)
Waipapa River at Landing	105706	121	1016.9	Poor (fair)
Omamari Beach Stream	102305	173	1207.7	Follow up (poor)
Kerikeri River	101530	187	4274.2	Very poor
Waitangi River	104830	240	1977.2	Very poor
Kapiro Stream	102838	246	1233	Poor
Mangakahia at Twin Bridges	105973	246	14823.4	Poor
Tirohanga Stream	102252	259	1378.55	Poor
Raumanga Stream	103246	278	3533.1	Poor
Otaua Stream	108510	281	4943.1	Very poor
Kaikou at Pipiwai	108919	309	9927	Poor
Waitaua Stream	105972	404	2618	Very poor
Waiharakeke at Lucas Road	108921	419	3352.15	Very poor
Ocean Beach Stream	102077	985	10864	Very poor
Langs Beach Stream	104539	1145	4118	Very poor
Otamure Bay Stream	108859	1223	15644.4	Very poor

9 CONCLUSIONS FROM THE SURVEY

The overall findings from the 2007-08 summer survey were that most of the rivers throughout Northland were generally acceptable for swimming and other freshwater recreational activities during the dry periods, but after heavy and/or prolonged rain, the waterways became unsuitable for days afterwards. In a region such as Northland with a semi-tropical climate and a high annual rainfall, using 95th percentiles for grading sites results in grades that do not necessarily reflect the "true" state of Northland's freshwaters.

Exceptions were Wairoa, Otiria, Oceans Beach and Langs Beach streams (which were all removed from the 2007/2008 sampling programme) and Otamure Bay Stream, which were all generally unsuitable for freshwater contact in all conditions. Faecal source tracking investigation at these sites has ruled out the source of contamination as humans on three sampling occasions in 2008 and showed that the source at some sites is likely to be stock or water fowl.

Lakes typically have excellent microbiological water quality, as they 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. This is why the Lake Ngatu and Taharoa sites were removed from the programme prior to the 2007/2008 summer. There were elevated results in Lake Waro in 2005/2006 (NRC 2006), so Lake Waro remained in the programme. Lake Waro had good microbiological water quality in 2007/2008, which is likely to be as a result of a reduction in the resident population of water fowl.

Finally, it must be stressed that any findings presented in this document cannot be taken as absolute conclusions. In all likelihood the Langs Beach Stream sites, Ocean Beach Stream, Otamure Bay Stream, Otiria and Wairoa sites are not the only unsafe sites in Northland and just because many of the sites were relatively good over the summer months does not necessarily make them suitable all year round, let alone from year to year. The impact that human activities have had on the health of our waterways should not be underestimated and it is probably best that, if you are unsure of the quality of a given swimming site, then that site should be considered potentially unsafe until you know otherwise.

10 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, many of them following on from previous years:

10.1 Further Sampling

Further investigation into the source of contamination at ongoing problem sites be carried out using faecal sterol analysis as was done at several sites in 2008 or possibly testing for pathogens (NRC is currently investigating this through an Envirolink application with ESR).

Key Recommendation: Faecal sterol analysis and other techniques be used to investigate the source of contamination at problem sites as required.

10.2 Education

The main purpose of these summer surveys is to determine what the potential risk is to those who indulge in freshwater recreation. This programme is now six years old and it may now be worthwhile to investigate setting some additional goals. In essence it is recommended that the NRC, in partnership with Northland Health and Northland's district councils, begin to become more proactive.

People's health is inextricably linked to the health of their environment. In other words, and in very broad terms, if our waters are healthy then we as a people will be as well. The Regional and district councils have developed, or are in the process of developing plans which, among other things, address water quality issues. However, this does not mean that the authorities involved need not take further action. By developing and promoting a region-wide health campaign, there is a real possibility that local authorities can make a massive, positive impact on the health and wellbeing of Northland's people and its environment.

Northland Health has distributed brochures detailing the simple ways in which people can determine how safe a body of water is for swimming or gathering shellfish, 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 making the pamphlets available and discussing the principles of safe bathing as part of their own educational programmes. Individually, each organisation can only do so much and an integrated approach could make a real difference. It is therefore recommended that all of Northland's TLAs should become involved in disseminating the pamphlets by having them available with their other pamphlets and handing them out to schools when representatives make visits.

Schools need to be the primary target in any education campaign because children are both the most numerous users of inland swimming holes, plus 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.

As well as warning people of the potential dangers, an education campaign should make people more aware of their own actions; "Am I or my family part of the problem?" is a question that, when linked to something as dear to people's hearts as water quality, can have a major impact. It is common knowledge that children are impressionable, that it is important for adults to set the "right" examples, but what is often forgotten is that children can also be extremely influential and that teaching our children is often the best way to get the message through to adults as well. Therefore an education programme, particularly targeted at schools, should aid in the dual goals of improving people's health and reducing the impact we, as a species, have on the environment (by improving stream health). The NRC, for example, is currently involved in making school children (and their teachers) aware of water quality issues and therefore it should not be too difficult to include some discussion on the causes and effects of bacteriological contamination as well.

In this regard it may be beneficial for policy-makers and those involved in the monitoring of Northland's bathing sites alike to perhaps set some long-term goals, especially in terms of awareness. Local bodies can lead the way on issues such as health and the environment, but it is up to the community as a whole if any substantial change is to occur.

Key Recommendation: That TLAs become involved with the distribution of the pamphlets developed by Northland Health.

Key Recommendation: That the issues relating to freshwater contact recreation be integrated into all relevant agencies' education programmes.

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