RIVER AND STREAMS

The Northland Regional Council carries out State of the Environment Monitoring in several Northland rivers and streams to identify significant environmental issues and trends in water quality. The performance targets relating to SOE monitoring of river water quality are:

- Operate a region-wide water quality network for the measurement, recording and reporting of river water quality trends, and

- Carry out sampling and reporting on summer freshwater bathing water quality.

Both of these performance targets were met in 2005-2006.

The Regional Council carried out sampling at 23 freshwater bathing sites throughout Northland to check whether microbiological water quality was suitable for contact recreation. These sites were sampled weekly for 12 weeks over summer. The results are presented in the **Recreational Bathing Water Quality** section of this report (Refer to page 2).

The **River Water Quality Monitoring Network** (RWQMN) includes 21 sites scattered throughout Northland's major river systems. These sites were monitored monthly for several water quality parameters and annually for stream macroinvertebrates. The majority of these sites now have enough data for long-term trend analysis. The 2005-2006 results and long-term trends in water quality are presented in the RWQMN section of this report (Refer to page 5).

Photo: Waipoua River in Waipoua Forest

Recreational Bathing Water Quality

The Northland Regional Council, in conjunction with the District Council's and Northland Health, survey the water quality at a number of the region's most popular freshwater bathing sites every summer. 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. The most common sources of bacterial contamination are human sewage, stormwater and rural run-off, which can include bacteria from both agricultural land use and feral animals.

Twenty three swimming sites at 20 of Northland's rivers, lakes and streams were sampled over a 12-week period, from the start of December 2004 through to the end of February 2005. Samples were collected weekly from each site and analysed for the pollution indicator bacteria, *Escherichia coli* (*E. coli*) following the recommended methods in the '*Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas'* developed jointly by the Ministry for the Environment (MfE) and the Ministry of Health (MoH). The '*Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas'* are available for viewing under publications on the Ministry for the Environment's website.

The results were compared to the recommended guidelines and all results were forwarded to the district councils, as well as Northland Health, for follow up action when *E. coli* levels were elevated above the guidelines. The table below shows the guidelines used for microbiological water quality in relation to recreational bathing in Northland and the recommended follow up by District Council's based on the national guidelines above.

***E. Coli* count (cells/100mL)**	**Status**	**Suggested follow up**
Less than or equal to 260	Acceptable	▪ No response necessary – continue weekly sampling
Greater than 260 but less than or equal to 550	Alert	▪ Increase sampling to daily ▪ Undertake sanitary survey to isolate source of faecal contamination
Greater than 550	Action	▪ Increase sampling to daily ▪ Undertake sanitary survey ▪ Erect warning signs ▪ Inform public through the media that a public health risk exists

Results

The overall findings from the 2005-06 summer survey were that most of the rivers throughout Northland were generally acceptable for swimming and other freshwater recreational activities during dry weather, but after heavy and/or prolonged rain, the waterways became unsuitable for several days afterwards. Exceptions were Lake Waro and Langs Beach, Ocean Beach, Otiria and Wairoa Streams, which were all generally unsuitable for freshwater contact in all conditions. Otiria and Langs Beach streams are of the most concern as *E. coli* levels were consistently above the alert threshold over the entire summer. Lake Waro has had good water quality in the past in terms of bacterial levels. It is thought that the problems that arose during the 2005-06 summer are mostly as a result of faecal material from high numbers of wild fowl on the lake. Whangarei District Council have reduced their numbers and this site will be closely watched next summer.

On the other hand the water quality of the other two lakes sampled, Ngatu on the Aupouri Peninsula and Taharoa in the Kai iwi lakes group, were generally excellent over the entire 2005-06 survey, indicating that microbiological water quality was consistently suitable for recreational bathing. Lakes are not as susceptible to rainfall as rivers and streams are, particularly the dune lakes of Northland, which do not have any significant surface inflows. For more information on the results for 2005-2006 check out the detailed pdf report available on the Regional Council website.

Interim grades, based on the national guidelines developed by MfE and MoH, were calculated for all sites with data stretching back over at least five summers. The process has tended to overstate the health risks at some sites due to the high rainfall Northland experiences with its semi tropical climate and as Northland's current recreational bathing programme is still short of the 20 weeks that the national guidelines recommend and are based on. All the sites with enough data have been graded as either "poor" or "very poor" with the exception of Lakes Ngatu and Taharoa.

The table below shows the 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	Median E. coli (No./100mL)	95th percentile (E. coli/100mL)	Interim grade
Lake Taharoa	5	122	Very Good
Lake Ngatu	10	134	Good
Kaihu River	109	5285	Poor
Waipapa Stream	140	1218	Poor
Omamari Beach Stream	160	1248	Poor
Kapiro Stream	180	739	Poor
Waitangi River	189	2525	Very Poor
Twin Bridges	246	4783	Poor
Lake Waro	259	2951	Very Poor
Raumanga Stream	265	5342	Poor
Kerikeri River	275	6593	Very Poor

Tirohanga Stream	277	1214	Poor
Otaua Stream	317	3586	Poor
Waitaua River	399	4788	Very poor
Wairoa Stream	660	6723	Very Poor
Ocean beach stream	711	6867	Very poor
Otiria Stream	1122	3716	Very Poor
Langs beach stream	1254	3914	Very poor

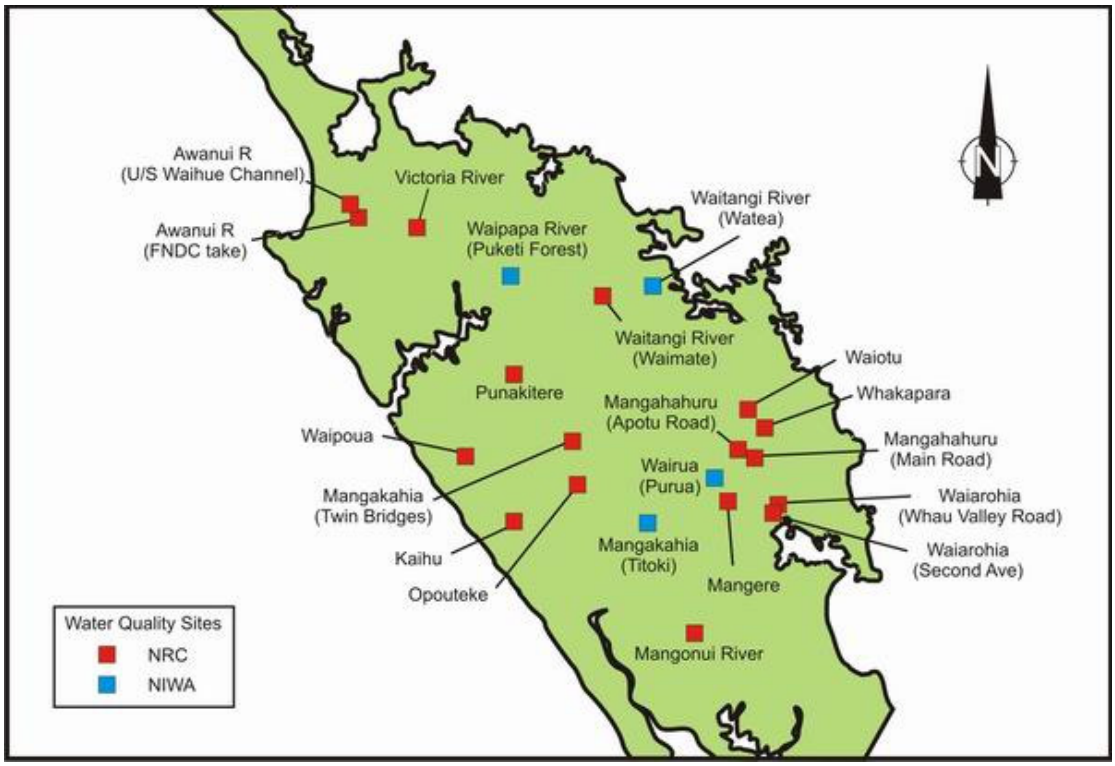
Finally, it must be stressed that any findings presented cannot be taken as absolute conclusions. In all likelihood the Langs Beach, Otiria and Wairoa stream sites are not the only unsafe sites in Northland and just because many of the sites were relatively good over the summer months does not necessarily make them suitable all year round, let alone from year to year. 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.

River Water Quality Monitoring Network

Our regional River Water Quality Monitoring Network (RWQMN) involves the monitoring of water quality and macroinvertebrate biota in an increasing number of rivers around Northland.

The network currently includes 21 sites on several river systems throughout Northland as shown on the map below, of which four sites are part of the National River Water Quality Network monitored by National Institute of Water and Atmospheric Research (NIWA) staff. These four sites are Waipapa River in Puketi Forest, Waitangi River at Watea, Mangakahia River at Titoki and Wairua River at Purua. More information about the national network can be viewed on NIWA's website.

Three new sites were added to the network in 2005-2006; two sites on Waiarohia Stream in Whangarei to monitor urban impacts on water quality and one site on the Mangahahuru Stream as a background site to the existing site at Apotu Road and to monitor the impacts of forestry on water quality.



Monthly water quality sampling is carried out at each site for a range of chemical and physical parameters, which are shown in the table below. The purpose of the network is to provide information about the general state of Northland's rivers, so that long-term trends can be detected and analysed.

Most results are compared to the New Zealand trigger values for the protection of aquatic ecosystems in the '*Australian and New Zealand Guidelines for Fresh and Marine Water Quality'* (ANZECC 2000), which can be accessed in the publications section of the Ministry for the Environment's website.

It is important to note that the trigger values are used to assess the risk of adverse effects on the ecosystem and when results are outside trigger values further investigation is required to determine whether there is adverse effects on the environment and to what extent. There are two sets of trigger values; one for upland rivers, which only includes one site in the network (Waipoua River), and for lowland rivers as shown in the table below.

Levels of the indicator bacteria *Escherichia coli* (*E. coli*) are compared to the '*Microbiological Water Quality Guidelines for Marine and Freshwater Recreational areas*' (see the **recreational bathing water quality section** of this report) and the commonly used minimum for dissolved oxygen is 6 mg/L (see section 7 of the '*Regional Water and Soil Plan for Northland*').

Parameter	**Guideline trigger values (NZ lowland rivers)**	**Guideline trigger values (NZ upland rivers)**
Temperature (Degrees Celsius)	-	-
Dissolved oxygen (mg/L)	> 6*	> 6*
Dissolved oxygen (% Saturation)	98 - 105	99 – 103
Conductivity (mSm)	-	-
Water clarity (m)	> 0.6	> 0.8
Turbidity (NTU)	< 5.6	< 4.1
E. coli (n/100mL)	< 126^	< 126^
Dissolved reactive phosphorus(mg/L)	< 0.01	< 0.009
Total phosphorus (mg/L)	< 0.033	< 0.026
Ammoniacal nitrogen (mg/L)	< 0.021	< 0.01
Total nitrogen (mg/L)	< 0.614	< 0.295
pH	7.2 – 7.8	7.3 – 8.0

* accepted level of dissolved oxygen (mg/L)
^ *E. coli* guideline for recreational bathing in freshwater

Refer to the next page (page 7) for the water quality results for 2005-2006. The regional River Water Quality Monitoring Network began in 1996, so the Regional Council now has enough data for most rivers to begin looking for long-term trends in water quality (Refer to page 29).

Stream macroinvertebrate monitoring is carried out at each RWQMN site once a year during summer. A summary of the 2005-2006 results are presented in this report (Refer to page 32).

In the 2006-2007 financial year three additional sites will be added to the network; Ruakaka River at Flyger Road, Waiharakeke Stream in Moerewa and Kaeo River downstream of Kaeo township. These sites will help to fill a gap in the network for shorter easterly flowing rivers. Also extra sampling will be carried out at selected sites to investigate ongoing elevated or unusual results such as the high phosphorus levels in Opouteke River or sites that have consistently poor water quality such as Mangere River.

Water Quality Results

Rivers have been ranked for 2005-06 by listing each in order for the range of parameters, from best to worst (i.e. highest to lowest water clarity, or least to most nitrogen).

The order of the sites from overall best water quality to worst is very similar to last financial year with Waipoua River ranked the best and Mangere River the worst. Also similarly to 2004-2005 the ranking of sites is linked to catchment land use, with the best sites having catchments dominated by native forest, moving through to sites with a mix of forestry, native forest and agriculture, to the worst sites being those with their catchment dominated by intensive agriculture land use. Some sites have been shown with equal ranking, as it was difficult to differentiate between them, which one was in better condition.

Ranking	Site	River system	Land use
1	Waipoua River	Waipoua	Native forest
2	Victoria River	Victoria/Awanui	Agriculture/native forest
3	Waipapa River	Waipapa	Native forest
4	Mangahahuru at Main Road	Wairua	Forestry
4	Opouteke River	Wairua/Mangakahia	Forestry/native forest
6	Kaihu River at gorge	Wairua	Agriculture/forestry
7	Mangakahia at Twin Bridges	Wairua/Mangakahia	Agriculture/forestry
7	Waitangi at Waimate North	Waitangi	Agriculture/native forest
9	Waitangi at Watea	Waitangi	Agriculture/native forest
10	Whakapara River	Wairua	Agriculture
11	Waiarohia at Second Ave	Waiarohia	Urban
11	Awanui at FNDC water take	Victoria/Awanui	Agriculture
13	Mangakahia at Titoki	Wairua/Mangakahia	Agriculture
14	Mangahahuru at Apotu Rd	Wairua	Agriculture
14	Waiarohia at Whau Valley Rd	Waiarohia	Agriculture/native forest
16	Punakitere River	Punakitere	Agriculture
17	Waiotu River at SH 1	Wairua	Agriculture
18	Awanui at Waihue Channel	Victoria/Awanui	Agriculture
18	Manganui River	Manganui	Agriculture
20	Wairua River at Purua	Wairua	Agriculture
21	Mangere River at Knights Rd	Wairua	Agriculture

This report presents a summary of the 2005-2006 water quality results for each of these sites (refer to pages 8 – 28). Graphs for each parameter at each site are available in the River and Streams section of the Annual Monitoring Report on the Regional Council website. A summary of the long term trend analysis is also presented in this report (See page 29).

Waipoua River

The Waipoua River originates in and flows through Waipoua Forest, the home of the legendary giant Kauri Tree, Tane Mahuta on the West Coast of Northland. The river cuts through volcanic soils, and has a predominantly indigenous forest catchment. The Waipoua River site is the only site in the network that is classified as "hill elevation" by the '*River Environment Classification'* (NIWA & MfE 2004) and therefore the results have been compared to the trigger values for an upland river. The Waipoua River is one of the nearest to pristine condition of all the rivers in the network.

The 2005-2006 results for the Waipoua River site are summarised in the table below including the median, range and percentage of sampling occasions that comply with relevant guidelines for the 12 sampling occasions. Medians shown in red are outside the recommended guidelines.

Parameter	Median	Range	% comply with guideline
Temperature (deg. cel.)	13.6	9.3 - 17.9	
Dissolved oxygen (mg/L)	10.8	9.2 - 11.9	100
Dissolved oxygen (% Sat.)	101.8	96.3 - 106	75
Conductivity (mSm)	9.9	7.2 - 11	
Water clarity (m)	2.44	1.02 - 3.85	100
Turbidity (NTU)	1.8	0.9 - 4.4	100
E. coli (n/100mL)	25	10 - 359	92
Dissolved reactive phosphorus (mg/L)	0.018	0.002 - 0.24	33
Total phosphorus (mg/L)	0.025	0.008 - 0.375	75
Ammoniacal nitrogen (mg/L)	0.005	0.005 - 0.03	92
Total nitrogen (mg/L)	0.076	0.054 - 0.524	100
pH	7.5	6.8 - 7.9	75

The results confirm that Waipoua River remains in a relatively pristine condition. The medians of all parameters, except for dissolved reactive phosphorus, were within their relevant guideline for an upland river. Also the majority of parameters met the guidelines on either 11 or all of the 12 sampling occasions. The median dissolved reactive phosphorus of 0.018 mg/L slightly exceeds the trigger value for the protection of aquatic ecosystems for an upland site of 0.009 mg/L.

The slightly elevated dissolved reactive phosphorus levels at this site are a concern, as this is the first year that elevated levels have been detected and the guideline was exceeded on eight of the 12 sampling occasions in 2005-2006. This will be investigated further, to identify potential sources of contamination.

The Waipoua River site was only added to the network in 2002, meaning there will not be adequate data available for long-term trend analysis until the end of 2006-2007. However it is clear from the four years data currently available that water quality in Waipoua River is excellent, with consistently good water clarity and dissolved oxygen, and low nutrient levels.

Victoria River

The Victoria River begins in the native forest of the Mangamuka Ranges, and runs north through pasture before joining with the Awanui River near Kaitaia. Approximately two kilometres from the native forest, the site is somewhat affected by pastoral land use, however the catchment is still dominated by indigenous forest. The geology of this site is classified as volcanic acidic in the '*River Environment Classification'* (NIWA & MfE 2004).

The 2005-2006 results for the Victoria River site are summarised in the table below including the median, range and percentage of sampling occasions that comply with relevant guidelines for the 12 sampling occasions. Medians shown in red are outside the recommended guidelines.

Parameter	Median	Range	% comply with guideline
Temperature (deg. cel.)	14.3	10.1 - 19.3	
Dissolved oxygen (mg/L)	10.1	7.2 – 13.6	100
Dissolved oxygen (% Sat.)	97.7	76.8 - 137	33
Conductivity (mSm)	16.5	13 - 17.4	
Water clarity (m)	2.00	0.5 - 2.3	91
Turbidity (NTU)	1.1	0.2 – 13.5	83
E. coli (n/100mL)	181	19 - 1658	25
Dissolved reactive phosphorus (mg/L)	0.017	0.00 - 0.03	25
Total phosphorus (mg/L)	0.022	0.01 - 0.036	92
Ammoniacal nitrogen (mg/L)	0.005	0.005 – 0.01	100
Total nitrogen (mg/L)	0.066	0.051 - 0.203	100
pH	7.4	6.7 - 7.9	67

For the most part, the water quality of the Victoria River is excellent. The median for the majority of parameters are within relevant guidelines and five parameters are within guidelines on at least 11 sampling occasions; dissolved oxygen, water clarity, total nitrogen, total phosphorus and ammoniacal nitrogen.

The parameters of the most concern are dissolved oxygen saturation and dissolved reactive phosphorus. Dissolved oxygen saturation was outside the trigger value range of 98 to 105% on 8 of the 12 sampling occasions, however raw dissolved oxygen levels are consistently above the commonly used guideline of 6 mg/L. The elevated dissolved reactive phosphorus tend to occur during slightly increased flows and are associated with elevated turbidity and bacterial results, and therefore is most likely as a result of land use within the farming catchment.

A positive result at the Victoria River site are long-term trends indicate that nitrate/nitrite nitrogen (NNN) and turbidity levels are declining. However, there is also long term trends indicating that pH is increasing (becoming more alkaline) and dissolved oxygen (% saturation) is increasing. It is unknown at this stage whether these are positive or detrimental trends.

Waipapa River

The Waipapa River originates in and flows through Puketi forest in central Northland, meandering through farmland until it reaches the upper Hokianga Harbour. The sampling site is within the forest and therefore the catchment is predominantly indigenous forest with some small areas of exotic forestry in the headwaters. The geology of the Waipapa River is soft sedimentary (siltstones and mudstones). Similarly to the Waipoua River site, this site on the Waipapa River is near pristine condition. The Waipapa site is one of four sites in Northland that are part of the National River Water Quality Network administered by NIWA.

The 2005-2006 results for the Waipapa River site are summarised in the table below including the median, range and percentage of sampling occasions that comply with relevant guidelines. Note: Nutrient results were only available for seven sampling occasions (July 2005 – January 2006), except for total phosphorus and nitrogen and the results for June 2006 where not available at the time of data analysis. Medians shown in red are outside the recommended guidelines.

Parameter	Median	Range	% comply with guideline
Temperature (deg. cel.)	14.6	10 - 20	-
Dissolved oxygen (mg/L)	9.9	8.6 - 11.1	100
Dissolved oxygen (% Sat.)	97.7	94.5 - 100.3	36
Conductivity (mSm)	12.0	9.8 - 13	-
Water clarity (m)	2.45	0.22 - 3.42	91
Turbidity (NTU)	1.6	0.6 - 18	91
E. coli (n/100mL)	98	13 - 1201	64
Dissolved reactive phosphorus (mg/L)	0.005	0.003 - 0.011	86
Total phosphorus (mg/L)	0.01	0.006 - 0.026	100
Ammoniacal nitrogen (mg/L)	0.002	0.001 - 0.006	100
Total nitrogen (mg/L)	0.126	0.063 - 0.292	100
pH	7.6	7.4 - 7.7	100

The 2005-2006 results show that the Waipapa River remains in a relatively pristine state. With the median of all parameters, except dissolved oxygen (% saturation) meeting relevant guidelines and five parameters complying with their respective guidelines on all 11 sampling occasions; dissolved oxygen (mg/L), total phosphorus, ammoniacal nitrogen, total nitrogen and pH.

For results from October 1996 to May 2006, there were significant decreasing trends for dissolve reactive phosphorus, ammoniacal nitrogen and nitrate in Waipapa River. There is also an increasing trend in pH; however it is not known whether this is a deterioration or improvement at this stage.

Mangahahuru Stream at Main Road

The Mangahahuru Stream, which begins in *Pinus radiata* forestry southeast of Hikurangi, is a small tributary of the Wairua River. This site is located in the upper catchment and therefore the landuse is predominately exotic forestry. It was added to the River Network in 2005-2006, to include a hard sedimentary, exotic forestry site to the network. It is also a good comparison for the Mangahahuru Stream site at Apotu Road.

The first year of results for the Mangahahuru Stream at Apotu Road are summarised in the table below including the median, range and percentage of sampling occasions that comply with relevant guidelines for the 12 sampling occasions. Medians shown in red are outside the recommended guidelines.

Parameter	Median	Range	% comply with guideline
Temperature (deg. cel.)	14.5	9.8 - 19.3	
Dissolved oxygen (mg/L)	10.0	8.6 - 12.9	100
Dissolved oxygen (% Sat.)	96.4	93 - 114	33
Conductivity (mSm)	9.7	8.7 - 10	
Water clarity (m)	2.08	0.75 - 2.95	100
Turbidity (NTU)	3.5	2.6 - 13.1	83
E. coli (n/100mL)	204	20 - 2247	25
Dissolved reactive phosphorus (mg/L)	0.005	0.002 - 0.01	100
Total phosphorus (mg/L)	0.018	0.015 - 0.033	100
Ammoniacal nitrogen (mg/L)	0.005	0.005 - 0.02	100
Total nitrogen (mg/L)	0.146	0.107 - 0.526	100
pH	7.2	6.7 - 7.4	50

As expected this new site on the Mangahahuru Stream appears to have much better water quality than the site at Apotu Road. In general this site has relatively good water quality, with consistently low nutrient levels and moderate to good water clarity i.e. met their respective guidelines 100% of the time. However bacterial levels are often elevated, only meeting the freshwater bathing guideline of 126/100mL on three sampling occasions.

Opouteke River

The Opouteke River drains from predominantly exotic forestry (pine forest), through a small area of pasture before reaching the Mangakahia River. The only pastoral farming land use upstream of the sampling site is sheep and beef farming, although there are dairy farms further downstream. Acidic volcanic rocks make up the underlying geology.

The Opouteke River results for 2005-2006 are summarised in the table below including the median, range and percentage of sampling occasions that comply with relevant guidelines for the 12 sampling occasions. Medians shown in red are outside the recommended guidelines.

Parameter	Median	Range	% comply with guideline
Temperature (deg. cel.)	15.4	11.3 - 23.5	-
Dissolved oxygen (% Sat.)	109.1	101.8 - 116.5	42
Conductivity (mSm)	13.1	11.5 - 14.9	
Water clarity (m)	1.88	0.55 - 3.65	92
Turbidity (NTU)	3.0	0.4 - 10	67
E. coli (n/100mL)	111	23 - 336	55
Dissolved reactive phosphorus (mg/L)	0.016	0.002 - 0.072	42
Total phosphorus (mg/L)	0.025	0.007 - 0.079	58
Ammoniacal nitrogen (mg/L)	0.005	0.005 - 0.07	92
Total nitrogen (mg/L)	0.162	0.054 - 0.427	100
pH	7.8	7 - 8.3	42

Similarly to last year dissolved oxygen concentrations (% saturation) and phosphorus levels are often elevated in Opouteke River. However phosphorus levels were not as high in 2005-2006 as they have been in the past, with approximately half of the results for both total and dissolved reactive phosphorus within their respective trigger value. The trend analysis on the ten years data available for Opouteke River shows that dissolved reactive and total phosphorus levels are decreasing.

Unlike other sites on the network, the source of this phosphorous is probably not agricultural run-off, as nitrogen and bacterial levels are low. More research is required to investigate the problem further, partly because the source of the high phosphorus levels is unclear and also they are exhibiting an unusual oscillating pattern.

Like many of the other sites in the RWQMN there is a significant increasing trend in pH in Opouteke River (i.e. trend analysis indicates that this site is becoming more alkaline). This could be a detrimental trend at this site, as pH is often above the 7.2 to 7.8 trigger value range.

Kaihu River

The Kaihu River originates in native forest west of Trounson Kauri Park, and drains into the Wairoa River in Dargaville. The catchment is a mix of both exotic and indigenous forestry, agriculture and horticulture, but dairy farming is the dominant land-use, especially in the middle and lower reaches. Kaihu River is one of six sites in the network that have volcanic acidic catchment geology.

The 2005-2006 results for the Kaihu River site are summarised in the table below including the median, range and percentage of sampling occasions that comply with relevant guidelines for the 12 sampling occasions. Medians shown in red are outside the recommended guidelines.

Parameter	Median	Range	% comply with guideline
Temperature (deg. cel.)	14.8	10.2 - 19.7	
Dissolved oxygen (mg/L)	10.7	9 - 11.8	100
Dissolved oxygen (% Sat.)	104.4	98.8 - 107.4	58
Conductivity (mSm)	11.4	7.2 - 13.7	
Water clarity (m)	1.75	0.68 - 3.3	100
Turbidity (NTU)	2.9	0.7 - 15.6	83
E. coli (n/100mL)	188	31 - 980	33
Dissolved reactive phosphorus (mg/L)	0.018	0.002 - 0.046	42
Total phosphorus (mg/L)	0.027	0.007 - 0.075	67
Ammoniacal nitrogen (mg/L)	0.005	0.005 - 0.03	92
Total nitrogen (mg/L)	0.326	0.066 - 0.691	75
pH	7.4	6.7 - 8.2	75

The results from 2005-2006 indicate that Kaihu River is only slightly impacted. The medians for all parameters, except *E. coli* and dissolved reactive phosphorus, are within the relevant guidelines. Bacterial levels are often elevated, with only four results under the recreational bathing guideline of 126 *E. coli*/100mL.

Over the last year spikes in bacterial, nitrogen and phosphorus results were associated with increased flow and turbidity such as on 12 October 2005. This contamination is most likely as a result of run-off from forestry and/or pastoral land uses within the catchment.

Similarly to Waipoua River, the Kaihu River site was added to the network in 2002 and therefore there is not adequate data yet to carry out long-term trend analysis on water quality in the Kaihu River.

Mangakahia River at Twin Bridges

The Mangakahia River originates from Matarua Forest and flows southwest until it reaches the Wairua River. There are two sites on the Mangakahia River in the network; one at Twin Bridges and the other at Titoki Bridge in the lower reaches. The Twin Bridges lie at the confluence of the Awaroa and Mangakahia Rivers. The sampling site is directly upstream of the confluence, on the Mangakahia River. Located in a reserve area, Twin Bridges is a popular swimming spot and picnic area for tourists and locals alike. The upstream catchment is a mix of plantation forestry, and beef and sheep farming, with a volcanic acidic underlying geology.

The 2005-2006 results at Twin Bridges on the Mangakahia River are summarised in the table below including the median, range and percentage of sampling occasions that comply with relevant guidelines for the 12 sampling occasions. Medians shown in red are outside the recommended guidelines.

Parameter	Median	Range	% comply with guideline
Temperature (deg. cel.)	15.8	11.7 - 24.2	-
Dissolved oxygen (% Sat.)	107.1	102.4 - 115.9	42
Conductivity (mSm)	11.0	8.7 - 19.3	
Water clarity (m)	1.64	0.52 - 2.73	92
Turbidity (NTU)	3.3	0.5 - 9.1	75
E. coli (n/100mL)	135	52 - 354	45
Dissolved reactive phosphorus (mg/L)	0.024	0.002 - 0.102	25
Total phosphorus (mg/L)	0.046	0.00 - 0.143	42
Ammoniacal nitrogen (mg/L)	0.005	0.005 - 0.19	83
Total nitrogen (mg/L)	0.252	0.061 - 0.409	100
pH	7.7	7 - 8.2	50

Mangakahia River had the second highest temperature of all the RWQMN sites recorded in 2005-2006 on 15 February 2006 of 24.2°C (Waiarohia Stream at Second Ave had the highest). It is generally thought freshwater ecosystems, particularly fish and macroinvertebrate communities are likely to be detrimentally effected if water temperatures exceed 25°C. It is likely that temperature exceeds this at Twin Bridges at certain times of the day in summer months.

The greatest concern with water quality at the Twin Bridges site is the elevated phosphorus levels that are occurring all year around. Both the median amount of dissolved reactive and total phosphorus for 2005-2006 exceeded guideline trigger values, with less than half of the sampling occasions for both parameters being within guidelines. There is also a significant increasing trend in dissolved reactive phosphorus.

The median of dissolved oxygen percentage saturation and bacterial levels (*E. coli*) were also above the recommended levels, but the elevated *E. coli* results tend to occur in conjunction with increased flows and the high dissolved oxygen levels occur in summer when photosynthesis rates by plants are greater. Overall, the Twin Bridges site represents a moderately impacted site, which could easily be improved with some riparian planting and fencing.

Waitangi River at Waimate North

The Waitangi River originates just east of Lake Omapere, and flows into the Bay of Islands. There are two sites on Waitangi River in the Regional Council's river network; one in the upper to mid reaches at Waimate North and the other in the lower reaches at Watea. At the Waimate North site, the catchment is a mix of beef, sheep and dairy farming, with significant areas of indigenous forest in the headwaters. The underlying geology is predominantly acidic volcanics.

The 2005-2006 results for Waitangi River at Waimate North are summarised in the table below including the median, range and percentage of sampling occasions that comply with relevant guidelines for the 12 sampling occasions. Medians shown in red are outside the recommended guidelines.

Parameter	Median	Range	% comply with guideline
Temperature (deg. cel.)	14.9	10.6 - 20	
Dissolved oxygen (mg/L)	10.1	9.1 - 12.7	100
Dissolved oxygen (% Sat.)	99	70.7 - 114.2	50
Conductivity (mSm)	9.35	8.7 - 12.9	
Water clarity (m)	1.53	0.36 - 2.62	90
Turbidity (NTU)	3.05	1.6 - 55	75
E. coli (n/100mL)	565	166 - 4611	0
Dissolved reactive phosphorus (mg/L)	0.003	0.002 - 0.012	92
Total phosphorus (mg/L)	0.022	0.014 - 0.101	92
Ammoniacal nitrogen (mg/L)	0.01	0.005 - 0.03	92
Total nitrogen (mg/L)	0.551	0.257 - 0.871	75
pH	7.1	6.8 - 7.6	42

In general, water quality in Waitangi River at Waimate North is quite good with nutrient levels elevated above the guidelines on only a few occasions in 2005-2006. Similarly to last financial year, only the median for *E. coli* and pH were not within accepted guidelines. In fact, the bacteria *E. coli* exceeded the bathing guideline of 126 per 100mL on all sampling occasions.

A median as high as 565 *E. coli* per 100 mL and consistently elevated results indicate that intermittent sources of *E. coli* such as leaking septic tanks, or stock with access to the river may be more of a problem at this site than surface run-off. Restricting stock access and encouraging the maintenance of septic tanks can reasonably easily mitigate these sources.

Like last year, although only significant at a 90% confidence level (not shown on the table in the trends section of this report) there is a long term trend suggesting that bacterial levels are increasing at the Waimate North site. The trend suggests that *E. coli* counts are increasing at a rate of 38/100mL per year.

There was also a long term trend suggesting that pH is increasing at this site by 0.1 pH units/year. Although in general it is not known whether an increase in pH is beneficial or detrimental, it is likely at this site that an increase in pH is beneficial, as pH levels were often below the optimum pH range for the protection of aquatic ecosystem in 2005-2006, never above.

Waitangi River at Watea

The Waitangi River originates in roughly the middle of Northland and flows East where it joins the coast at Waitangi. There are two sites on the Waitangi River that form part of the river network, one at Waimate North and the other at Watea near Waitangi. The catchments of both sites are dominated by pastoral farming. However, the geology of the upstream site at Waimate North is predominantly volcanic acidic, while the site at Watea is dominated by hard sediments. Unlike many of Northland's rivers, a riparian buffer strip of vegetation exists along the majority of the Waitangi River. The Watea site on the Waitangi River is one of four sites in Northland that are part of the National River Water Quality Network administered by NIWA.

The 2005-2006 results for the Waitangi River at Watea site are summarised in the table below including the median, range and percentage of sampling occasions that comply with relevant guidelines. Note: Nutrient results were only available for seven sampling occasions (July 2005 – January 2006), except for total phosphorus and nitrogen and the results for June 2006 where not available at the time of data analysis. Medians shown in red are outside the recommended guidelines.

Parameter	Median	Range	% comply with guideline
Temperature (deg. cel.)	16.4	12 - 22.4	
Dissolved oxygen (mg/L)	9.9	7.4 - 11.1	100
Dissolved oxygen (% Sat.)	100.5	84.5 - 104	64
Conductivity (mSm)	11.8	9.4 - 13.7	
Water clarity (m)	1.62	0.14 - 2.78	82
Turbidity (NTU)	2.6	1.0 -34	82
E. coli (n/100mL)	118	53 - 6488	55
Dissolved reactive phosphorus (mg/L)	0.004	0.003 - 0.018	71
Total phosphorus (mg/L)	0.018	0.012 - 0.085	80
Ammoniacal nitrogen (mg/L)	0.008	0.002 - 0.034	71
Total nitrogen (mg/L)	0.42	0.204 - 1.05	80
pH	7.5	7.0 - 7.7	91

The 2005-2006 results show that the Watea site has similar water quality to the Waimate North site further up the Waitangi River. However all medians for the Watea site are within recommended guidelines and water quality tends to be good (i.e. parameters met the guidelines) for 50 to 80% of the sampling occasions.

Again bacterial contamination is the most concerning result. Although six of the 11 samples were below the recreational bathing guideline of 126 E. coli/100mL, there was still some extremely high results such as on 15 September 2005, where it peaked at 6488 per 100 mL. This spike in bacterial contamination was associated with increased flow and is likely to be a result of surface run off.

Based on data from October 1996 to May 2006, the trend analysis shows that there is a significant decreasing trend for nitrate (NO_3) of 0.009 mg/L per year at a 95% confidence interval (not shown in the trends table) for the Watea site on Waitangi River, however there was no significant trend for total nitrogen. There was no significant trends for any of the other parameters.

Whakapara River

The Whakapara River originates from the ranges east of Hikurangi and Whakapara, to eventually mix with the Waiotu River, forming the headwaters of the greater Wairua River. The river cuts through hard sediments formed from faulted greywacke, along a relatively low gradient. The site is located in a beef and sheep farm near State Highway one, with an upstream catchment dominated by forested hills and pastoral farming.

The 2005-2006 results for the Whakapara River site are summarised in the table below including the median, range and percentage of sampling occasions that comply with relevant guidelines for the 12 sampling occasions. Medians shown in red are outside the recommended guidelines.

Parameter	Median	Range	% comply with guideline
Temperature (deg. cel.)	15.8	11.2 - 21.1	-
Dissolved oxygen (mg/L)	10.2	8.6 - 12.8	100
Dissolved oxygen (% Sat.)	102.5	82.5 - 120	33
Conductivity (mSm)	9.2	6.8 - 10.2	-
Water clarity (m)	1.62	0.2 - 2.33	90
Turbidity (NTU)	4.4	2 - 106	75
E. coli (n/100mL)	174	73 - 24192	25
Dissolved reactive phosphorus (mg/L)	0.030	0.014 - 0.059	0
Total phosphorus (mg/L)	0.056	0.038 - 0.361	0
Ammoniacal nitrogen (mg/L)	0.02	0.005 - 0.12	50
Total nitrogen (mg/L)	0.47	0.207 - 1.53	75
pH	7.2	6.5 - 7.5	50

Both total phosphorus and dissolved reactive phosphorus in Whakapara River in 2005 –2006 were elevated on all sampling occasions, with no samples meeting the guideline values. Although they were consistently high they did also appear to be related to flow.

Although the medians for dissolved oxygen (% saturation), and *E. coli* met their respective guidelines, there are several sampling occasions that they did not. Similarly to the phosphorus results these tend to occur in conjunction with elevated flows. The effect of runoff could be minimised with appropriate riparian management such as fencing and planting of a buffer strip of vegetation.

There are long term trends suggesting that both dissolved oxygen (mg/L) and DO percentage saturation are increasing in Whakapara River. This could be related to an increase in the biomass of oxygen weed and other macrophytes in the river. It is unknown whether this is a detrimental or positive trend, as dissolved oxygen levels can be both below and above the optimum range for the protection of aquatic ecosystems.

Other significant long term trends in Whakapara River include an increasing pH, decreasing turbidity with a corresponding increasing trend in water clarity and decreasing trend in nitrite/nitrate nitrogen (NNN) levels, which are all seen as improving trends.

Waiarohia Stream at Second Ave

Waiarohia Stream is a small stream originating from Pukenui Forest and the Western Hills in Whangarei. The upper catchment is mainly indigenous forest with some exotic forestry. The stream flows through a small area of low intensity farm land with mostly lifestyles blocks, before it reaches residential housing and the central business area of Whangarei. This site is located in the central business area and was added to the RWQMN in 2005-2006 to look at urban influences on water quality. Results for this site can be compared to the upstream site in Whau Valley.

The first year of results for the Waiarohia Stream site at Second Ave are summarised in the table below including the median, range and percentage of sampling occasions that comply with relevant guidelines for the 12 sampling occasions. Medians shown in red are outside the recommended guidelines.

Parameter	Median	Range	% comply with guideline
Temperature (deg. cel.)	17.5	12.7 - 24.4	
Dissolved oxygen (mg/L)	10.8	8.8 - 13.6	100
Dissolved oxygen (% Sat.)	111.2	95.6 - 142.6	25
Conductivity (mSm)	24.6	14.3 - 37.1	
Water clarity (m)	1.60	0.21 – 2.60	92
Turbidity (NTU)	2.8	1.8 - 63	83
E. coli (n/100mL)	507	299 - 9804	0
Dissolved reactive phosphorus (mg/L)	0.022	0.006 - 0.042	33
Total phosphorus (mg/L)	0.051	0.018 - 0.216	17
Ammoniacal nitrogen (mg/L)	0.005	0.005 - 0.03	92
Total nitrogen (mg/L)	0.648	0.235 - 1.28	33
pH	7.4	7 - 7.7	83

This is the first year of results so limited conclusions can be drawn at this stage; however the 2005-2006 results highlight several areas of concern in the Waiarohia Stream. The highest temperature of all the RWQMN sites was recorded at this Second Ave site on 18 January 2006 of 24.4°C. It is commonly accepted that water temperatures of greater then 25°C are potentially harmful or even lethal for aquatic biota. It is likely that this site exceeds 25°C on occasion at certain times of the time in the hottest summer days.

Bacterial levels are consistently elevated, with none of the samples meeting the recreational bathing guideline of 126 E. coli/100 mL. Dissolved reactive phosphorus, total phosphorus and total nitrogen are also often elevated with none of their medians for 2005-06 meeting their respective guidelines. The source of the nutrient and bacterial contamination is likely to be surrounding small scale pastoral farming and related to the direct access that stock have to the stream in many places.

Commencing in 2006-2007 sediment samples will be collected and analysed for several indicator heavy metals at this site to better understand the effects of urban land use on water quality.

Awanui River at FNDC water take

The Awanui River originates from Raetea Forest (Mangamuka's) and meanders north for a significant distance through pasture and the Kaitaia township, eventually flowing into the Rangunu Harbour. There are 3 sites on the Awanui River system in the network; one in the upper reaches on Victoria River, one in the mid reaches at the FNDC water take and the last one in the lower reaches directly above Waihue channel. The FNDC water take from the Awanui River is beside State Highway 1, just south of Kaitaia. The upstream catchment is predominantly pastoral land use, with some semi-forested tributaries such as the Victoria River. Most of the river's bottom is made up of soft sediments, and riparian planting varies from non-existent to quite dense.

The 2005-2006 results for the Awanui River at the location of the FNDC water take are summarised in the table below including the median, range and percentage of sampling occasions that comply with relevant guidelines for the 12 sampling occasions. Medians shown in red are outside the recommended guidelines.

Parameter	Median	Range	% comply with guideline
Temperature (deg. cel.)	16.2	11.3 - 21.8	
Dissolved oxygen (mg/L)	8.3	5.3 - 11	92
Dissolved oxygen (% Sat.)	84.7	59.2 - 120.5	0
Conductivity (mSm)	19.7	15.5 - 20.8	
Water clarity (m)	0.60	0.4 - 1.5	55
Turbidity (NTU)	6.0	1.5 - 47	50
E. coli (n/100mL)	304	104 - 3654	8
Dissolved reactive phosphorus (mg/L)	0.019	0.006 - 0.033	8
Total phosphorus (mg/L)	0.046	0.02 - 0.118	25
Ammoniacal nitrogen (mg/L)	0.005	0.005 - 0.01	100
Total nitrogen (mg/L)	0.278	0.101 - 0.636	92
pH	7.5	6.9 - 8.1	75

Similarly to the last two years the nitrogen concentrations were satisfactory, however dissolved oxygen saturation, phosphorus, turbidity, water clarity and *E. coli* failed to meet the guidelines. Some of these elevated results coincide with elevated flows and therefore are most likely as a result of surface run-off during rainfall events. However some of the spikes in *E. coli* and phosphorus cannot be as easily linked to rainfall events. This contamination could be as a result of leaking septic tanks or stock with access to the river.

Improved riparian management will assist with mitigating some of these elevated results, by restricting stock access, and reducing excess run-off. Better maintenance of septic tanks within the catchment is also likely to reduce the number and size of contamination events. Another potential source of phosphorus is inefficiently applied fertiliser. Accurate nutrient budgeting and appropriate application can reduce the amount of fertiliser wasted by being washed into streams.

This site was only established in March 2002 and therefore there will not be sufficient data to carry out trend analysis until the end of the 2006-2007 financial year.

Mangakahia River at Titoki

The Mangakahia River originates from native bush near Waipoua Forest flowing southwest until it reaches the Wairua River. There are two sites on the Mangakahia River; one mid catchment at Twin Bridges and the other at Titoki Bridge in the lower reaches. By the time the Mangakahia River reaches the settlement of Titoki, land use is predominantly beef and dairy farming, still with an underlying geology of acidic volcanics. Riparian management along the lower Mangakahia varies in quality, from quite dense to non-existent. This site is one of four sites in Northland that are part of the National River Water Quality Network, administered by NIWA.

The 2005-2006 results for the Mangakahia River site at Titoki Bridge are summarised in the table below including the median, range and percentage of sampling occasions that comply with relevant guidelines for the 12 sampling occasions. Note: Nutrient results were only available for seven sampling occasions (July 2005 – January 2006), except for total phosphorus and nitrogen, and the results for June 2006 where not available at the time of data analysis. Medians shown in red are outside the recommended guidelines.

Parameter	Median	Range	% comply with guideline
Temperature (deg. cel.)	17.6	12.3 - 23.7	
Dissolved oxygen (mg/L)	9.2	8.1 - 10.5	100
Dissolved oxygen (% Sat.)	96.1	91.8 - 107.1	27
Conductivity (mSm)	14.2	10.3 - 16.4	
Water clarity (m)	0.68	0.18 - 1.49	64
Turbidity (NTU)	5.3	2 - 26	64
E. coli (n/100mL)	192	38 - 3448	45
Dissolved reactive phosphorus (mg/L)	0.007	0.004 - 0.012	71
Total phosphorus (mg/L)	0.028	0.016 - 0.052	70
Ammoniacal nitrogen (mg/L)	0.013	0.001 - 0.024	86
Total nitrogen (mg/L)	0.228	0.167 - 0.648	90
pH	7.4	7.0 - 8.1	64

The 2005-2006 results indicate that the Mangakahia River has moderate water quality by the time it reaches Titoki. The median *E. coli* and dissolved oxygen (% saturation) results for 2005-06 do not meet their respective guidelines. The peaks in bacterial contamination could be related to increased flow; however, when flows get extremely high there could be a dilution effect occurring, as bacterial levels are a lot lower than for moderate increases in flow.

Trend analysis on data from October 1996 to May 2006 shows there are decreasing trends in dissolved reactive phosphorus and nitrate at the Titoki site but not in total nitrogen or phosphorus.

Mangahahuru Stream at Apotu Road

The Mangahahuru Stream, which begins in *Pinus radiata* forestry southeast of Hikurangi, is a small tributary of the Wairua River. Other than the exotic forestry in the headwaters the catchment is predominantly agricultural land use, with an increasing number of lifestyle blocks. Riparian management in the catchment is variable. The underlying geology is hard sedimentary.

The 2005-2006 results for the Mangahahuru Stream at Apotu Road are summarised in the table below including the median, range and percentage of sampling occasions that comply with relevant guidelines for the 12 sampling occasions. Medians shown in red are outside the recommended guidelines.

Parameter	Median	Range	% comply with guideline
Temperature (deg. cel.)	16.0	11.1 - 20.4	
Dissolved oxygen (mg/L)	10.2	8.7 - 13.4	100
Dissolved oxygen (% Sat.)	100.9	87.8 - 124	8
Conductivity (mSm)	13.3	11.1 - 15.3	
Water clarity (m)	1.20	0.2 - 2.05	82
Turbidity (NTU)	5.3	2 - 102	58
E. coli (n/100mL)	485	249 - 15531	0
Dissolved reactive phosphorus (mg/L)	0.038	0.012 - 0.085	0
Total phosphorus (mg/L)	0.077	0.054 - 0.274	0
Ammoniacal nitrogen (mg/L)	0.020	0.005 - 0.11	58
Total nitrogen (mg/L)	0.643	0.292 - 1.41	42
pH	7.1	6.5 - 7.4	33

The Mangahahuru Stream is significantly impacted on, with the phosphorus and *E. coli* results for 2005-2006 exceeding their respective guideline values on all sampling occasions and the median for total nitrogen also exceeding guidelines.

Non-point diffuse surface run off is the likely source of most of the contamination, as spikes in contamination are associated with elevated river flows. However some may also be contributed to poorly maintained septic tanks, stock access to the stream or point source consented discharges such as the Hikurangi Oxidation Pond or Dairy Factory discharges.

There is cause for reserved optimism though, as the long-term trends for ammoniacal nitrogen, turbidity, clarity and pH all suggest that the situation is improving in the long term.

There is however some negative trends for the Mangahahuru Stream, including increasing conductivity, increasing dissolved oxygen and decreasing flow. The latter is of the most concern in terms of demands on water resources in this area; however, caution needs to be taken interpreting this as a true result as this trend is only based on the flow rate at the time of water quality sampling. This concerning trend will be investigated further by the hydrology team using the entire flow dataset for this site.

Waiarohia Stream at Whau Valley Road

Waiarohia Stream is a small stream originating from Pukenui Forest and the Western Hills in Whangarei. The upper catchment is mainly indigenous forest with some exotic forestry. The stream flows through a small area of low intensity farm land with mostly lifestyles blocks, before it reaches residential housing and the central business area of Whangarei. This site is located upstream of the majority of residential housing in the upper catchment of the Waiarohia Stream. It was added to the network in 2005-2006 as a background site to compare the urban Second Ave site to.

The first year of results for the Waiarohia Stream site at Whau Valley Road are summarised in the table below including the median, range and percentage of sampling occasions that comply with relevant guidelines for the 12 sampling occasions. Medians shown in red are outside the recommended guidelines.

Parameter	Median	Range	% comply with guideline
Temperature (deg. cel.)	16.2	12.5 - 20.2	
Dissolved oxygen (mg/L)	9.5	8.1 - 10.6	100
Dissolved oxygen (% Sat.)	97.5	88.7 - 102.7	33
Conductivity (mSm)	29.8	15 - 46.9	
Water clarity (m)	0.88	0.34 - 1.52	92
Turbidity (NTU)	6.9	3.7 - 34	25
E. coli (n/100mL)	726	179 - 12033	0
Dissolved reactive phosphorus (mg/L)	0.007	0.002 - 0.018	75
Total phosphorus (mg/L)	0.067	0.041 - 0.155	0
Ammoniacal nitrogen (mg/L)	0.005	0.005 - 0.02	100
Total nitrogen (mg/L)	0.784	0.414 - 0.954	17
pH	7.2	6.8 - 7.5	67

This is the first year of results so limited conclusions can be drawn at this stage; however the 2005-2006 results highlight several areas of concern in the Waiarohia Stream. Similarly to the Second Ave site bacterial levels are consistently elevated, with none of the samples meeting the recreational bathing guideline of 126 E. coli/100 mL. Total phosphorus and total nitrogen are also often elevated, with their medians for 2005-06 exceeding their respective guidelines. Turbidity and water clarity also appears to be an issue at this site on several occasions.

The source of the nutrient and bacterial contamination is likely to be surrounding small scale pastoral farming and related to the direct access that stock have to the stream in many places.

Punakitere River

The Punakitere River, originating from a wetland area southwest of Kaikohe, is a major tributary into the Waima River (which flows into the Hokianga Harbour). The catchment is predominantly agricultural land use with an underlying geology of soft sediments.

The 2005-2006 results for Punakitere River are summarised in the table below including the median, range and percentage of sampling occasions that comply with relevant guidelines for the 12 sampling occasions. Medians shown in red are outside the recommended guidelines.

Parameter	Median	Range	% comply with guideline
Temperature (deg. cel.)	15.7	10.7 - 21.3	
Dissolved oxygen (mg/L)	9.8	8.2 - 12.7	100
Dissolved oxygen (% Sat.)	96.6	90.5 - 114.3	33
Conductivity (mSm)	12.7	11.3 - 15	
Water clarity (m)	1.30	0.22 - 2.32	73
Turbidity (NTU)	5.4	1.3 - 24	50
E. coli (n/100mL)	394	162 - 1414	0
Dissolved reactive phosphorus (mg/L)	0.033	0.01 - 0.079	8
Total phosphorus (mg/L)	0.067	0.025 - 0.134	8
Ammoniacal nitrogen (mg/L)	0.010	0.005 - 0.06	83
Total nitrogen (mg/L)	0.862	0.301 - 1.24	33
pH	7.6	6.8 - 7.9	83

Similarly to the last two year's results, the 2005-2006 results indicate that Punakitere River suffers from significant nutrient overloading and bacterial contamination, with the median E. coli, dissolved reactive phosphorus, total phosphorus and total nitrogen results exceed their respective guidelines. Run-off is the likely source of nutrient and bacterial contamination in Punakitere River.

There is only just five years data to be able to carry out trend analysis on the results from Punakitere River, so caution should be taken as these trends could possibly change or more could become apparent next year when the trend analysis is repeated. However at this stage the only two significant trends are decreasing nitrite/nitrate nitrogen and increasing pH, both of which are seen as an improvement.

Waiotu River at SH1

The Waiotu River is a hard sediment bottomed river derived from a predominantly agricultural catchment. The river originates from hills to the northeast of State Highway one between Kawakawa and Whangarei, to eventually combine with the Whakapara River and form the greater Wairua River.

The 2004-2005 results for the Waiotu River site are summarised in the table below including the median, range and percentage of sampling occasions that comply with relevant guidelines for the 12 sampling occasions. Medians shown in red are outside the recommended guidelines.

Parameter	Median	Range	% comply with guideline
Temperature (deg. cel.)	15.5	11 - 20.9	
Dissolved oxygen (mg/L)	9.5	6.9 - 12	100
Dissolved oxygen (% Sat.)	93.7	75.6 - 109.5	8
Conductivity (mSm)	10.0	8.4 - 14.6	
Water clarity (m)	0.75	0.35 - 1.97	82
Turbidity (NTU)	9.2	3 - 25	25
E. coli (n/100mL)	370	74 - 3255	8
Dissolved reactive phosphorus (mg/L)	0.029	0.013 - 0.048	0
Total phosphorus (mg/L)	0.075	0.039 - 0.136	0
Ammoniacal nitrogen (mg/L)	0.025	0.005 - 0.15	50
Total nitrogen (mg/L)	0.685	0.216 - 1.09	25
pH	7.0	6.8 - 7.4	25

Water quality is highly impacted at the Waiotu River site, with the medians for the majority of parameters above not meeting their respective guidelines. Dissolved reactive and total phosphorus exceeded their respective ANZECC trigger values on all 12 sampling occasions.

The trend analysis suggests that there is a decreasing trend in ammoniacal nitrogen, nitrate/nitrite nitrogen (NNN) and total nitrogen and increasing trend in pH. These are all seen as beneficial trends; however caution should be taken as these trends are based on only six years data at this stage.

Awanui River at Waihue Channel

The lowest of three sites on the Awanui River system it is located directly downstream of the discharge from Kaitaia oxidation ponds and upstream of the Waihue Channel. By the time it reaches this point the Awanui River has flowed through more than 30 km of agricultural land and Kaitaia township. The '*River Environment Classification'* identifies this site as a low elevation river with soft sediment geology and pastoral land use.

The 2005-2006 results for the Awanui River site at Waihue Channel are summarised in the table below including the median, range and percentage of sampling occasions that comply with relevant guidelines for the 12 sampling occasions. Medians shown in red are outside the recommended guidelines.

Parameter	Median	Range	% comply with guideline
Temperature (deg. cel.)	16.8	12 - 22.7	
Dissolved oxygen (mg/L)	8.2	7.3 - 10.2	100
Dissolved oxygen (% Sat.)	85.1	72.7 - 108	9
Conductivity (mSm)	20.8	16.7 - 22.9	
Water clarity (m)	0.50	0.4 – 1.0	30
Turbidity (NTU)	7.3	3.2 - 25	18
E. coli (n/100mL)	323	141 - 1860	0
Dissolved reactive phosphorus (mg/L)	0.060	0.018 - 0.166	0
Total phosphorus (mg/L)	0.107	0.032 - 0.259	9
Ammoniacal nitrogen (mg/L)	0.005	0.005 - 0.2	64
Total nitrogen (mg/L)	0.554	0.221 - 0.91	73
pH	7.5	6.9 - 8.4	82

This site on the Awanui River is severely impacted. The medians for dissolved oxygen (% saturation), water clarity, turbidity, E. coli, dissolved reactive phosphorus and total phosphorus do not meet their respective guidelines. The particularly concerning results as with many of the other impacted sites in the river network, is the consistently high phosphorus results. The source of this phosphorus is likely to be run-off from pastoral land use within the catchment but the Kaitaia oxidation pond discharge directly upstream could also be a source.

The good news is that the long-term trends for this site suggest that dissolved reactive phosphorus, total phosphorus and ammoniacal nitrogen are declining. However there is also significant trends suggesting pH, conductivity and total kjeldahl nitrogen (organic nitrogen) are increasing.

Manganui River

The Manganui is a major tributary into the Wairoa River, flowing from the western fringes of the Marertu forest to join the Wairoa just east of Dargaville. The river runs through extremely low gradient predominantly agricultural pastures, with some forestry blocks scattered through the catchment. The underlying geology at the site is soft sediments.

The 2005-2006 results for the Manganui River are summarised in the table below including the median, range and percentage of sampling occasions that comply with relevant guidelines for the 12 sampling occasions. Medians shown in red are outside the recommended guidelines.

Parameter	Median	Range	% comply with guideline
Temperature (deg. cel.)	16.9	10.7 - 23.8	
Dissolved oxygen (mg/L)	8.1	6.2 - 9.9	100
Dissolved oxygen (% Sat.)	81.5	57.6 - 109.2	0
Conductivity (mSm)	20.6	15.3 - 22.4	
Water clarity (m)	0.83	0.33 - 1.26	82
Turbidity (NTU)	5.7	3.4 - 49	50
E. coli (n/100mL)	164	40 - 2613	42
Dissolved reactive phosphorus (mg/L)	0.058	0.044 - 0.082	0
Total phosphorus (mg/L)	0.102	0.061 - 0.167	0
Ammoniacal nitrogen (mg/L)	0.005	0.005 - 0.07	83
Total nitrogen (mg/L)	0.646	0.301 - 1.16	50
pH	7.2	6.4 - 8.7	50

The Manganui River has been heavily impacted on and in turn has relatively poor water quality. The medians of six parameters did not meet their respective guideline values. Similarly to last year, none of the dissolved oxygen saturation results for 2005-2006 were within the optimum range for the protection of aquatic ecosystems. These low dissolved oxygen results are not surprising with the sluggish nature of the extremely low gradient Manganui River.

High levels of all nutrients but particularly dissolved reactive and total phosphorus suggest that agricultural run-off is a problem in the Manganui catchment. All DRP and TP results were above their respective guideline trigger values. Elevated phosphorous in particular is a sign that a significant amount of the fertilisers applied to paddocks are not being absorbed, but washing into streams and rivers instead. Better riparian management and fertiliser application practices would help prevent such run-off.

With five years data for the Manganui River site, there is now enough data for trend analysis. The only significant trend with five years of data is a deceasing trend in nitrite/nitrate nitrogen (NNN) levels at 0.032 mg/L per year. This is a positive trend, as the NNN levels usually contribute about half of the total nitrogen at this site.

Wairua River at Purua

The Wairua River flowing west above Whangarei all the way into the Kaipara Harbour, is one of the major tributaries of the greater Wairoa River. Upstream of the sampling site the catchment is predominantly pastoral, with the river cutting through hard sediments along a low gradient. The Wairua River site at Purua is one of four sites in Northland that are part of the National River Water Quality Network administered by NIWA.

The 2005-2006 results for the Wairua River at Purua are summarised in the table below including the median, range and percentage of sampling occasions that comply with relevant guidelines for the 12 sampling occasions. Note: Nutrient results were only available for seven sampling occasions (July 2005 – January 2006), except for total phosphorus and nitrogen and the results for June 2006 where not available at the time of data analysis. Medians shown in red are outside the recommended guidelines.

Parameter	Median	Range	% comply with guideline
Temperature (deg. cel.)	17.1	12.3 - 23.6	
Dissolved oxygen (mg/L)	9.0	7.5 - 9.8	100
Dissolved oxygen (% Sat.)	91.8	71 - 115.3	9
Conductivity (mSm)	12.60	10.2 - 14.1	
Water clarity (m)	0.58	0.18 - 1.3	45
Turbidity (NTU)	8.3	3.4 - 36	27
E. coli (n/100mL)	99	44 - 6488	64
Dissolved reactive phosphorus (mg/L)	0.024	0.011 - 0.055	0
Total phosphorus (mg/L)	0.079	0.043 - 0.144	0
Ammoniacal nitrogen (mg/L)	0.02	0.004 - 0.172	29
Total nitrogen (mg/L)	0.758	0.236 - 1.87	30
pH	7.0	6.4 - 7.9	18

The 2005-2006 results suggest that the Wairua River is a moderately impacted waterway, with poor dissolved oxygen levels, poor water clarity, elevated phosphorus and nitrogen levels and low pH results the majority of the time. This relatively poor water quality is a result of intensive surrounding agricultural land use.

Trend analysis on data from October 1996 to May 2006 shows several positive trends including decreasing ammoniacal nitrogen concentrations, decreasing turbidity and deceasing total nitrogen results, which is linked to a decreasing trend in nitrate (not shown on the trends table). There is also a trend suggesting that pH is increasing. This is likely to be a beneficial trend for this site as pH is often below the optimum range for the protection of aquatic ecosystems. There is also increasing trends in dissolved oxygen (both in mg/L and % saturation) but it is not known whether this is a positive or detrimental trend at this stage.

Investigation into diurnal patterns in dissolved oxygen levels will be investigated at selected RWQMN sites in 2006-2007. From this it will be determined whether trends of increasing dissolved oxygen levels at RWQMN sites is of concern. Especially as there are several sites that are showing a increasing trend in dissolved oxygen.

Mangere River at Knights Road

The Mangere River is a low-lying sluggish tributary to the Wairua River, flowing through a mostly intensive agricultural catchment. The river begins as the Mangere Stream, which flows east out of the Pukenui forest near Whangarei, becoming a river on the flats before joining the Wairoa River just west of Kokopu. For the most part, soft sedimentary rocks make up the underlying geology with small pockets of riparian vegetation remaining along the river.

The 2005-2006 results for the Mangere River are summarised in the table below including the median, range and percentage of sampling occasions that comply with relevant guidelines for the 12 sampling occasions. Medians shown in red are outside the recommended guidelines.

Parameter	Median	Range	% comply with guideline
Temperature (deg. cel.)	15.4	10.6 - 20	
Dissolved oxygen (mg/L)	8.6	5.7 - 10.2	92
Dissolved oxygen (% Sat.)	84.8	62.8 - 91.7	0
Conductivity (mSm)	17.2	15.9 - 24.5	
Water clarity (m)	1.11	0.45 - 1.87	75
Turbidity (NTU)	5.2	3 - 19.5	58
E. coli (n/100mL)	898	461 - 4352	0
Dissolved reactive phosphorus (mg/L)	0.120	0.069 - 0.292	0
Total phosphorus (mg/L)	0.172	0.101 - 0.591	0
Ammoniacal nitrogen (mg/L)	0.050	0.005 - 0.23	17
Total nitrogen (mg/L)	1.179	0.416 - 2.23	17
pH	7.2	6.6 - 7.6	50

The Mangere River is the most impacted river in the regional network with the worst water quality of the 21 sites monitored. Nutrient and bacterial levels are consistently elevated above guideline values throughout the year. A already high *E. coli* median of 898 per 100mL for 2005-2006, may only get worse as a long term trend as been detected that suggests that *E. coli* counts are increasing at a rate of 86/100mL/year.

However there have also been several trends detected that are a positive result for the highly degraded Mangere River. This includes decreasing ammoniacal nitrogen, decreasing nitrate/nitrite nitrogen, increasing pH, increasing water clarity, decreasing temperature, and decreasing total nitrogen. If these trends of improving water quality continue, there is a chance that water quality in the Mangere will noticeably improve.

Trends in water quality

Long-term trend analysis was carried out using a Seasonal Kendall test, which eliminates any seasonal influences on the results. The table below shows water quality trends for 15 of Northland's river network sites, which are those that have five or more year's data. There is not yet enough data for Awanui at FNDC watertake, Kaihu and Waipoua Rivers, as well the three new sites added in 2005-06 (two Waiarohia sites and Mangahahuru at Main Road). The start of dataset for trend analysis is shown in brackets in the table below, and the end is June 2006 or May 2006 for the four NIWA sites.

Only significant trends are shown, which are those with at least a 95% confidence level i.e. 95% likelihood that the trend is "real". It must be highlighted that 5 years data is a minimum for carrying out long term trend analysis and that these trends could change when the analysis is carried out again next year, especially for the sites where there is only just five years data.

In the table an up arrow indicates an increasing trend, a down arrow a decreasing trend and a green arrow a desirable trend, while a red arrow indicates an undesirable trend. A blue arrow has been used where it is not yet known whether this is an improvement or deterioration.

There were no significant trends at a 95% confidence level for water temperature at any of the sites. Many of the sites could not have trend analysis done on ammoniacal nitrogen as too many results were below detection limit, shown as NA in the table below. Some sites had insufficient data for that parameter to carry out trend analysis, shown as ID in the table. Note: the decreasing trend marked with an asterisk for the four NIWA sites is for nitrate (NO_3) only, not NNN.

Site	Cond	DO%	DO	pH	Clarity	Turb	*Ecoli*	TKN	NH4	NNN	TN	DRP	TP
Awanui Waihue channel (Oct 1996)	↑			↑					↓			↓	↓
Victoria (Oct 1996)				↑					NA				
Opouteke (Oct 1996)			ID	↑					NA				
Mangakahia Twin Bridges (Oct 1996)			ID	↑					NA			↑	
Mangahahuru (Oct 1996)	↑	↑	↑	↑	↑	↓			↓				
Waiotu (March 2000)		↑	↑	↑	ID				↓	↓			
Whakapara (Oct 1996)		↑	↑	↑					NA	↓			↑
Waitangi Waimate North (Aug 1999)		↑	↑	↑					NA	↓			
Mangere (Oct 1996)				↑	↑		↑		↓	↓	↓		
Punakitere (Aug 2001)				↑	ID				NA	↓			

Manganui (Aug 2001)					ID				NA	↓			
Waipapa (Oct 1996)				↑			ID		↓	↓*		↓	
Wairua (Oct 1996)		↑	↑	↑			ID		↓	↓*	↓	↓	
Mangakahia Titoki bridge (Oct 1996)							ID			↓*			
Waitangi Watea (Oct 1996)							ID			↓*		↓	

Conductivity

Conductivity (COND) is a measure of the amount of ions in the water column and can be used as in indicator of nutrient enrichment. There is an increasing trend in conductivity at only two sites; Awanui River at Waihue channel and Mangahahuru at Apotu Road. This is most likely an indication of increasing enrichment and therefore has been shown as an undesirable trend.

Dissolved oxygen

There is an increasing trend in dissolved oxygen (DO) at Mangahahuru at Apotu Road, Whakapara River, Waiotu at SH1, Waitangi at Waimate North and Wairua River sites. It is unknown whether this trend is beneficial or detrimental, because for all these sites dissolved oxygen is both above and below the optimum range on several occasions.

Although dissolved oxygen is required for freshwater fauna to survive, an extremely high DO during the day could indicate that DO lags during the night or early morning. All of these five sites are dominated by aquatic macrophytes such as *Egeria densa* (oxygen weed), which produce copious amounts of oxygen during the day while they are able to photosynthesis but not at night when lags in DO can occur. Diurnal patterns in dissolved oxygen will be investigated at these sites.

Water clarity

The trend analysis shows that water clarity has increased (improved) by 8 cm per year in Mangahahuru Stream and 6 cm/year in Mangere River. It is not obvious why water clarity has improved at these sites; it could be as a result of reduced land run off in conjunction with improved farming and forestry practices or better quality discharges from point source discharges. There has been a corresponding decrease in turbidity of 0.4 NTU/year at a 95% CI in Mangahahuru Stream and of 0.23 NTU per year at only 80% CI in Mangere River.

Bacterial contamination

There was only one site that showed a significant trend in bacterial quality (*E. coli*); Mangere stream in which *E. coli* has increased by 86 per 100 mL per year, which is seen as a deterioration. Similarly to water clarity, these trends cannot be attributed to anything in particular at this stage. This is the only detrimental trend significant at a 95% confidence level for this site.

Nutrients

In general nutrient levels are showing decreasing trends at the majority of sites, including decreasing dissolved reactive phosphorus, ammoniacal nitrogen, nitrite/nitrate nitrogen and in turn total nitrogen and phosphorus. This could be a result of overall improving farm management practices throughout the region,

including increased stock exclusion from waterways, riparian planting and better fertiliser application procedures. It also could be a result of better quality point source discharges such as farm dairy effluent, oxidation ponds and other industrial discharges. However many of these sites still have very high nutrient levels and there is a long way to go until desirable levels are met.

Macroinvertebrate Monitoring

Different stream macroinvertebrates show different responses to changes in their environment such as water quality or low flows and different species show different tolerances to pollution. Macroinvertebrates are good indicators of local conditions because they tend to stay in one place and are affected by the environmental conditions over an extended period of time, unlike water quality results, which tend to be spot measurements, i.e. that exact point in time. Also stream macroinvertebrates are the best indicator of the life supporting capacity of a stream or river, as they are usually near the middle of the food web and an important component of stream ecosystems.

This report summarises the results from the February/March 2006 round of macroinvertebrate monitoring carried out at four Waiarohia Stream sites, the 19 River Water Quality Monitoring Network sites, four Otarao catchment sites and six rivers both upstream and downstream of different resource consent activities throughout Northland.

The monitoring was carried out following the standard protocols developed by the NZ Macroinvertebrate working group in 2001; *'Protocols for sampling macroinvertebrates in Wadeable streams' (Stark et al. 2001[1])*. Four standard biotic indices were calculated to assess water quality and biological health at the sites;

- Species richness
- Macroinvertebrate Community Index (MCI)
- Semi Quantitative Macroinvertebrate Community Index (SQMCI)
- The percentage of Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies) taxa (%EPT taxa)

For more information on sampling methods and biotic indices check out the detailed **macroinvertebrate monitoring report for 2006** on the Regional Council website.

[1] Stark, J.D.; Boothroyd, I.K.G.; Harding, J.S.; Maxted, J.R. and Scarsbrook, M.R. (2001). **Protocols for sampling macroinvertebrates in wadeable streams.** New Zealand Macroinvertebrate Working group Report No. 1. Prepared for the Ministry for the Environment. Sustainable Management Fund Project No. 5103, 57p.

Biotic indices results

The table below shows the four biotic index scores for all sites monitored in 2006. MCI, SQMCI and %EPT taxa have been colour coded to show the range in water quality or degradation at each site. For example, red indicates poor water quality and a severely degraded site, through orange and yellow which indicate moderate water quality, to green which indicates good water quality or a stream still in a relatively 'pristine' state (very little impact from humans).

Waiarohia sites

Site description	Species richness	MCI	SQMCI	%EPT taxa
Rust Ave Bridge	18	79	4.45	16.7
Russell Road Bridge North	17	85	4.64	23.5
Kamo tributary	14	70	2.82	14.3
Whau Valley Road	19	86	4.16	26.3

RWQMN sites

Site description	Species richness	MCI	SQMCI	%EPT taxa
Awanui @ Waihue channel	18	77	4.11	22.2
Awanui @ FNDC water take	17	92	4.52	47.1
Victoria @ Thompsons Bridge	18	78	3.99	22.2
Waipapa @ Forest Ranger	29	125	6.04	55.2
Waitangi @ Waimate North	24	108	5.83	45.8
Waitangi @ Watea	16	69	3.89	6.3
Whakapara @ Cableway	11	80	4.35	36.4
Mangahahuru @ Apotu Road	10	78	3.47	20
Mangahahuru @ Main Road	22	86	5.08	31.8
Wairua @ Purua	11	66	3.99	0
Mangere @ Knights Road	23	80	4.36	13.0
Mangakahia @ Titoki	11	89	4.10	27.3
Opouteke @ Suspension Bridge	14	77	2.68	35.7
Mangakahia @ Twin bridges	16	78	3.14	12.5
Punakitere @ Taheke Recorder	19	98	4.49	47.4
Waiotu @ SH1	15	80	3.98	33.3
Kaihu @ gorge	20	79	4.04	20.0
Waipoua @ SH12 Rest area	20	136	8.11	65.0
Manganui @ Permanent station	13	80	4.22	7.7

Otarao catchment sites

Site description	Species richness	MCI	SQMCI	%EPT taxa
Otarao near Mangakahia River	11	70	4.14	0
Ruahuia at Viaduct	20	133	7.39	60
Otarao at Norvil Road	10	78	4.18	0
Otarao above Mangakahia Road	15	83	4.36	13.3

Resource consent sites

Site description	Species richness	MCI	SQMCI	%EPT taxa
Dam B downstream	17	89	3.69	29.4
Dam B upstream	31	123	5.11	54.8
Dam C downstream	15	89	3.83	20
Dam C upstream	13	128	7.23	53.8
Oxidation pond A downstream	12	71	3.06	0
Oxidation pond A upstream	8	57	3.82	0
Meat works downstream	10	69	4.28	10
Meat works upstream	8	80	4.00	25
Oxidation pond B downstream	22	98	4.54	40.9
Oxidation pond B upstream	18	101	6.66	50.0
Quarry downstream	22	112	6.65	36.4
Quarry upstream	15	100	4.07	33.3

Interpretation of MCI & SQMCI (Boothroyd & Stark 2000[2])

Interpretation	MCI score	SQMCI score
Clean water	>120	>6.0
Doubtful quality or possible mild pollution	100-119	5.0-5.99
Probable moderate pollution	80-99	4.0-4.99
Probable severe pollution	<80	<4.0

Colour codes for %EPT taxa

>60% EPT taxa
40 – 59.9% EPT taxa
20 – 39.9 % EPT taxa
Less than 20% EPT taxa

[2] Boothroyd, I and Stark, J. (2000). **Use of invertebrates in monitoring.** *In*: Collier, K.J.; Winterbourn, M.J. *eds*. New Zealand stream invertebrates: ecology and implications for management. New Zealand Limnological Society, Chirstchurch. Pp. 344 373.

Macroinvertebrate results summary

Waiarohia Stream sites
Similarly to last year the three of the Waiarohia Stream sites; at Rust Ave Bridge, at the Northern Russell Road Bridge and Whau Valley Road, had macroinvertebrate communities associated with moderate water quality and impacted stream ecosystem. While the small tributary that flows from Kamo into Waiarohia Stream had macroinvertebrate index scores indicative of a severely degraded stream with poor water quality.

River Water Quality Monitoring Network Sites
Of the 19 RWQMN sites monitored in 2006 only two sites had biotic indices results that showed the stream ecosystem is still in a relatively pristine state (i.e. no or very little impact from humans); the Waipoua River site in Waipoua Forest and Waipapa River site in Puketi Forest. This is consistent with the water quality results for these sites.

There is only one site, Waitangi River at Waimate North, that has macroinvertebrate index scores that indicate a slightly impacted stream ecosystem and/or mild water pollution, compared to four in 2005. Of most concern is Victoria River at Thompsons Bridge, which has had a significant change in its macroinvertebrate communities in the last year. This could indicate a deterioration in water quality, however this site is still ranked amongst the best sites of the RWQMN sites in terms of its water quality results for 2005-2006.

The macroinvertebrate results indicate that the following sites are severely impacted and/or have poor water quality:

- Waitangi River at Watea
- Wairua River at Purua
- Mangakahia at Twin bridges

Otarao catchment sites
The Otarao stream is a relatively small catchment which flows into the Mangakahia River near Titoki which is the subject of an integrated catchment management project. The Regional Council, New Zealand Landcare Trust, Mangakahia Landcare Group and landowners within the catchment have been working together for four years with the overall aim of improving water quality in the Otarao stream. This includes work such as farm workshops, fencing and planting days, farm mapping and water quality and macroinvertebrate monitoring.

Of the four sites monitored for macroinvertebrates in 2006 the native forest site (Ruahuia Stream) in the headwaters is still in a relatively pristine state, while the lowest site in the catchment near Mangakahia River is the most degraded, with macroinvertebrate communities indicative of poor water quality. The macroinvertebrate communities for the other two sites on the Otarao Stream, which are mid catchment, indicate moderately to severely impacted water quality and stream health.

Resource Consent sites
In 2006 macroinvertebrate communities upstream and downstream of two dams in Northland were sampled. The results show a difference in macroinvertebrate communities at both dams upstream and downstream, with the macroinvertebrate index scores for downstream showing poorer water quality or more degradation when

compared to the upstream sample. However some of this difference is most likely as a result of differences in surrounding land use.

Likewise macroinvertebrates were monitored upstream and downstream of two oxidation pond discharges and similarly to the dams both downstream sites had macroinvertebrate index scores indicating worse water quality or more impacted stream health than the upstream sites.

Macroinvertebrates are also sampled every year upstream and downstream of the discharges from an operating quarry and meatworks. Similarly to last years results, the 2006 macroinvertebrate results show that neither of these operations appear to be having a detrimental effect on water quality or stream health.

For more detailed information on the 2006 macroinvertebrate survey results or changes in macroinvertebrate communities over time, check out the detailed report available on the Regional Council Website.