Waitangi River

Catchment Description

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Executive Summary

The Waiora Northland Water (WNW) programme for improving the management of water quality and quantity across the region brings together and coordinates a number of Northland Regional Council's water management responsibilities, including its programme for implementing the National Policy Statement for Freshwater Management 2011 (NPS). WNW will include both catchment specific and region-wide approaches to water management.

This document describes the Waitangi catchment and the current state of its freshwater bodies and immediate marine receiving environment. Freshwater bodies in the catchment have been divided into five sub-catchments: Upper Waitangi; Lower Waitangi; Manaia Stream, Puketotara and Waiaruhe.

On paper, water is highly allocated within the Waitangi catchment and demand is only likely to increase. This was a significant factor in Northland Regional Council identifying the Waitangi as a catchment warranting a specific approach as a priority catchment.

Water takes are naturally a reflection of predominant land uses with most of take in this catchment being for stock drinking, dairy washdown and domestic supply. Water is exported for use outside the catchment with the municipal drinking water abstraction at Haruru that supplies the wider area, and the Kerikeri irrigation scheme which supplies water to horticulture sites north of the catchment. Operation of the Ngawha Geothermal Power Station can involve abstraction of significant quantities of water, however most is currently re-injected into the geothermal groundwater aquifer. These geothermal waters and the hot springs have very high cultural value.

The Waitangi River monitoring sites are located at Watea and Waimate North (at Waimate Road). Surface water quality at these sampling sites is described as "good[1]". However, faecal indicator bacteria counts are consistently recorded well above guideline values – highlighting the need for good land management and sewage disposal systems to protect both the freshwater and the receiving marine environment in the Bay of Islands.

There is concern over potential effects resulting from increased sedimentation rates in the Bay of Islands. , Research to date indicates that the Waitangi catchment contributes approximately 15% of the sediment being deposited into the Bay of Islands.

Stream invertebrate monitoring used to indicate stream health consistently places the Waitangi River in the "probable severe pollution" and "probable moderate pollution" categories. This is further reflected in habitat quality monitoring that consistently scores the river as "marginal". Similarly fish studies at the Waimate Road site recorded just three native species (longfin eel, shortfin eel and crans bully) along with the pest fish gambusia.

Headwaters in the catchment have some areas classed as having high natural character and regionally significant ecological value associated with a remnant population of Northland mudfish that represents more than 5% of their national population.

[1] Good means median values for five of the six variables are within guideline values, of which dissolved oxygen is one variable that must be met.

According to the New Zealand Freshwater Fish Database (NZFFD), fish species that have been recorded in the catchment include longfin eel, shortfin eel, common bully, crans bully, koura and burgundy mudfish as well as banded kokopu, and three pest fish species gambusia, rudd and tench. The presence of gambusia within the catchment is a concern as they are known to attack native fish.

The catchment is also regionally and locally important for its recreational and amenity values such as swimming, kayaking and sightseeing at Haruru Falls.

It is intended that the cultural values of importance to Māori in the area will be identified as part of the WNW programme. It is recognised that Māori have a living relationship with freshwater that is founded in the respective cosmologies of each iwi spanning the full breadth of cultural, environmental, social and commercial interests.

The catchment contains a large proportion of pastoral land. The local community (in particular pastoral farmers and schools) with assistance from the Regional Council, NZ Landcare Trust and other organisations, have started to put measures into place over recent years to control sediment discharge within the catchment. Measures include:

- Applying soil conservation techniques to slips, gullies and other obvious erosion features;
- Improving pasture density and grazing rotations that allow for pasture recovery;
- Protecting existing wetlands to filter nutrients and sediment from runoff; and
- Improved management of farm tracks.

1 Introduction

Waiora Northland Water

WNW is a programme for improving the management of water quality and quantity across the region. It brings together and coordinates a number of Northland Regional Council's water management responsibilities, including its programme for implementing the National Policy Statement for Freshwater Management 2011 (NPSFM).

The NPSFM requires Regional Council to establish freshwater objectives and set associated water quality and quantity limits for every stream, river, lake, wetland and aquifer in the region. It then requires Regional Council to implement regulatory and non-regulatory actions to achieve these freshwater objectives.

Regional Council has committed to an approach that involves setting a combination of specific objectives and policy limits in priority catchments and region-wide interim and/or default limits for other freshwaters. Regional Council is also aware of the strong correlation between freshwater and coastal water in Northland, especially given that all of the region's major river systems drain to estuaries and harbours. The proposed Regional Policy Statement for Northland (proposed RPS), notified in October 2012, establishes a framework for the integrated management of fresh and coastal waters, including by identifying a number of regulatory and non-regulatory actions to be implemented by Regional Council.

Regional Council has identified the Waitangi catchment as a priority catchment – see **Figure 1 NRC Priority Management Areas** below. Priority catchments will receive a specific approach that may include establishing a catchment group of local stakeholders, who will guide selection of freshwater uses and values, objectives and actions for their catchment.

Figure 1 NRC Priority Management Areas

2 Purpose of the document

The catchment description informs the Waitangi Catchment Group and wider community of the catchment's state of freshwater management. The document provides reference material on water quality and quantity in the catchment, key water uses and users and stakeholders of the freshwater resource. It is intended to be a live document that can be added to as information becomes available. Catchment group members will be invited to contribute their local knowledge and identify knowledge gaps.

Figure 2 Waitangi catchment (showing localities)

3 The Waitangi River catchment

3.1 Overview

The Waitangi River catchment is centrally located within Northland and flows eastwards to the Waitangi estuary where it joins the Bay of Islands.

The Waitangi catchment drains an area from Okaihau in the north, to just north of Moerewa and Kawakawa in the south, from Kaikohe in the west and ends in the east as it enters the Bay of Islands estuary at Haruru Falls. The Waitangi River has a 302km^2 catchment that is 37km long and flows into the Bay of Islands at Waitangi.

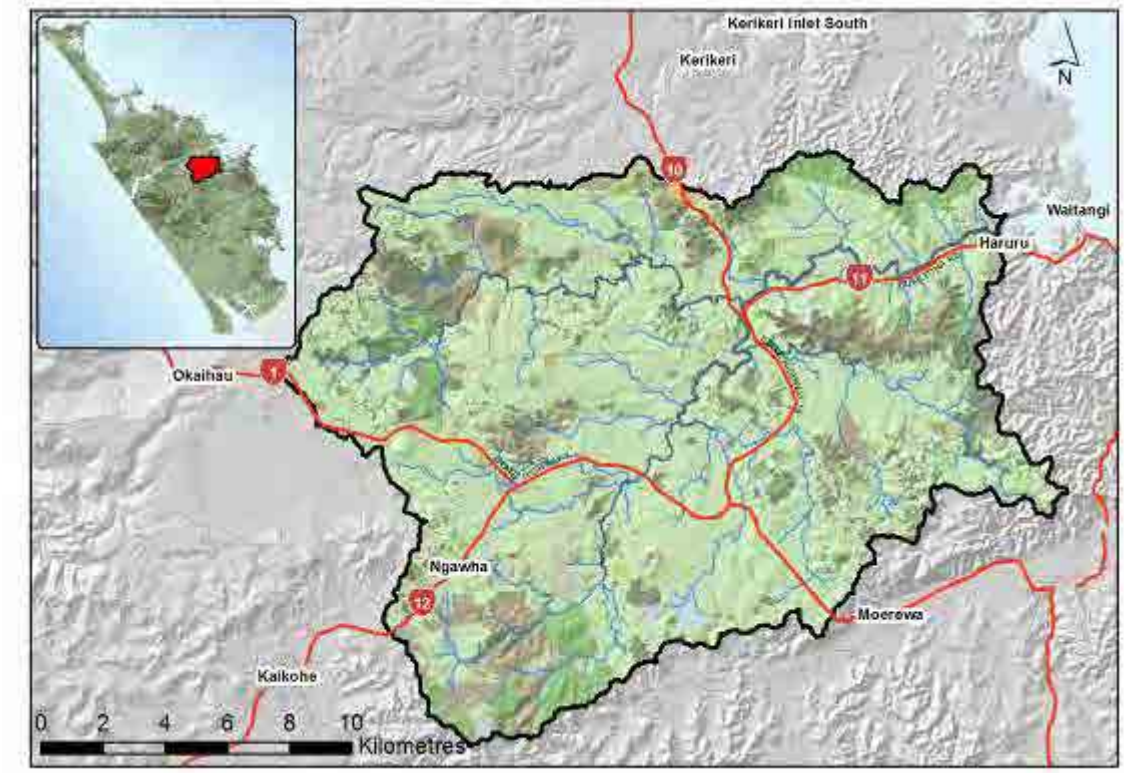


Figure 3 Waitangi catchment

Dominant land use within the Waitangi catchment is a mix of beef, dairy and sheep pastoral farming, pine forest and small areas of indigenous forest. The catchment also has cultural, recreational and ecological uses and values.

Water quality in the Waitangi River is generally good, except for faecal indicator bacteria concentrations which are often above values recommended for recreational use. However, the ecological health and habitat quality of the river is not so good. River degradation is due to a combination of intensified land use, habitat reduction, stream bank erosion and natural gully erosion in the catchment headwaters.

3.2 Geology

3.2.1 Catchment geology in brief

The underlying geology in the Waitangi catchment is greywacke (east), shale (south) and an overlay of basalt cones and flows (centre, west and north) as illustrated below in **Figure 4** and described in more detail below in sections 3.2.2 to 3.2.5.

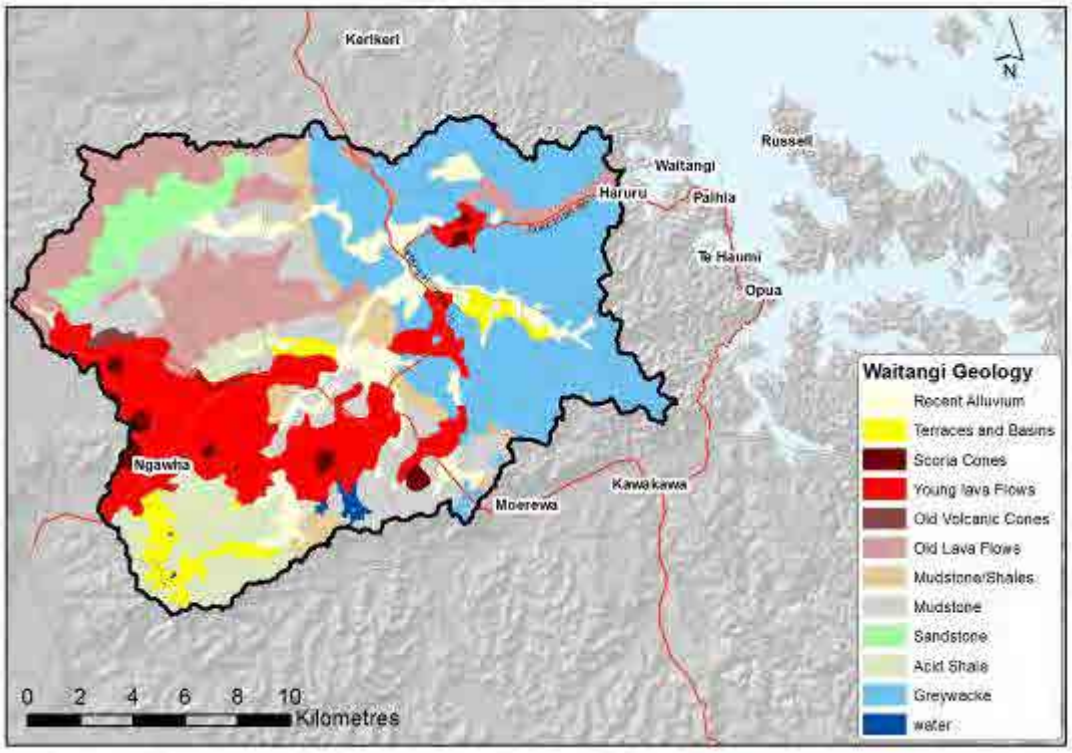


Figure 4 Geology of the Waitangi River Catchment

3.2.2 Greywacke Fault Blocks

The basement rock under the eastern side of Northland and the whole of this catchment is greywacke, hard indurated sandstone and argillite. A fault line runs from just west of Moerewa and generally along the line of SH10 to near Kerikeri Airport. East of that line are a series of east-west faults, the southernmost between Kawakawa and Moerewa, the next along the Oromahoe valley and finally between Puketona and Waitangi.

The fault blocks so created are tilted to the north with a steep scarp slope along their southern edge and a gentle dip-slope to the north. A stream flows at the toe of each of the scarp slopes.

Remnants of layers of softer sedimentary rocks (mudstone, shale, and argillaceous limestone) that overla the greywacke can be found along the western flanks of these fault blocks - weathered to a more subdued landscape than the harder greywacke.

The greywacke basement is much deeper to the west of the north-south fault, 700 metres below the surface in the Ngawha geothermal field.

3.2.3 Soft Sediments of the Northland Allochthon

Greywacke has been buried beneath soft sedimentary rocks of the Northland Allochthon, a large (250km long, 100 km wide and 7 km deep) mass of material that slid across Northland from the northeast some 25 million years ago.

Within this catchment the Allochthon rocks include:

- Highly erodible acid shale rocks, described in earlier geology surveys as Ngatuturi beds, between Kaikohe, Ngawha and Moerewa, sandstones;
- Inherently unstable banded sandstones and mudstones of the Mangakahia complex on the northern side of the upper Waitangi River (north of Waimate North);and
- Mudstones, described as 'Melange', a medley or mix, on the surface from the Waitangi River southwards to the catchment boundary at Moerewa.

3.2.4 Volcanic Activity and Basalts

There are several ages and types of basaltic volcanic activity affecting the catchment. The oldest of these are lava flows, most probably from vents in the vicinity of the Okaihau Golf Course, which have spread right across the catchment to Kaikohe, beyond Old Bay Road, to Kerikeri and down to Haruru Falls. These flows of very fluid and very dense rock created extensive plateaux. Their remnants form the catchment boundary from Kerikeri to Okaihau, and down the ridge from Lake Omapere, through Waimate North to near Puketona Junction. They have been eroded away across the middle of the catchment and exposed the underlying soft sedimentary rocks of the Allochthon. Dense and spiral shaped boulders have dropped from the edges and lie scattered across clay soils.

More recent basaltic eruptions have formed the prominent scoria cones of Te Ahuahu, Maungaturoto, Tarahi, Pouerua, Ngahuha and Puketona. The lava that flowed from these vents was more viscous and so did not flow as far, and the rock is 'bubbly' or more porous. This lava covered the older lava flows around Te Ahuahu and for a short distance near Puketona Quarry. The edges of these flows are very stony as evidenced by the area north and west of Pouerua and immediately downstream of Puketona.

The large volcanic explosion crater between SH14 and Ngawha Springs is not part of the basaltic eruptions (iron-rich rocks) and was formed by a rhyolitic eruption (silica-rich).

3.2.5 Alluvial Deposits

Alluvial material is described in two 'ages' on the geology map; older deposits as higher terraces (Oromahoe) and in-filled basins (Ngawha), and recent alluvium along the river valleys.

3.3 Soils of the Waitangi River catchment

3.3.1 Soils formed on Greywacke

Greywacke is the parent rock under most of the catchment east of a line from Kawiti, in the Kawakawa River catchment, through Pakaraka to Oromahoe, and Puketona Junction to Kerikeri Airport. Soil types on this rock range from:

- Moderately leached **Te Ranga steepland** soils on the scarp slopes and ridge tops along the southern boundary above Moerewa and the ridge above Puketona quarry;
- Moderately to strongly leached **Marua** soils on the strongly rolling to steep hill country of the Hupara and Whangae districts, easy hill country immediately east of SH10 at Oromahoe, the ridge and north slopes between Oromahoe and Paihia and the ridge east of SH10 between Puketona Junction and Pokaka (see **Figure 15**);

- Strongly leached to weakly podzolised **Rangiora** soils on the rolling to strongly rolling hill country and downland of the Whangae district, the north slopes east of Puketona quarry, and in association with Marua soils across the northern catchment boundary from Bull's Gorge to Waitangi; and
- Moderately podzolised **Hukerenui** soils on easy country around Oromahoe, Waimate North-Puketona, Haruru and from SH10 to Waitangi north of the Waitangi River.

Hukerenui soils have been podzolised under dense kauri forest and, as is common with such 'gumland' soils, is more accurately described as a mosaic of soil types with patches where kauri have grown so densely that the soil is completely podzolised to produce a **Wharekohe** soil. A dense silica pan, which sets like concrete in summer and is fluid in winter, impedes drainage whether the land is in poor gumland scrub or in pasture.

3.3.2 Alluvial and ash soils

Extensive ash deposits, either from local sources or from the central North Island, are found in higher terraces and adjoining gentle lower slopes in the eastern part of the catchment. The ash increases the silica content of the sediment, making it podzolise more quickly under kauri vegetation. Older basaltic lava flows blocked off the river in the vicinity of Puketona, causing the pumice ash to be deposited mainly in the upper catchment of Manaia Stream.

These ash-rich deposits have been weathered to produce a range of soil types including **Otao** soils and an extensive area mapped as a complex (**C1**). On the ground **C1** will present as a mosaic, ranging from moderately **Otao** soils, weakly podzolised **Waitemata** soils and moderately podzolised **Coatesville** soils. Peat will have developed in swampy valleys and basins to produce **Otonga** soils, again in complex with the ash soils.

Subsequent erosion within this eastern catchment and the Waitangi catchment as a whole has formed higher terraces and basins and the current floodplain of the various tributaries. Soils on these higher terraces range in age from moderately to strongly leached **Whareora** soils, strongly leached to weakly podzolised **Waipuna** soils, gleyed **Waipu** soils to mature podzols, **Kara** soils.

Alluvium from basalt land has been deposited in the Hupara, Pakaraka and Puketona areas and has gleyed to produce **Kamo** soils.

3.3.3 Soils formed on soft sedimentary rocks

The banded mudstones and sandstones of the upper Waitangi River sub-catchment have been weathered to produce clay soils – moderately to strongly leached **Omu** and **Aponga** soils and strongly leached to weakly podzolised **Okaka** soils. A basin in the upper catchment of Waipapa Stream, just south of the northern catchment boundary, has remained stable for a long time and has been weathered to produce true gumland soils, **Wharekohe** soils, including Wharekohe silt loam with a pan.

A band of mudstone extending across the middle of the catchment from Waimate North to the catchment boundary south of Lake Owhareiti, in places mixed with soft limestone, has been moderately weathered to produce **Aponga** soils. Easy hill country of similar landform, but of sandstone finely banded in places with mudstone, has been strongly weathered to produce Waiotira soils.

3.3.4 Soils on acid shale rocks

A block of acid shale, silica-rich rocks with, in places, high levels of sulphides, extends from near Kaikohe, through Ngawha and almost to Pouerua. Because of their high silica content, these rocks have podzolised much more quickly and strongly than other rocks within the catchment. Soil types include weakly podzolised **Pokapu** soils, moderately podzolised **Hukerenui** soils and the mature podzol, **Wharekohe** soils.

Basins within this area have infilled with alluvium from the shale rocks and have weathered to produce mature podzol, **Kara** soils. Swampy areas within these basins have become Kara peaty silt loam.

3.3.5 Soils formed on basalt volcanic material

Older lava flows extend across the northern side of the catchment from near the Okaihau Golf Course, south-westwards to Okaihau and eastwards to Kerikeri. Lava from other vents in the vicinity of Ngawha and Waimate North flowed down to Haruru Falls along the present course of the lower Waitangi River.

Soils on the eroded cones of these volcanoes and the upper parts of the lava flows include moderately to strongly leached **Waimate North** soils and **Waiotu** soils. These soils have patches of smooth but very dense basalt boulders and contain less rock than soils on more recent lava flows. Both are friable clays or clay loams. Moderately to strongly leached Apotu soils are found on the remnants of cones near the Okaihau golf course with strongly leached **Ruatangata** soils on upper parts of the lava flow. Patches of strongly to very strongly leached **Pungaere** soils and **Otaha** clay, in places the even more mature gravelly phase, occur amongst **Okaihau** soils around the western and northern rim of the upper Waitangi River catchment These latter three soils are often referred to as 'ironstone soils'. Extreme weathering under a warm, moist climate and kauri vegetation has leached all clay minerals from the topsoil. Iron and aluminium has been concentrated in the subsoil under this laterisation process, in places forming an iron pan.

More recent volcanic activity has created the distinct cones of Te Ahuahu, Tarahi, Maungaturoto, Pouerua, Ngahuha and Puketona and their very bouldery lava flows. The soil type on each of the cones is **Papakauri** silt loam and on the flows, either **Ohaeawai** or **Kiripaka** soils. **Whakapai** soils are found on outwash material from the collapsed sides of scoria cones below Tarahi and along SH12 between Ohaeawai and Ngawha. Because Whakapai is formed from ash and scoria of from the cone, it has few if any rocks.

3.4 Erosion

Figure 5 identifies farmland most susceptible to erosion and is based on soil, gradient and land cover.

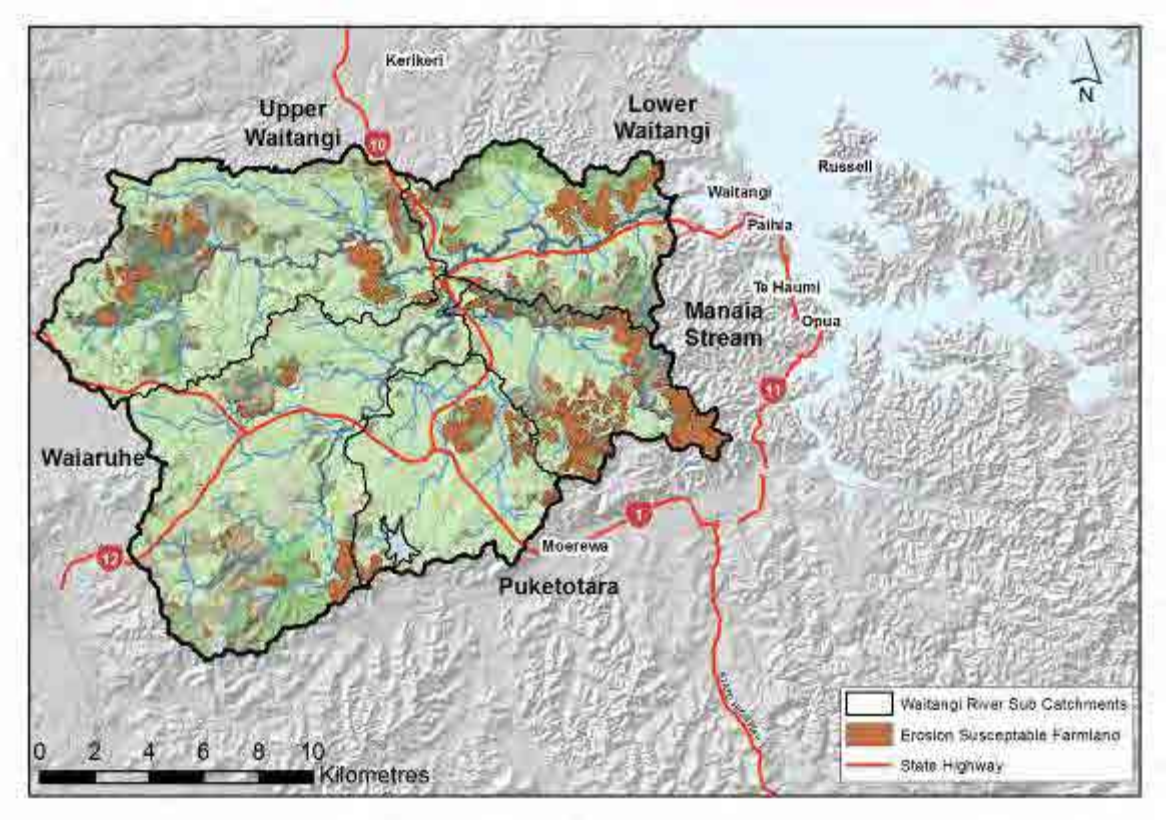


Figure 5 Erosion Susceptible Farmland based on soils, land use and gradient (2013 data)

Te Ranga, **Marua** and **Rangiora** soils are subject to slip erosion on steep slopes.. **Waiotira**, **Omu** and **Aponga** soils, that is, the clay soils on softer sedimentary rocks, are prone to gully, slip and earthflow erosion.

The hillsides of the northern side of the upper Waitangi River catchment are particularly prone to gully and earthflow erosion, almost regardless of land cover. These earthflows have worked along the hillside with the latest one affecting a block of regenerating scrubland immediately north of Whakataha Pa (see **Figure 5** & **Figure 13**). Whangai Stream is cutting down its bed as it flows over the edge of the plateau and down the hillside from Wiroa Road. This largely natural geological process is a major source of sediment in the upper Waitangi River catchment.

All the clay and gumland soils within the catchment are prone to gully erosion. The strong columnar subsoil of the gumland soils, in particular, makes them particularly susceptible. Once a gully head is created, by excavation or natural erosion in a drainage channel, erosion quickly cuts headwards.

The largest gullies within the catchment are found in the acid shale rocks between Ngawha, Moerewa and Waiomio. Until the early 1970s much of this land was frequently burnt scrubland, suffering from extensive sheet and gully erosion. Large amphitheatre-shaped gullies (see **Appendix 3 Erosion Sites**), some 30 metres or more deep, cut down into the acid shale rocks and generated an excessive sediment load in streams draining the area. Sediment from these gullies deposited along the banks of the Waiaruhe River in the lowland from just upstream of SH1 almost to SH10 at Puketona Junction, is now being remobilised by streambank erosion and is another major source of sediment within the catchment.

There are few other obvious major sources of sediment within the catchment. Serious erosion occurred in the past during successive waves of land development, generating significant volumes of coarse sediment. Maturing of pastural farming and exotic forests, and the control of burning to protect exotic forests have together reduced this source of sediment. There is now a much lesser volume of sediment being washed off the land but what there is, is much finer.

Colloidal clay washing off farmland, even when there is a strong grass cover, carries nutrients, phosphate in particular. Whereas water ponding in wetlands and on floodplains would have removed some of this material, drainage of these areas has sped up water flow and removed this natural filtering measure.

The establishment of exotic forest on some of the highly erodible acid shale hill country has encouraged the control of burning and recovery of shrubland cover, which has help control erosion and reduced sediment loss. It has also allowed wetlands in the valleys to re-establish which act as filters.

3.5 Sedimentation

3.5.1 Sedimentation: Source to receiving environment[2]

The erosion of soil and its transport as sediment through rivers and streams to the coastal environment is a natural process. However, the rate at which this is now occurring has been accelerated by land clearance for agriculture, forestry and urban development. Increased sediment inputs into our coastal environment can have a number of adverse impacts on both human and ecological values. Sediment can reduce light levels in the water which affects plant growth and the ability of animals to find prey and avoid predators. It can also smother marine plants and animals and cause a shift from sandy environments to shallow turbid muddy environments.

Discussion:
The Northland State of the Environment (SOE) Report 2012, reported on recent studies by Regional Council into sedimentation rates in Northland's coastal environment. This included:

- An investigation of historical sediment accumulation in the Kaipara Harbour, in conjunction with Auckland Council and NIWA.
- Analysis and interpretation of sediment and ecological data sets collected as part of the Land Information New Zealand (LINZ) Oceans 20/20 Bay of Islands survey (Oceans 20/20). http://www.nrc.govt.nz/Resource-Library-Summary/Research-and-reports/Coastal/Bay-of-Islands-Sedimentation-Report/
- Preliminarily findings of an investigation into sediment accumulation rates and sources of contemporary sediment in Whāngārei Harbour.

Since the SOE report was published, the investigation into sediment accumulation rates (SARs) in Whāngārei Harbour has been completed. The report "Whāngārei Harbour sedimentation – sediment accumulation rates and present day sources" is

[2] Northland Regional Council Environmental Management Committee, 24 September 2013 item 6 entitled "Sedimentation in Northland's coastal environment" by Richard Griffiths, Marine Research Specialist.

now available on the Regional Council website – www.nrc.govt.nz/Whāngārei sediment.

These studies estimated SARs in the Kaipara Harbour, Bay of Islands and Whāngārei Harbour of between 2.4 mm per year and 6.4 mm per year, over the last 100 years (**Figure 6**). This is consistent with previous work in the Hokianga Harbour, commissioned by NRC in 2003, that estimated SARs of between 2.8 and 6.7 mm per year.

These rates compare with an average SAR of 0.23 mm per year during the last 10,000 years prior to deforestation by people (estimated from radio carbon dating of cores collected from the Bay of Islands). This order of magnitude increase in sedimentation is consistent with increased soil erosion following large-scale deforestation and indicates a major shift in the sedimentary regime of Northland estuaries.

These studies have also identified the current sources of sediment being deposited in these systems. In the Bay of Islands analysis of present day sediment sources, using the compound specific stable isotope method, indicated that pasture farming land is the source of more than 60% of the sediment entering the Bay of Islands from all of the major rivers except the Waikare which is dominated by native forest and Kanuka scrub.

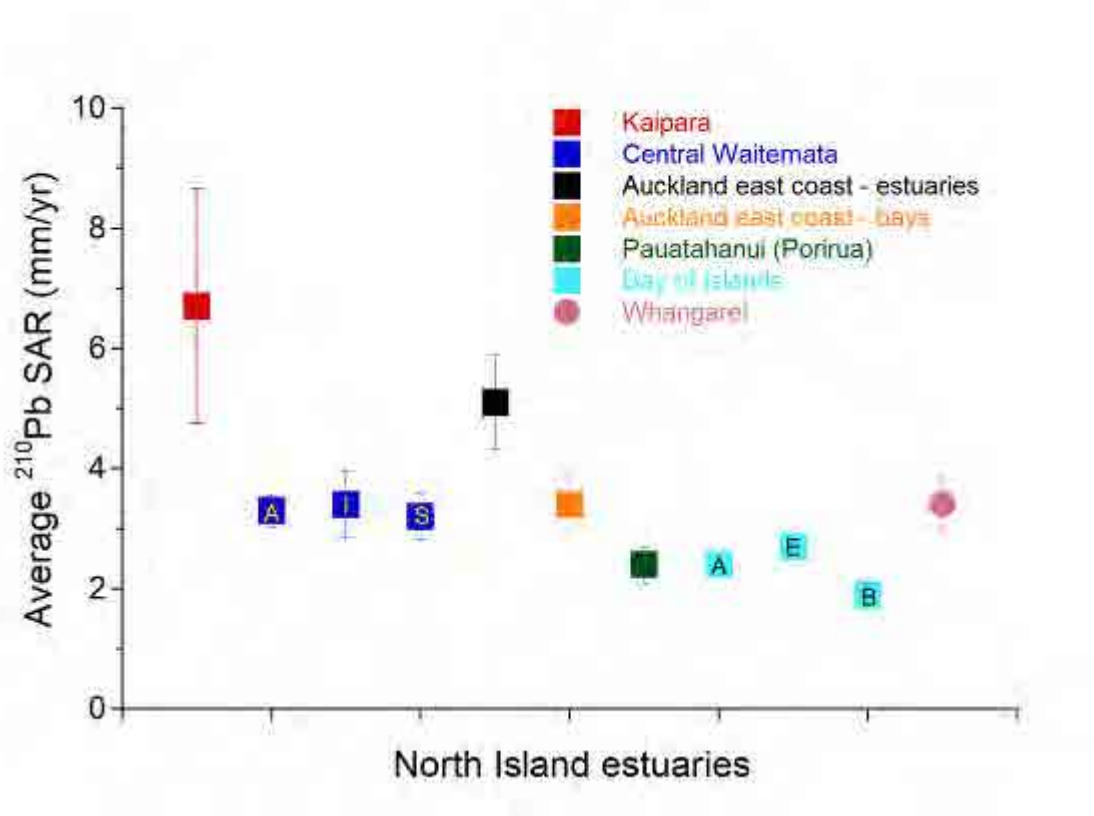


Figure 6 Comparison of average ^{210}Pb sediment accumulation rates (SAR) in North Island estuaries.

3.5.2 Bay of Islands sedimentation (Oceans 20/20)

Two models CLUES (Catchment Land Use for Environmental Sustainability) and WRENZ (Water Resources Explorer NZ) were used to estimate mean annual river

inputs and sediment and nitrogen and phosphorus loadings for the ten main rivers in the area.

Flow from the Waitangi River in 2008 was highly episodic. Flow rate is generally higher in winter, there are more short episodes during winter but the magnitude of the episodes appears to be independent of season.

Mean annual flow increase reasonably smoothly with catchment area, with the Kawakawa River having the largest catchment and the highest mean annual flow.

Waitangi had a sediment load of 63 kt/y compared to Kawakawa (339.8 kt/yr), Kerikeri (12.1), Waipapa (4.3) and Waikare (9.1).

Table 1 Mean annual river discharges (WRENZ) and sediment yields for the four major river inflows to the Bay of Islands (Oceans 20/20[3])

River / Catchment	Mean annual discharge m^3/s	Mean annual sediment yield thousand tonnes per year	Percentage contribution to Bay of Islands sediment yield
Kerikeri	3.73	12.1	3 %
Waitangi	7.53	62.7	15 %
Kawakawa	10.02	339.8	79 %
Waikare	0.83	9.1	2 %
Total sediment yield: 428.3 kt per year			

The Oceans 20/20 research suggests that 94% of silt in the Bay of Islands (BOI) is discharged from Waitangi (15%) and Kawakawa (79%) rivers during floods. These silts are transported and dispersed widely by freshwater runoff and tidal currents into the central Bay, before being transported by the tide into Te Rawhiti Inlet.

The capacity of the BOI estuaries to accommodate sediment inputs over the next century was evaluated based on measured 210Pb SAR and historical rates of sea-level rise (SLR) at the Port of Auckland (1.5 mm ±0.1 mm/yr), which is the closest tide-gauge with a reliable long-term record. The most rapid loss of accommodation space has occurred in the Waikare, Veronica and Te Rawhiti Inlets. These areas are most likely to experience large-scale environmental changes in the future.

3.5.3 Waitangi catchment sediment sources & potential control measures

Historically the major source of sediment within the Waitangi River catchment in the 1970s was erosion on the Ngatuturi beds (Hay, 1960), acid shale rocks, in the vicinity of Ngawha. In particular, two large amphitheatre-shaped gullies, 1.6km northeast of Ngawha, discharged directly to the Ngawha Stream, which in turn carried the sediment into Mangamutu Stream and the Waiaruhe River. The often-burnt gumland around these gullies also suffered serious sheet erosion which, together with the gullies themselves, contributed large volumes of sediment.

By the time this sediment reached SH1 it was of sand texture and a high proportion was deposited in vegetation on the banks and on the floodplain of the Waiaruhe

[3] New Zealand (LINZ) Oceans 20/20 Bay of Islands survey http://www.nrc.govt.nz/Resource-Library-Summary/Research-and-reports/Coastal/Bay-of-Islands-Sedimentation-Report/

River between SH1 near Pakaraka and SH10 at Puketona Junction. Sediment from some of the other tributaries of the Waiaruhe River – Puketotara and Patukauwae Streams - is being trapped in the extensive swamps between Pakaraka and Puketona Junction.

Establishment of pine forests in the vicinity of Ngawha and strict controls over burning have enabled shrub to regenerate and even bush to establish along the river valley, greatly reducing the discharge of sediment from the upper catchment. However, the Waiaruhe River is eroding its banks between the two State Highways. The soft sandy banks are being eroded on the outside of bends and sediment is being deposited on the inside bends and in riparian vegetation through this stretch.

The major source of sediment now is a large gully and earthflow system within the Whangai Stream catchment north of Waimate North (Figure 13) and Photo 3 Appendix 3 Erosion Sites. This upper left bank tributary of the Waitangi River drains a part of the plateau between Wiroa and Lodore Roads before plunging over the edge of the plateau. The stream is eroding soft material in its bed and banks, causing extensive earthflow erosion within a block of regenerating scrub before the stream joins the Waitangi River 4.5 kms upstream of Waimate North Road.

Discussions between council staff and Dr Max Gibbs, NIWA Oceans 20/20 lead author, suggest the Oceans 20/20 source tracking data indicates this as one of the single largest sources of sediment within the catchment.

Infestations of crack willow (*Salix fragilis*), a build up of sediment and streambank are all affecting the movement of sediment between Puketona Junction and the lava flow rapids at Puketona.

3.5.3.1 Summarised - the current sources of sediment are:

- Large gully and earthflow below Wiroa Road, due north of Waimate North, where the Whangai Stream is eroding its bed as it drops from the plateau to the valley bottom. The land is reverting from scrub to bush but the crushed mudstone and sandstone rock hillside is flowing into the channel. Source tracking by NIWA of sediment currently being laid down in the BOI has identified this as the dominant current source within the catchment.
- Streambank erosion on the Waiaruhe Stream between SH1 and SH10 is the next major source of sediment.
- The third significant source of sediment is streambank erosion between SH10 at Puketona Junction and the Lily Pond. This, like the erosion in the Waiaruhe Stream, is re-working of older sediment deposits. The erosion has been exacerbated by some stream straightening work and by willow blockages.
- It is likely that a large proportion of remaining sediment is captured by wetlands within the catchment.

3.6 Landuse and land cover

Land cover within the catchment is predominantly pasture, a fifth is forest cover (12% indigenous and 8% exotic) and the remainder being mostly Manuka/Kanuka (6%). The catchment includes areas of reverting farmland, gorse and woolly nightshade.

Table 2 Waitangi Catchment Primary Land Cover

High Producing Exotic Grassland	68%
Indigenous Forest	12%
Exotic Forest	8%
Manuka and/or Kanuka	6%
Broadleaved Indigenous Hardwoods	2%
Gorse	1%

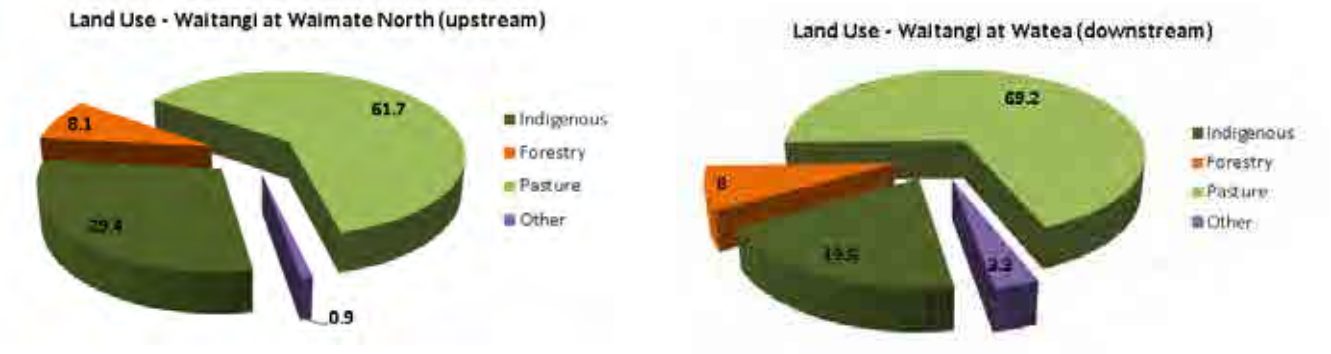


Figure 7 Land uses within the Waitangi River Catchment

Table 2 and **Figure 7** illustrate the proportions of dominant land uses within the catchment.

Currently there are over 20 dairy farms, dairy support units and some intensive beef units where stocking rates match dairy units. These land uses have high potential to adversely affect water quality.

The extent of pasture is illustrated in **Figure 8** with mapped areas of high producing grassland. There is little urban or horticultural land and typical with much of Northland, exotic forestry is located in the upper catchments on steep land.

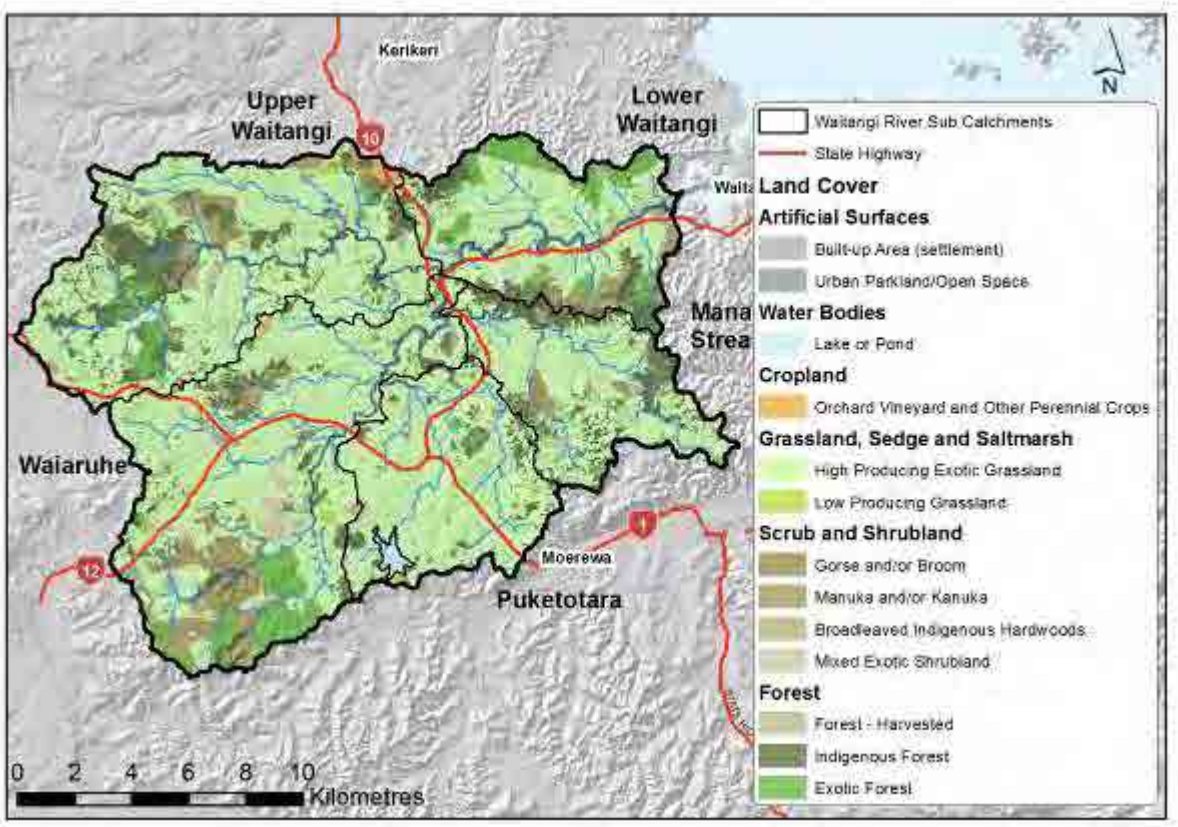


Figure 8 Land uses within the Waitangi River Catchment

There are a small number of public conservation land parcels (managed by Department of Conservation) and district council reserves located within the catchment as illustrated by **Figure 9**. These coupled with QEII[4], Top 150 wetlands[5], and Northern Heathlands/ Gumlands, represent areas currently recognised for biodiversity values. This includes a the large wetland between Pakaraka and Puketona that is likely to be providing benefit to the catchment through sediment capture and nutrient reduction, whilst also having benefits to flood hazard reduction and reducing severity of low flows.

[4] QEII National Trust helps private landowners in New Zealand protect significant natural and cultural features on their land with open space covenants

[5] The 'Top 150 Wetlands' is a Northland Regional Council scoring and grouping system for ranking Northlands wetlands based on accepted Landcare Research methodology and including weighted scores for rarity or uniqueness of wetland type

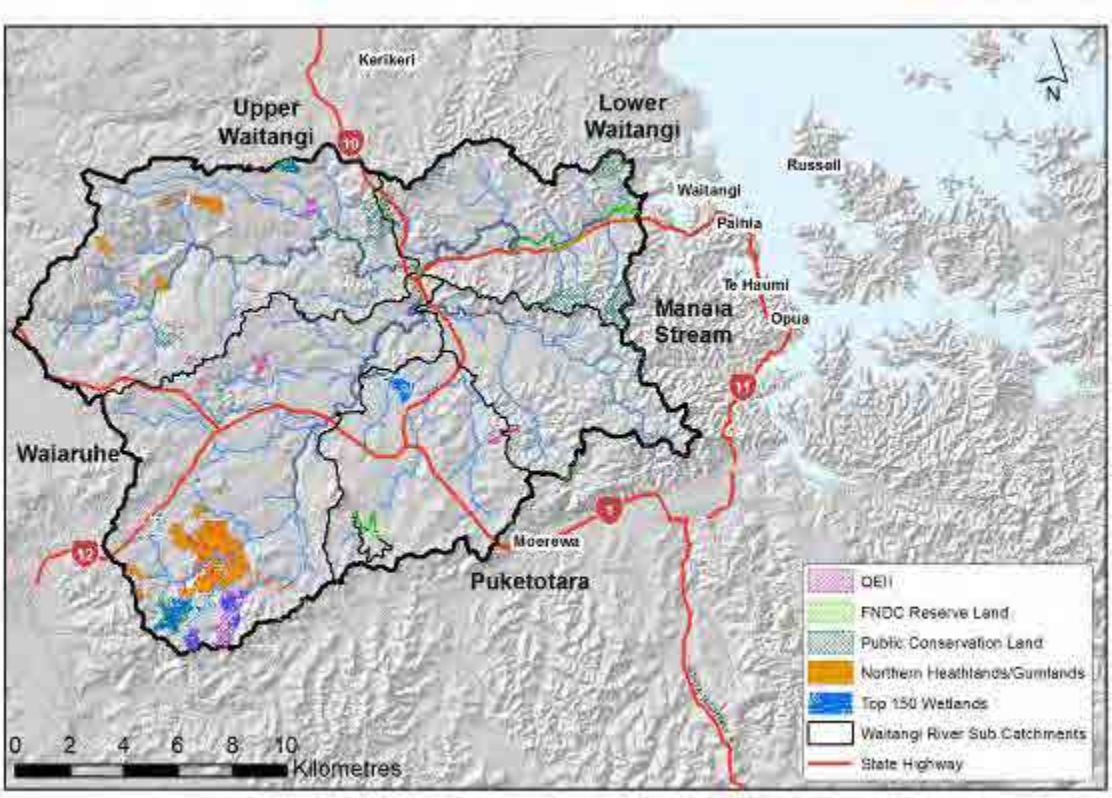


Figure 9 Wetlands, Northern Heathlands including gumlands and land with higher biodiversity or recreation values

3.7 Sub-catchment Descriptions

The Waitangi River catchment consists of five main sub-catchments: Manaia Stream; Puketotara; Waiaruhe; and the Upper and Lower Waitangi River sub-catchments (as labeled in **Figure 9**).

The following descriptions detail the characteristics of each sub-catchment:

3.7.1 Manaia Stream sub-catchment

Tributaries of Manaia Stream drain the northern, dip/slope of the Whangae (greywacke) fault block towards Oromahoe Road where they join Manaia Stream flowing along the foot of the scarp of the next (Opua) fault block. That is, several smaller tributaries drain northwards through rolling to easy rolling greywacke hill country and downland before flowing westward through older terraces along a fault line to join the Waiaruhe River in a slow moving section of water west of Oromahoe.

In the south of this catchment 90% of land is in pasture, mainly beef farming but with up to 5 dairy farms or dairy support blocks. The narrow strip north of Manaia Stream is mainly in native forest. Gully erosion in natural watercourses and in drains, both on farm and on roadsides, is a moderate problem and a source of sediment within this sub-catchment.

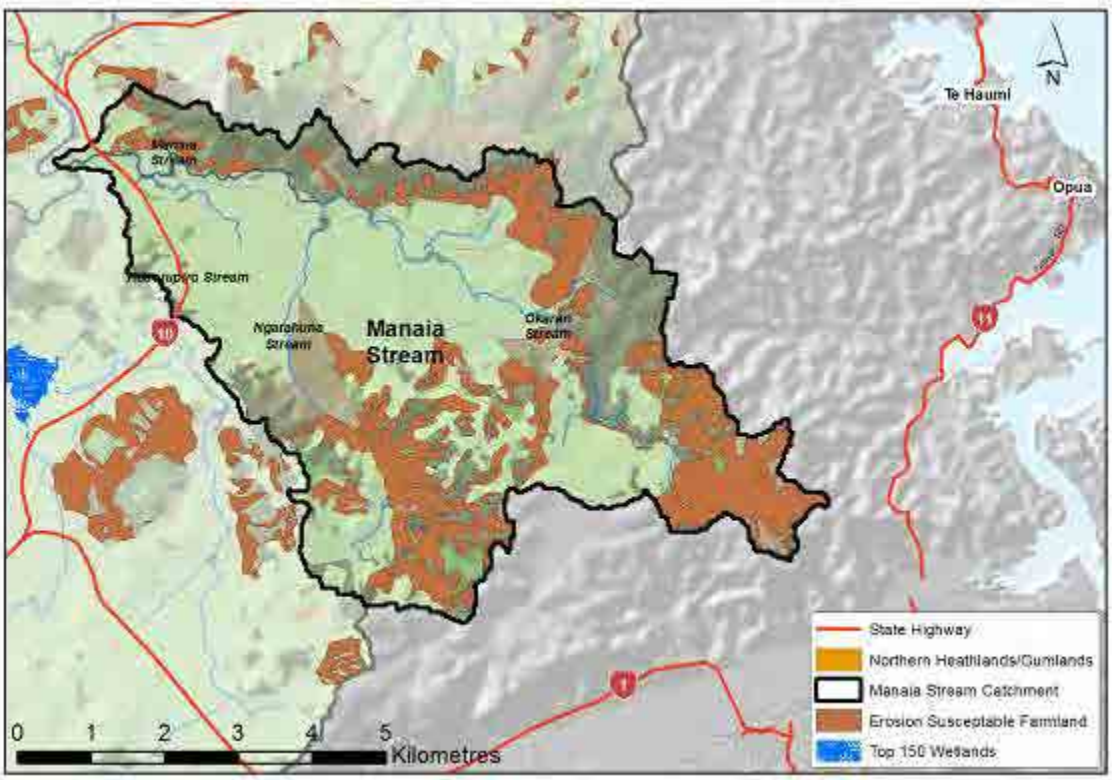


Figure 10 Manaia Stream sub-catchment

In Summary

- Land use is mainly sheep & beef farming, dairy and some native bush.
- Gully erosion is a moderate problem.

3.7.2 Puketotara sub-catchment (Patukauwae and Puketotara Streams)

Patukauwae Stream flows north before swinging westwards under SH10 and discharging into a large swampy basin near Oromahoe. It drains a basin created by lava flows blocking the valley at Oromahoe and again at Hupara. SH1 traverses this basin between the top of Turntable Hill, Moerewa, and Pakaraka. The eastern side of this sub-catchment is easy to rolling greywacke hill country while the southern edge is easy rolling to undulating sandstone and mudstone hill country.

The catchment of Puketotara Stream, which drains the middle of this sub-catchment, is dominated by scoria cones and basalt lava flows. Lake Owhareiti has been created by volcanic activity blocking off a valley. Numerous springs emerge from around the edges of the lava flow. There are up 6 dairy farms or dairy support blocks within the sub-catchment and on lava flows between this and the next (Waiaruhe River) sub-catchment. The Puketotara Stream also drains into a large swampy basin called the Waitangi Wetlands, which is listed in the NRC's top 150 wetlands in Northland and is in a moderate condition and crosses multiple ownerships.

The catchment of Lake Owhareiti includes one intensively farmed beef property and a number of smaller lifestyle blocks. The eroding surface overflow from the lake has contributed sediment to the stream but has been fenced and planted. Lake Owhareiti

has had some recent fencing in 2013 following rising water levels that had submerged previous fencing.

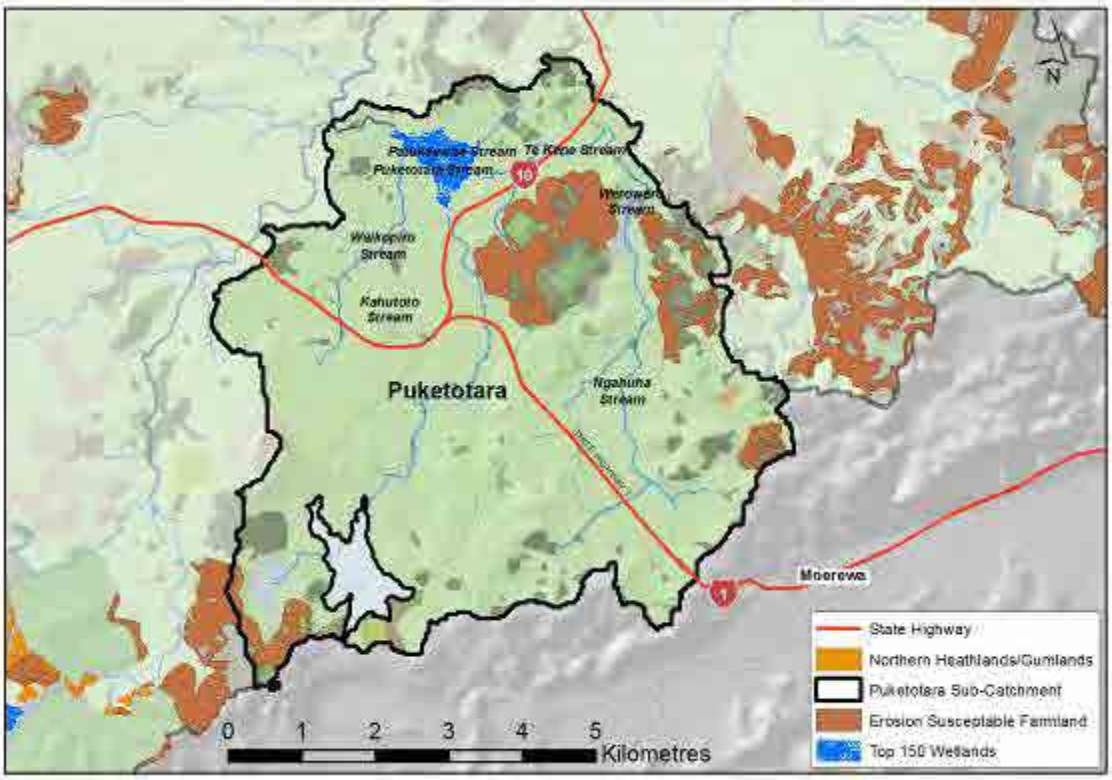


Figure 11 Puketotara sub-catchment

Water from Lake Owhareiti has historically drained northwards through porous scoria and lava rock erupted from Pouerua but the rate of discharge has declined overtime as this material has become clogged with fines and organic matter. Whereas the lake has historically only overflowed after very heavy rain and then dropped back to a lower level, but now overflows for a period each year. It is this overflow across a grassed paddock that has eroded and is now fenced and planted with a diversion bund diverting flow from the eroding gully head and down a grassed waterway running parallel to the gully.

In Summary

- Land use is dairy, some intensive beef farming and lifestyle blocks.
- Some fencing & planting has minimised erosion/sedimentation issues, but more required.
- Lake Owhareiti overflows more regularly now than in past.

3.7.3 Waiaruhe sub-catchment (Waiaramu Stream & Waiaruhe River)

3.7.3.1 WAIARUHE RIVER

The Waiaruhe River drains highly erodible Ngatuturi shale, a very acid rock, from the western edge of the basalt lava flow area at Pakaraka through to Ngawha and SH12. This area used to contribute very large volumes of coarse, sandy sediment to the river (see Appendix 3 Erosion Sites). However, afforestation and associated fire control since the early 1980s has both stabilised the land with forest and, where not in pines, has allowed native shrublands to regenerate.

There are 3-4 dairy farms within this sub-catchment and some intensively farmed beef units.

The western edge of this sub-catchment is volcanic land, two ages of basalt volcanics with more recent Ohaeawai soils on lava flows and volcanic material washed off adjoining slopes (Whakapai soils) overlying older lava flows and remnants of scoria cones with Waiotu soils. There are 3-4 dairy farms in this sub-catchment.

One of the concerns with the free-draining (Ohaeawai) volcanic soils is that heavy applications of sprayed effluent and heavy stocking rates under beef or dairying may contaminate groundwater. Springs and the streams they feed are an important water resource in the area.

In the lower reaches of the Waiaruhe River, between SH1 and SH10, the river, all the tributaries upstream including the Ngawha, Waiparera, Pekapeka and the Waikaramu Streams, meet in a slow moving river basin, trapped by lava flows (near Puketona) and by sediment deposited by the Waitangi River. This basin performs an important ponding function, storing floodwaters and releasing them gradually into the Waitangi River at Puketona. It is likely to also settle out a high proportion of the sediment carried by the floodwaters. Coarser sediment (sands and gravels) will tend to accumulate in channels and on the inside of river bends.

Sediment from erosion in the catchment above (particularly in the gumland/Ngatuturi shales) has been deposited on the river banks through this middle stretch between the highways. Streambank erosion is now reworking these deposits, remobilising the sediment and sending it on down river. Five or six properties are being affected by this intense stream bank erosion and the largest of which is already started doing erosion control work.

3.7.3.2 WAIARAMU STREAM

The Waikaramu Stream drains the southern and eastern edge of the Waimate North area, a mix of steep clay (from mudstone) hill country and easy volcanic soils, the eroded remnant of an older basalt cone and its associated lava flows.

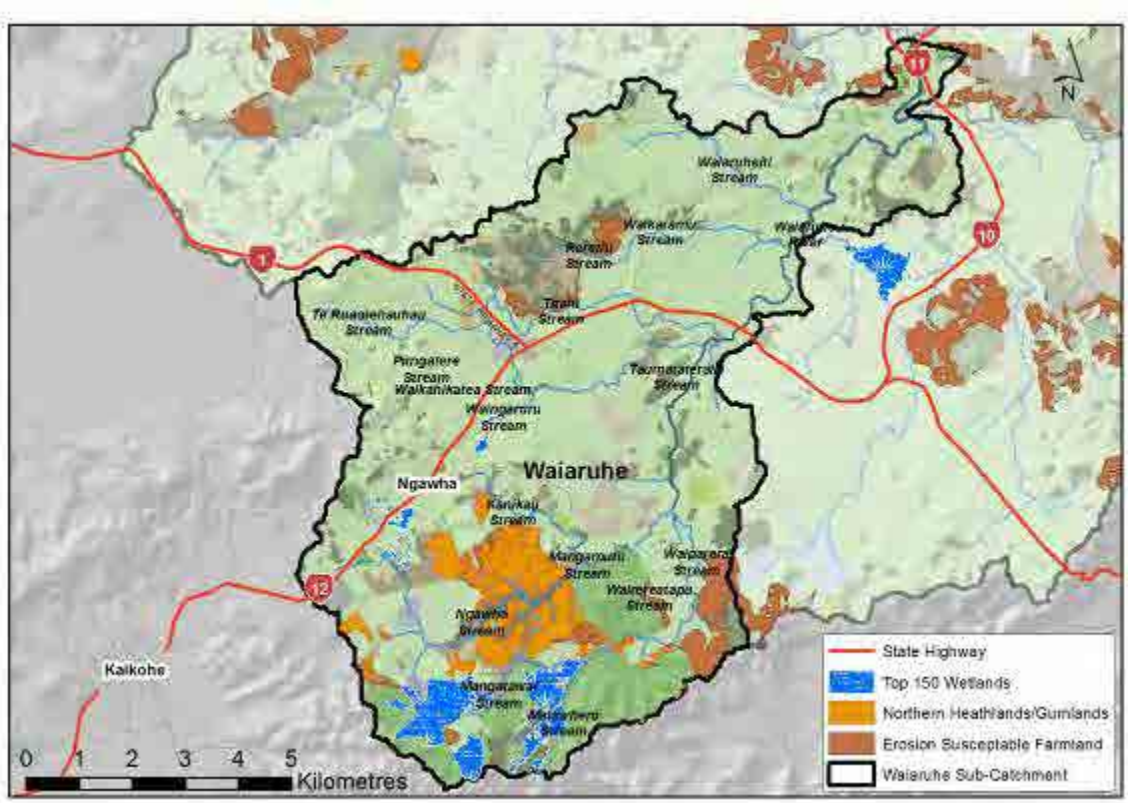


Figure 12 Waiaruhe sub-catchment

Gully and slip erosion are problems on the clay hill country, particularly during land development or when drains are cut on a steep grade or are shortened by straightening. Channels in this catchment are very different to those in the main Waiaruhe catchment, having clay rather than gravel beds. Most natural watercourses have been replaced with excavated drains, in some of which the grade is too steep. Gully erosion is manageable with suitable planting and, if necessary, grade control structures.

Waiaruhe River in summary

- Weeds and stock access are a problem.
- Underlying geology, in places, is highly erodible with potential to generate huge stream sediment loads.
- Some volcanic soils types are free-draining, where without careful nutrient management, groundwater is at risk of elevated nutrient loading. Afforestation helps, but good forestry practice is essential on upland erodible soils.
- Streambank erosion is a strong feature of the middle reaches of this sub-catchment.

Waikaramu Stream in summary

- Underlying clay hills are prone to gully & slip erosion.
- Natural watercourses have been replaced with excavated drains (including roadside drains & outfalls).

3.7.4 Upper Waitangi River Sub-catchment

3.7.4.1 WAITANGI RIVER HEADWATERS

The upper Waitangi River flows between the volcanic dome of Waimate North and the plateaus of Lake Omapere, Okaihau and Wiroa Road. That is, its catchment is bounded by the eroded Waimate North dome, recent volcanics at Te Ahu Ahu, and the old lava flows from near the Okaihau Golf Course south westwards to Okaihau and eastwards to Kerikeri.

All of these volcanic areas, but particularly the lava flows to the west and north of the catchment, overly soft sedimentary rocks, mainly soft mudstones and shales. Water draining out through and over these softer rocks causes them to gully, slump and flow towards the Waitangi River. The most recent and now very active area of erosion and movement is within a scrub-covered block of land through which Whangai Stream descends from the plateau (see Appendix 3 Erosion Sites Aerial Photo 3). There is serious erosion of the bed and the banks of the stream, causing the adjoining hillsides to flow into the gully. This is the single most serious and currently active erosion site and source of sediment within the Waitangi River catchment. Older movements further up the Waitangi River valley towards Okaihau are currently stable but would be more so with strategic planting of poplars and willows to prevent gully erosion.

Sediment from this erosion is deposited on the banks of the Waitangi River above Waimate North Road from where it is reworked and carried on down the river. The travel time of water from the headwaters of the Waitangi to Puktona is up to approximately 8 hours.

3.8.4.2 WAIMATE NORTH AREA

The Waimate North area is the eroded remnant of a large old volcanic cone and its associated lava flows. The friable soils are not free-draining to depth, infiltration being impeded by the presence of clay in the lower topsoil and subsoil. Groundwater is therefore reasonably well shielded from farming activities on the soil above.

3.4.8.3 WAIPAPA STREAM

The Waipapa Stream drains from old basalt volcanic soils immediately north of Wiroa Road. These ‘ironstone soils’, laterites with very high levels of iron and aluminium in their subsoils, fix any excess phosphate into insoluble forms effectively stripping them out of the system. The high iron and aluminium content of these subsoils are toxic to plants at low pH.

The middle Waipapa Stream catchment, in the vicinity of Waimate North Road, is a complex of terraces and basins of gumland (podzolised) soils from sedimentary rocks, and ironstone (laterite) soils formed on old lava flows, mature, or as both are often described, ‘senile’ soils. There are shallow podzolised soils over solid lava in some places and bouldery areas.

The stream then descends down over slightly younger but still strongly weathered volcanic soils (Ruatangata soils), sandstone and greywacke downland before joining the Waitangi River.

In their lower valleys Waipapa Stream and Waitangi River are flanked by rolling hill country comprising soils derived from greywacke, mainly in pasture but with patches of bush. These remnant patches of bush are in the heads of gullies on the steeper Marua and Rangiora soils are performing an important soil conservation function. The gentler slopes are gumland soils with potential for gully and sheet erosion.

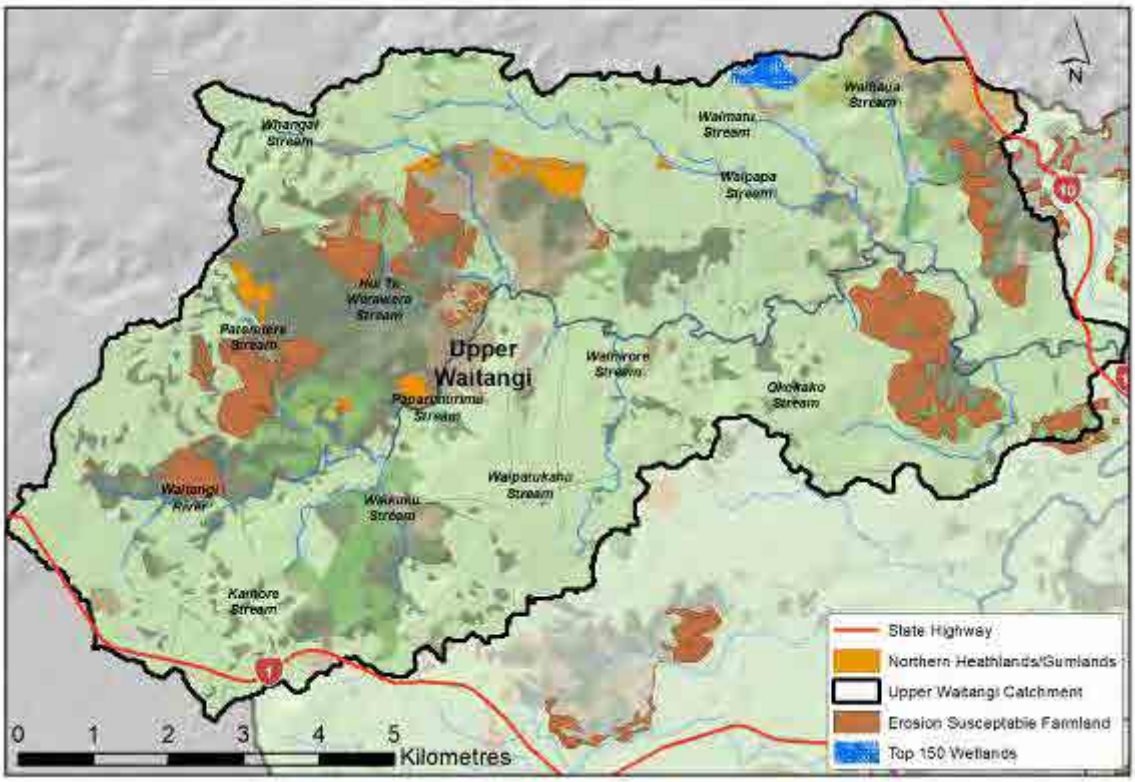


Figure 13 Upper Waitangi River sub-catchment

Waitangi River and Waipapa Stream in summary

- Serious erosion along Whangae Stream is causing significant sedimentation in river.
- Soils by Waipapa Stream have high iron & aluminium levels and are difficult to re-vegetate when subsoil is exposed.
- Willows and gravel accumulation are problems near Puketona.

Waimate North area in summary

- Volcanic clay subsoils help to protect groundwater from farming activity.

3.7.5 Lower Waitangi River Sub-catchment

3.7.5.1 LEFT BANK, POKAKA TO HARURU FALLS

A range of soil types developed on greywacke, from less mature Marua soils through to Hukerenui to Wharekohe soils, cover the hills from Pokaka to Mt Bledisloe. Patches of bush are found in gully heads west of SH10 and around the catchment boundary east of the highway. Further east the hills are contained within the Waitangi Forest, a mix of production (pine) forest, scrub and swampland, mainly on gumland soils within the Waitangi River catchment. The rolling land and terraces between these hills and the Waitangi River comprise a mix of deeply weathered and podzolised soils, mature podzols on flat to gentle slopes and old volcanic soils along the river.

The steeper soils are subject to shallow slipping and would benefit from strategic planting of poplars. Gully erosion on the older soils can be controlled by fencing and planting, with willows to gain initial control but later under-planted with natives.

Fenced and planted waterways and drainage depressions provide corridors between the kiwi population in Waitangi Forest and the remnant bush on the banks of the Waitangi River.
While willow blockages are a problem in some places along the Waitangi River, other sections of riverbank need (shrubby) willow planting to control streambank erosion.

3.7.5.2 RIGHT (SOUTH) BANK FROM SH10 TO HARURU FALLS

The river through this stretch has some sections of alluvial deposits and others where it flows over basalt rapids, both ancient and recent. South of the river are areas of alluvial floodplain, higher alluvial terraces, even older podzolised terrace soils, low clay hills and both old and recent lava flows. As noted above, streambank erosion, exacerbated by willow blockages and/or accumulated gravel and sand, affects the river at several points but particularly in the basin around Puketona Junction. This basin has been formed by sediment dropped in the area when recent lava flows from Puketona dammed the valley.

There are stretches of the river with a dense stand of riparian bush.
A bush-covered greywacke ridge extends almost to Puketona. The steepest section is behind Puketona Quarry. Bush is regenerating on retired land between the quarry and Opua Forest at Paihia. Many of the valleys draining northwards through rolling hill country to the Waitangi River are fenced and, while once gorse infested, are reverting to bush.

Gully erosion is a problem on gumland soils on the easy lower slopes and terraces. Drains cut on steep grades or water concentrated in unprotected channels can quickly cut through the columnar subsoil. Gully heads then progress headwards. These soils are also subject to sheet erosion when overstocked and pugged.

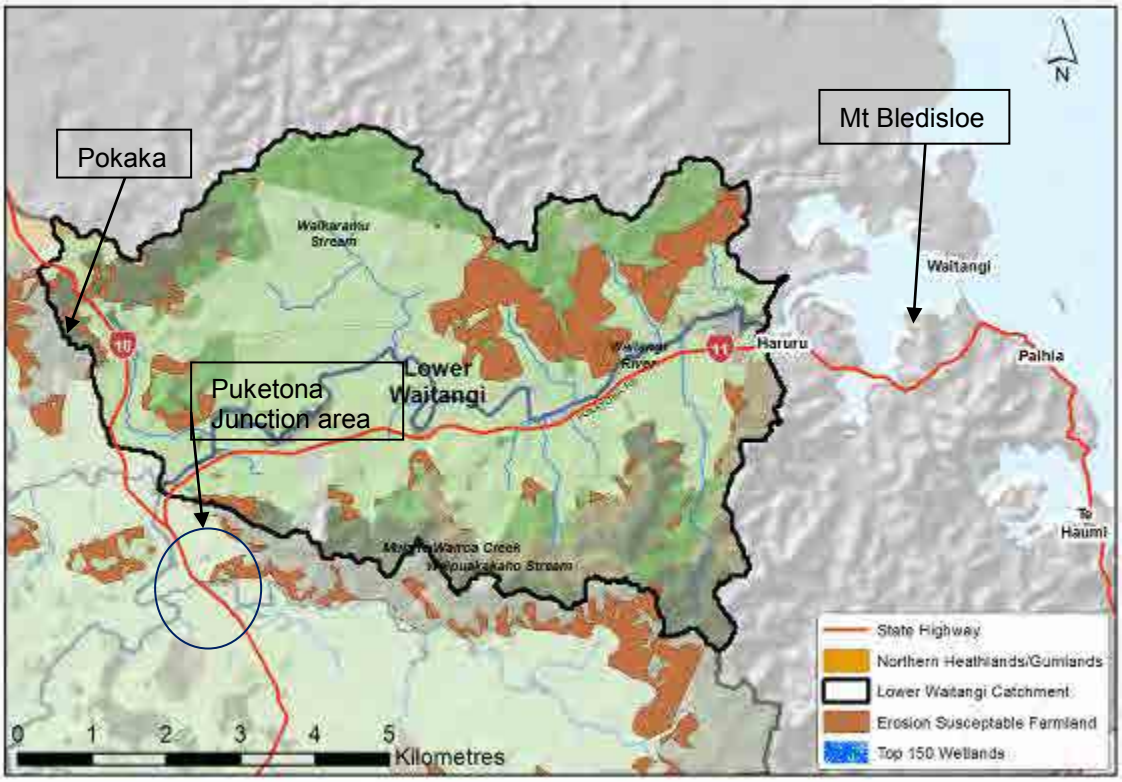


Figure 14 Lower Waitangi River sub-catchment

4 Recreational Fresh And Coastal Water Uses

4.1 Freshwater uses

Section **Error! Reference source not found.** "**Error! Reference source not found.**" outlines water takes, discharges and associated consents. Surface and groundwater within the catchment is used for irrigation (horticulture and pasture), municipal drinking water supply, stock and domestic drinking water, dairy shed washdowns and the operation of the Ngawha geothermal power station.

The majority of the Waitangi catchment is rural with pastoral farming dominating. With the exception of Haruru Falls, tourist traffic predominantly passes the Waitangi Catchment by.

Northtech currently runs a sport and recreation qualification that includes an introduction to white-water kayaking, utilizing the Waitangi River. Otherwise freshwater kayaking is likely to be sporadic and limited to larger flow conditions. Of far greater popularity is kayaking within the tidally influenced waters between Haruru Falls and either Waitangi or Paihia (see 4.2 Coastal water uses).

Ngawha Springs is a popular local attraction due to the presence of geothermal water, providing opportunities for hot water bathing. This use has high cultural values however factors influencing this use are likely to be localized and very limited. The geothermal waters flow into the Waiaruhe River via the Ngawha and Mangamutu Streams. Dissolved minerals associated with these waters may have some influence on water quality although the extent is not monitored by council.

The Waitangi catchment is not known as a popular recreational fishing destination given the small trout fishery however eel collection/ directly downstream of the catchment boundary and other mahinga kai may have some local significance. The Ministry of Fisheries report that Lake Owhareiti west of Moerewa provides opportunities for (commercial) eel fishing, although the Waitangi catchment generally has been found to have smaller than average eels suitable for collection[6].

4.2 Coastal water uses

4.2.1 Haruru Falls to Waitangi Bridge

This estuarial section is immediately outside of the eastern catchment boundary of the Waitangi River catchment. Recreational activities in the Waitangi Estuary include walking, camping, kayaking, bird watching, fishing (including the collection of seafood) and swimming/bathing. Many of these activities are centered between Paihia/Waitangi and Haruru Falls, 3 kilometres directly from the falls to the Waitangi bridge. The Twin Coast Discovery Route passes close to this area making it a popular part of the Northland tourist experience and a visit to the Bay of Islands.

[6] http://fs.fish.govt.nz/Doc/22892/11_28_FAR.pdf.ashx Ministry of Fisheries, New Zealand Fisheries Assessment Report 2011/28 June 2011

Haruru means 'big noise' which is appropriate when the waterfall is carrying large volumes of water after heavy rainfall. The falls form a horseshoe shape, a very rare phenomenon. It is a popular swimming spot in summer. A 6km walkway connects Haruru Falls with the Waitangi Treaty Ground, near the Waitangi golf course. The route follows the estuarine portion of the river and includes a mangrove boardwalk with many opportunities for bird watching. It is common to see shags nesting in the Pohutakawa trees lining the walkway, as well as heron diving for fish. The area is also a reserve for kiwis and no dogs are allowed on this stretch of river.

The settlement of Haruru Falls has grown considerably in recent years, partly due to the shortage of available land at Paihia and the growth of 'lifestyle' living. The population at 2006 was 786 however this is the permanent population and does not account for the increase from seasonal visitors in the summer months. The settlement includes a campground alongside the river and the Haruru Falls Resort as well as several other accommodation options. There are also opportunities to hire kayaks from Waitangi in the summer to paddle up to the falls.

4.2.2 Beyond Waitangi Estuary

The Bay of Islands is a destination of significance both to Northland and nationally. As well as cultural activities and values, there are commercial maritime activities including aquaculture, and extensive recreational activities including swimming, water skiing and jet skiing, fishing, yachting, diving, sail boarding, canoeing/kayaking and waka ama.

4.3 River values assessment system (RiVAS) & economic values assessment[7]

The trial application of the River Values Assessment System (RiVAS) on Northland rivers has been completed for the three values: native fish, river swimming and natural character. This will provide a reference for assisting collaborative catchment groups to consider the uses and values of water within their catchments.

4.3.1 Native Fish

There were 27 river catchments and catchment clusters assessed and these were categorized into three levels: national, regional or local significance. The results found 9 in the 'national' category and 18 as 'regional' (including Waitangi) and non as local.

[7] Environmental Management Committee, 24 September 2013, agenda item 3 'River Values Assessments Update' by Darryl Jones, Economist (Northland Regional Council) http://www.nrc.govt.nz/Resource-Library-Summary/Agendas-and-minutes/Environmental-Management-Committee/

Figure 15 Northland native fish river catchment/clusters by significance level

4.3.2 River swimming

Of the 45 swimming holes identified in Northland two are located within the Waitangi catchment. See 4.3.4 Waitangi catchment RiVAS ranking for more detail.

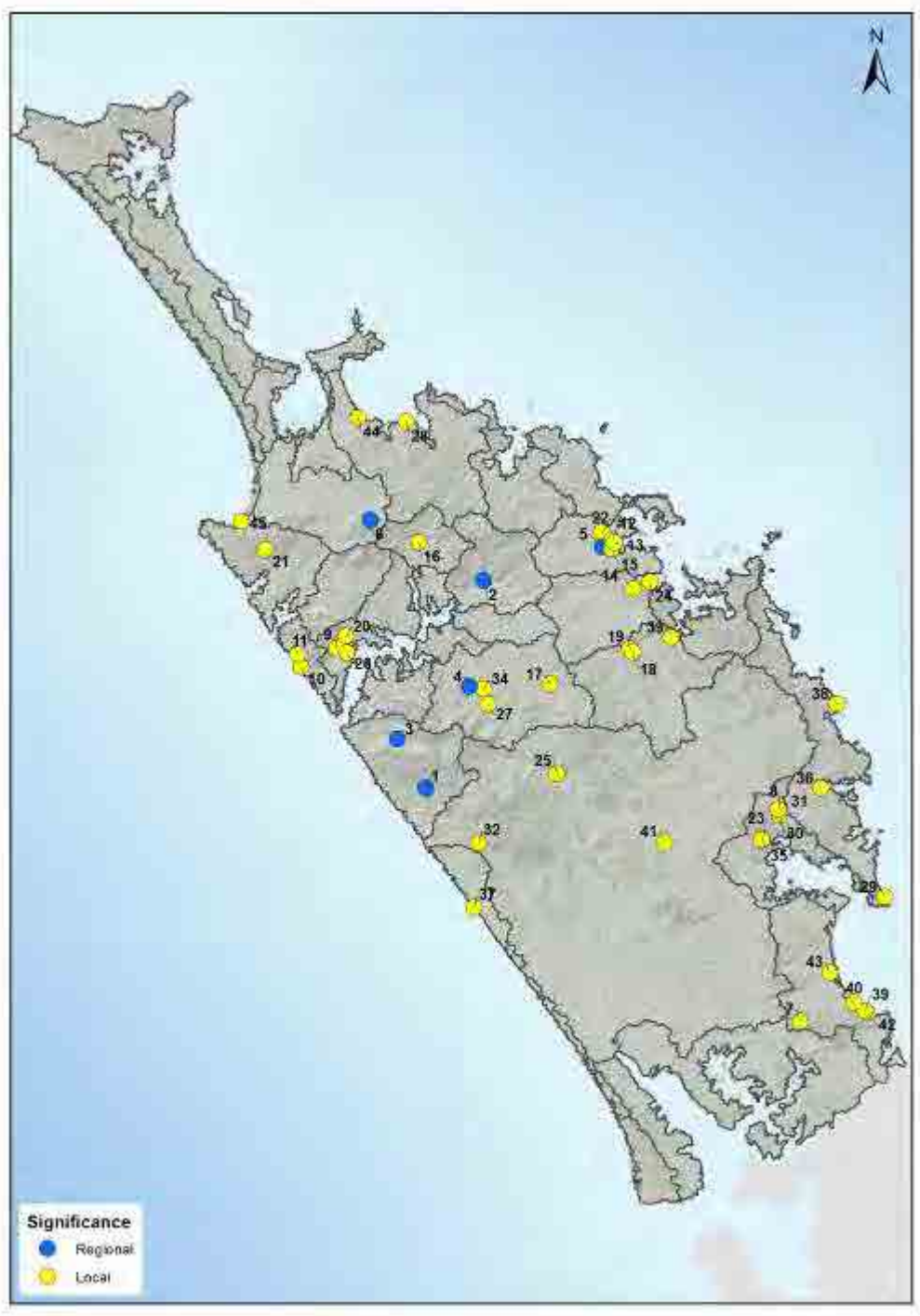


Figure 16 Northland river swimming sites by significance level

4.3.3 Natural character ranking

See 4.3.4 Waitangi catchment RiVAS ranking for more detail on natural character ranking.

Figure 17 Northland natural character river units by significance level

4.3.4 Waitangi catchment RiVAS ranking

The Waitangi catchment was categorised in the 'regional' significance level for native fish. This was largely due to more than 5% of the national population of the threatened Northland mudfish population being found in upper catchment areas. These are remnant populations and the optimal water quality and flow conditions needed for their life stages downstream are not known.

The swimming holes assessment considered two sites both in the lower Waitangi River with the first at 'the Lily Pond' / Site 14 and second 'Watea (NIWA Wakelines site)' / Site 24, which were ranked as locally significant. Other swimming spots are likely to be known locally but were not assessed, such as Lake Owhareiti.

In regard to natural character, the upper reaches of the Waitangi River were ranked 'high' largely relating to the significant population of Northland mud fish, and the remaining catchment was ranked as having moderate natural character. **Figure 18** shows more details:

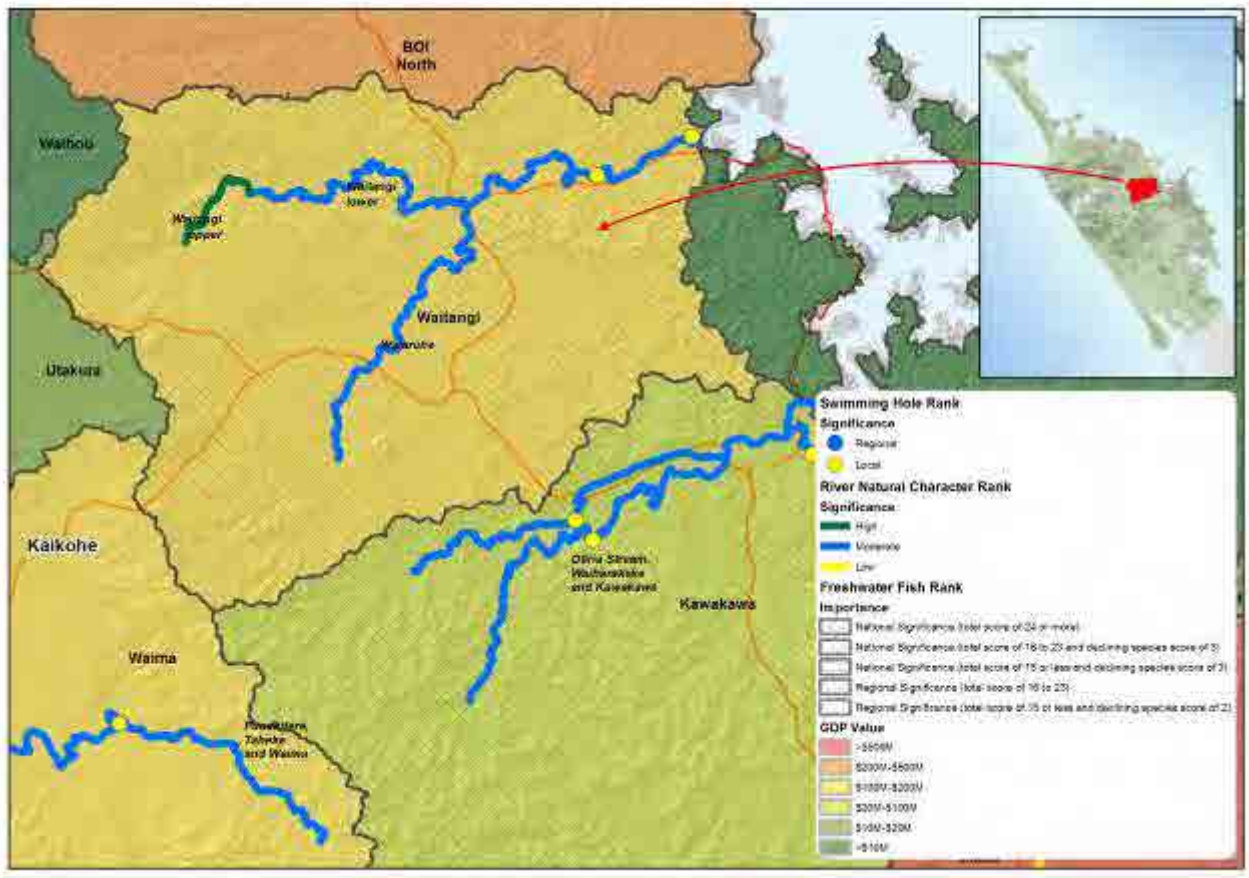


Figure 18 Waitangi Catchment RiVAS ranking for: freshwater fish; swimming holes and river natural character

Economic values associated with the use of water for commercial purposes, including stock drinking and irrigation, has been assessed (Regional Council, August 2013) using a "hybrid supply and use" method which matches water allocation with industry value added (contribution to Gross Domestic Product).

GDP value to each consented take and stock use in 1,400 catchments was grouped.

Of the 27 catchment areas two were greater than $500M GDP; five between $100-$500M GDP; nine between $10-$100M GDP and eleven were less than $10M. The economic assessment gave Waitangi catchment a GDP value of $100 to $200 million.

5 Current freshwater monitoring in the catchment

Northland Regional Council currently undertakes the following monitoring in the Waitangi catchment:

- **River Water Quality Monitoring Network** (RWQMN) established in 1996. Thirty six river sites throughout Northland encompassing 22 river catchments are monitored monthly for a range of parameters, including temperature, dissolved oxygen, pH, water clarity, nutrients and bacterial levels. This monitoring includes two sites on the Waitangi River located at Waimate North Road Bridge, and downstream at Watea above Haruru Falls. The Watea site has been sampled since 1989, and the Waimate site since 2002. Annual and 5 yearly reports are available here:

  http://www.nrc.govt.nz/Resource-Library-Summary/Environmental-Monitoring/State-of-the-Environment-Monitoring/

- **Stream invertebrate monitoring** at RWQMN sites since 1997. Every site in the Network is monitored once a year in summer. Monitoring at both network sites on the Waitangi started in 2008. Annual reports are available here:

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

- **Stream habitat assessments** at RWQMN sites since 2004. Assessments are typically carried out every second year. The Waitangi River sites have been assessed in 2008, 2010 and 2012. Reports are available here:

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

- **Lake Water Quality Monitoring Network** (LWQMN) established in 2005. 28 lakes throughout Northland are monitored four times a year for a range of parameters including total and dissolved nutrients, chlorophyll-α, suspended solids, water clarity, pH, temperature and dissolved oxygen. This monitoring includes one location at the deepest point in each lake. Each lake is sampled at the surface and bottom and temperature/dissolved oxygen profiles are done. This monitoring includes Lake Owhareiti that is approximately 96 ha and located on the southern boundary of the Puketotara sub-catchment. Section 7.1 provides further description and Annual reports are available here:

  http://www.nrc.govt.nz/Resource-Library-Summary/Environmental-Monitoring/State-of-the-Environment-Monitoring/

- **Hydrological monitoring.** There are automatic telemetered water level recorders in the Waitangi River at both the Waimate North Bridge and the Watea site. As well as specific monitoring programmes some ad hoc monitoring as also been carried out to check compliance with resource consent conditions and to investigate environmental incidents.

- **Coastal monitoring.** Council's coastal monitoring is described in section 8 'COASTAL ENVIRONMENT'.

Together, the information is central to assessing the state of the Waitangi River. The data obtained through these programmes and consent monitoring has been used to provide an overview of water quality and ecosystem health in the River.

There are two monitoring sites on the Waitangi River that form part of the River Water Quality Monitoring Network (RWQMN). One in the upper to mid reaches at Waimate North and the other in the lower reaches at Watea near Waitangi. The catchments of both sites are dominated by pastoral farming. 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 geology of the upstream site (Waimate North) is predominantly volcanic acidic, while the downstream site (Watea) is dominated by hard sediments such as greywacke and sandstone.

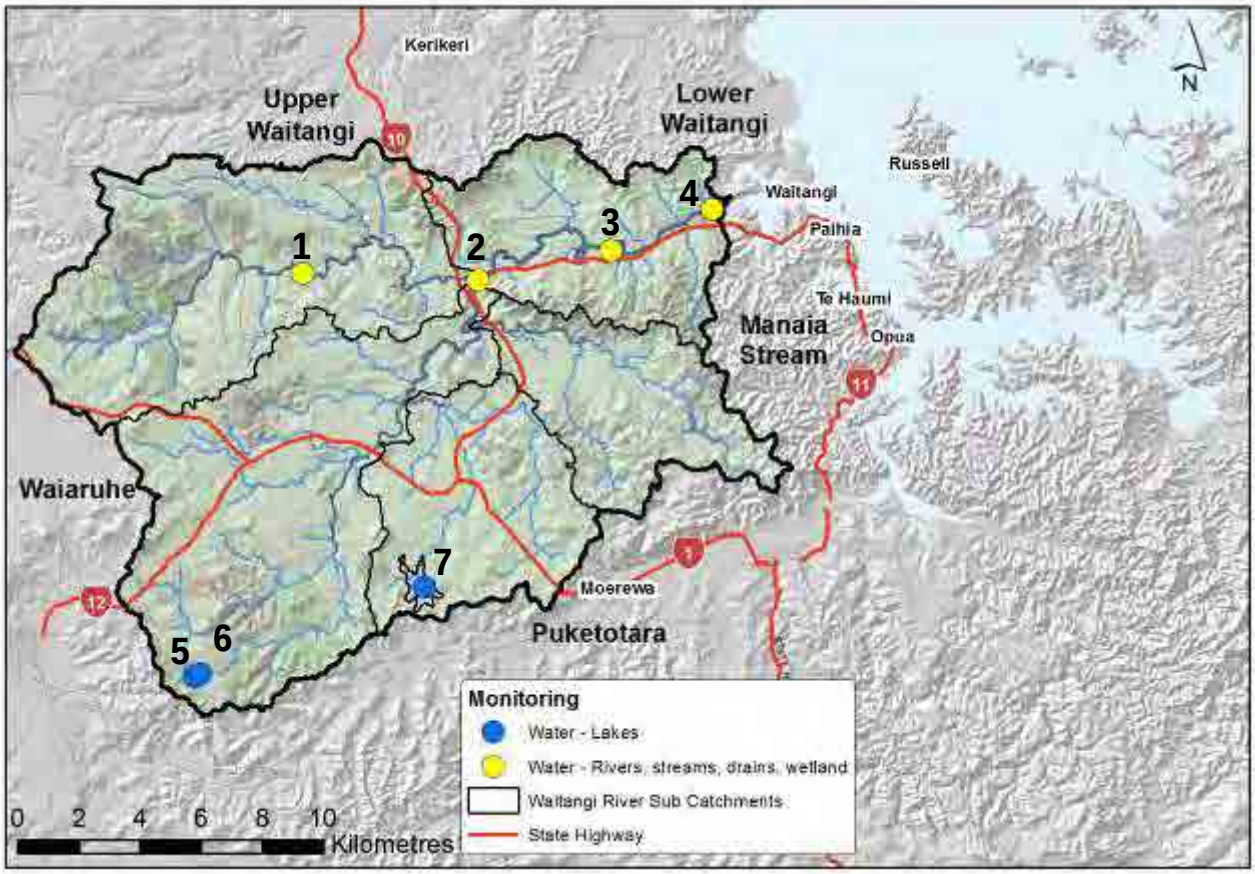


Figure 19 Sites currently monitored in the Waitangi River catchment

A major tributary – the Waiaruhe River – discharges into the Waitangi River before the Watea (downstream) site. This affects the flow and influences the different parameters measured. It is therefore important to take into account the influence of the Waiaruhe River when interpreting the results.

Monitoring at these sites involves taking samples and measuring a number of parameters each month. Results for the period 2007-11 – which comprises 60 samples per site – and percentage of sample compliance with relevant guidelines are listed in the table below.

Sites that are currently monitored in the Waitangi catchment are shown in Figure 20.

Monitoring site: NRC & Figure reference:	Site name	Site location
1 108857	Lake Ngamokaikai	Northern lake edge
2 108856	Lake Waiparaheka	SW lake edge
3 101989-90	Lake Owhareiti	Surface and depth sites
4 110325	Waitangi River	Puketona Reserve
5 103178	Waitangi River	Above Waimate Road bridge
6 104830	Waitangi River	Lily Pond Reserve
7 101752	Waitangi River	Wakelins / Watea (NIWA)

5.1 Water quality and the river ecosystem

The ecological health, or integrity, of the river ecosystems is related to a number of environmental factors including, but not limited to, the availability of suitable habitat types (e.g. diverse range of substrate sizes, aquatic plants, large woody debris and varied flow types), food and light availability, disturbance and high water quality. It is important to note that the relationship between ecosystem health and environmental factors is often very complex and unpredictable. In rivers the water quality parameters of concern in terms of ecological health are, in no particular order, temperature and dissolved oxygen, clarity, nutrients and suspended solids. Faecal pathogens are not known to affect aquatic ecosystems. The state of water quality from a human health perspective is discussed below in Section 5.5 ‘Faecal indicator bacteria and pathogens ’. Biological monitoring information, such as invertebrates,

periphyton, habitat assessment and fish, can be used to help determine the impacts of water quality, if any, on river ecosystems, however, as mentioned above causal effects are not always clear.

A water quality index is used to facilitate inter-site comparisons of the state of water quality in the region's rivers and streams. The water quality index is calculated using the median values for the following six variables: dissolved oxygen (% saturation), turbidity, ammoniacal nitrogen, nitrite-nitrate nitrogen, dissolved reactive phosphorus and *Escherichia coli* The application of the water quality index enables water quality at each site to be classified into one of four categories according to how many medians meet Ministry for the Environment guideline values (Table 3)

- **Excellent:** median values for all six variables are within guideline values.
- **Good**: median values for five of the six variables are within guideline values, of which dissolved oxygen is one variable that must be met.
- **Fair:** median values for three or four of the six variables are within guideline values, of which dissolved oxygen is one variable that must be met.
- **Poor:** median values for <3 of the six variables comply with guidelines.

Table 3 Water quality parameters and Ministry for the Environment guideline values

Identifier (+unit)	Abbreviation	Reference	Guideline value
Dissolved Oxygen	**DO**	RMA 1991 Third Schedule	≥80 (% saturation)
Dissolved Reactive Phosphorus	**DRP**	ANZECC (2000)	≤0.010 (mg/L)
Escherichia coli	**E coli**	ANZECC (1992)	≤126 (cfu/100 mL)
Ammoniacal Nitrogen	**NH4**	ANZECC (2000)	≤0.021 (mg/L)
Nitrite-Nitrate Nitrogen	**NNN**	ANZECC (2000)	≤0.444 (mg/L)
Turbidity	**TURB**	ANZECC (2000)	≤5.6 (NTU)

5.2 Water quality results

At present, two sites are monitored monthly for water quality on the Waitangi River, Waitangi at Watea and Waitangi at Waimate North Road. Both sites are classified as having GOOD overall water quality using Northland Regional Council's Water Quality Index. This puts them amongst the top 39% of sites in the region with 31% scoring 'good' and 8% scoring 'excellent'. A major unmonitored tributary – the Waiaruhe River – discharges into the Waitangi River before the Watea (downstream) site. It is therefore important to take into account the influence of the Waiaruhe River when interpreting the results. Many of the following figures and results in Section 5 have been compared with the nearby control monitoring site outside of the Waitangi catchment – the Waipapa River at 'Forest Pools' in the Puketi forest, which is a river derived mainly from a large pristine forested environment.

Table 4 Water quality index data for Waitangi River at Watea and Waimate North Road sites (2007-2011).

Waitangi at Watea	DO% % Sat.	DRP mg/L	E. Coli (CFU/100 ml)	NH4 mg/L	NNN mg/L	TURB (NTU)

Median	101	0.005	140.1	0.007	0.248	3.65
Minimum	82.6	0.0005	48.8	0.001	0.0005	0.8
Maximum	112.7	0.026	2419.2	0.087	0.935	42.3
Number	66	66	65	66	66	66
Pass	66	59	28	60	52	46
Fail	0	7	37	6	14	20
Percentage pass	100.0%	89.4%	43.1%	90.9%	78.8%	69.7%
Median within guidelines	yes	yes	no	yes	yes	yes
Classification: Good						

Waitangi at Waimate Road	**DO% % Sat**	**DRP mg/L**	**ECOLI (CFU/100 ml)**	**NH4 mg/L**	**NNN mg/L**	**TURB (NTU)**
Median	97.5	0.006	453.5	0.01	0.407	5
Minimum	68.8	0.004	148	0.01	0.053	1.8
Maximum	121.9	0.025	7701	0.15	0.82	200
Number	60	57	60	60	60	57
Pass	57	51	0	50	35	32
Fail	3	6	60	10	25	25
Percentage pass	95.0%	89.5%	0.0%	83.3%	58.3%	56.1%
Median within guidelines	yes	yes	no	yes	yes	yes
Classification: Good						

The following section describes water quality in the Waitangi catchment using box and whisker plots to graphically display the distribution of water quality data based on a five value summary: the minimum value, first quartile, median, third quartile, and maximum. The central rectangle spans the first quartile to the third quartile (the *interquartile range* or *IQR*) covering the middle 50% of data. A segment inside the rectangle shows the median and "whiskers" above and below the box show the minimum and maximum values. Any small circles or stars beyond the minimum/maximum values are considered outliers i.e. the value is 3 times the IQR or more above the third quartile, or 3 times the IQR or more below the first quartile.

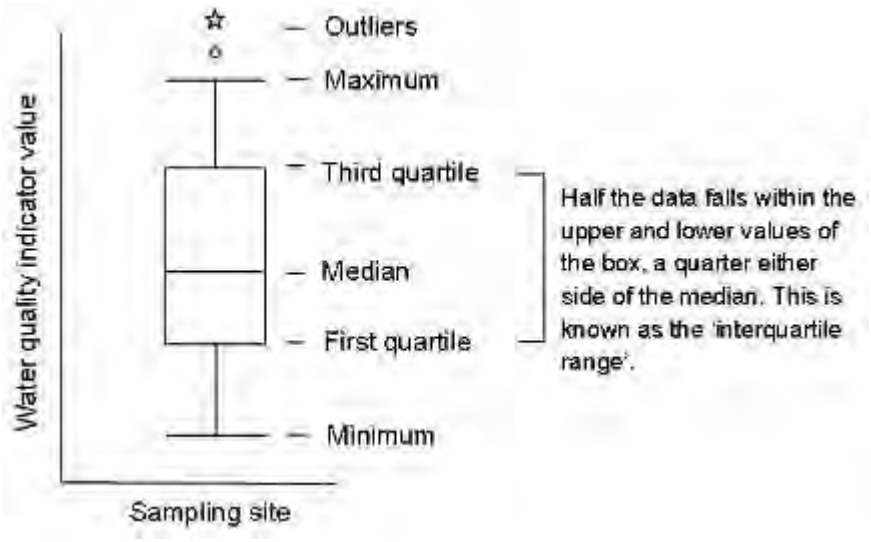


Figure 20 The Waitangi River at permanent monitoring sites at Watea above Haruru Falls (left) and further upstream at Waimate Road bridge (right)

Mineralisation associated with geothermal waters and potential high natural background levels of minerals in soils associated with the Ngawha geothermal area, could affect future water quality sampling data in those areas. However, given the Watea is upstream from any geothermally influenced confluence and the Waimate sample site location, is so far downstream the influence is likely to be negligible (particularly for the parameters tested).

5.3 Dissolved oxygen

Dissolved oxygen is important for freshwater invertebrates and fish, with some species being more sensitive to low oxygen levels than others. Dissolved oxygen levels vary with temperature, biological activity and how quickly it transfers from the atmosphere. Biological activity includes microbial activity by bacteria and primary production by plants and algae. Aquatic plants photosynthesise during the day (producing oxygen) and respire at night (using oxygen). With its elevated levels of macrophytoes (aquatic plants) the Waitangi River is likely to have large fluctuations in dissolved oxygen throughout the day compared to rivers such as the Waipapa within pristine native habitat with little or no aquatic plants (**Figure 21**).

Between 2007 and 2011 results for dissolved oxygen levels for the Waitangi River at Watea were always within recommended guidelines. The Waimate Road site met guideline levels 95% of the time but had a range of dissolved oxygen levels between 68.8% and 121.9% indicating that occasionally levels dip below/above points which are potentially harmful to aquatic life.

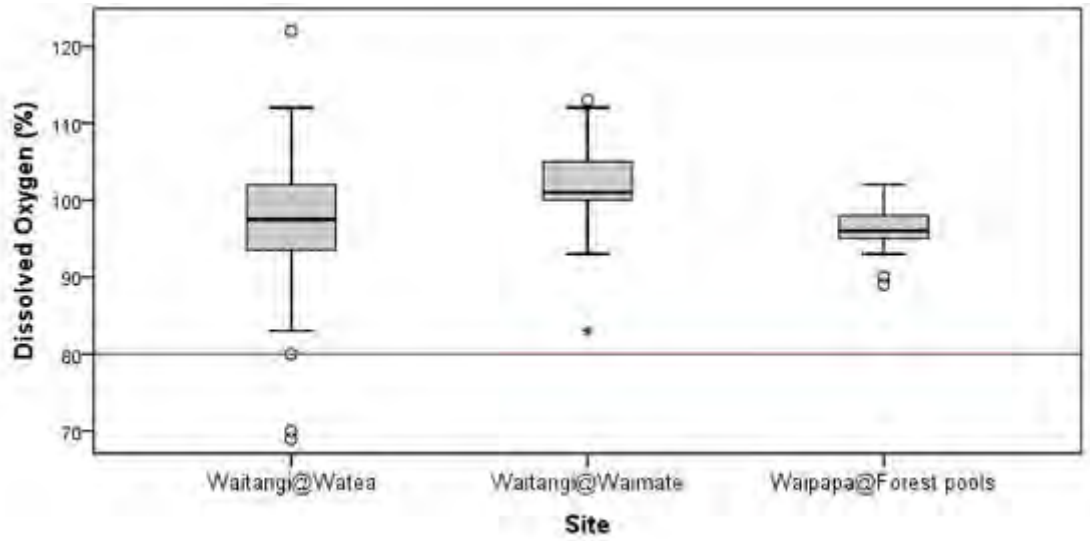


Figure 21 Dissolved oxygen (DO%) boxplots at two monitoring sites on the Waitangi River over the 2007-2011 period. *Note: The Waipapa site is displayed to provide a comparison with a forested monitoring site. The red line indicates the national guideline value (>80%).*

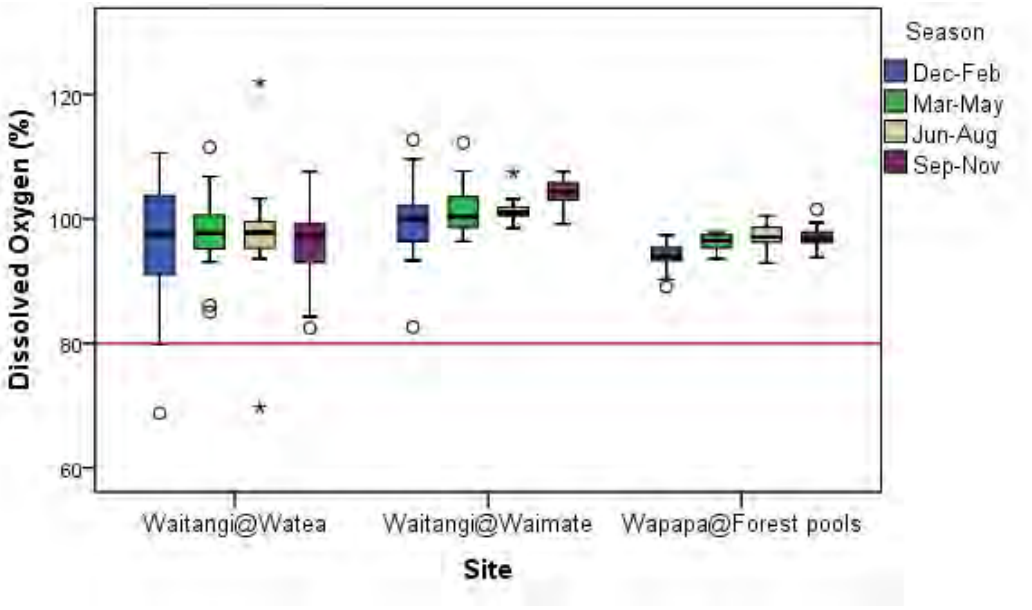


Figure 22 Seasonal variation in dissolved oxygen (DO%) levels at different sites. The red line indicates the national guideline value (>80%).

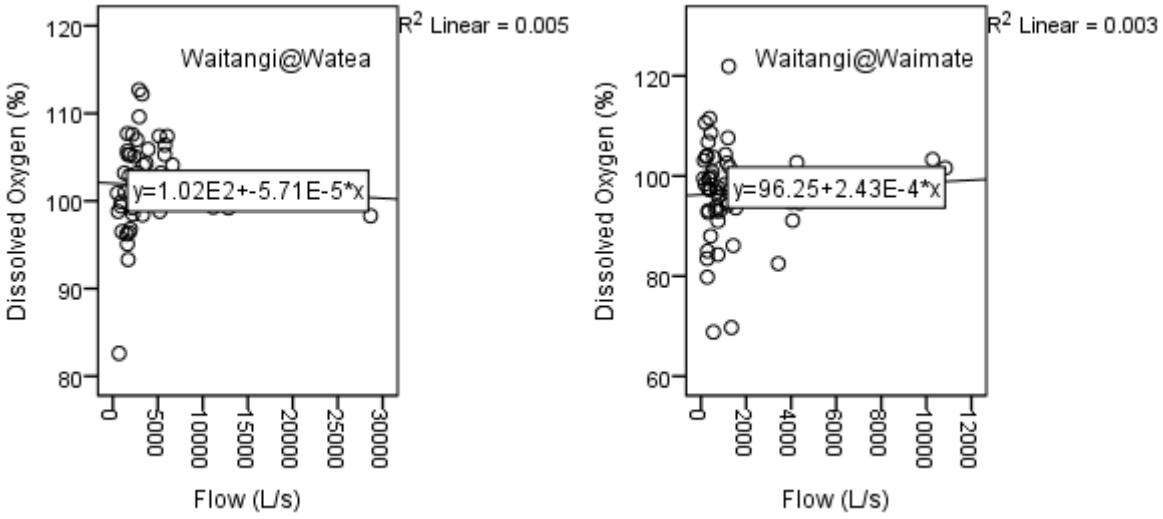


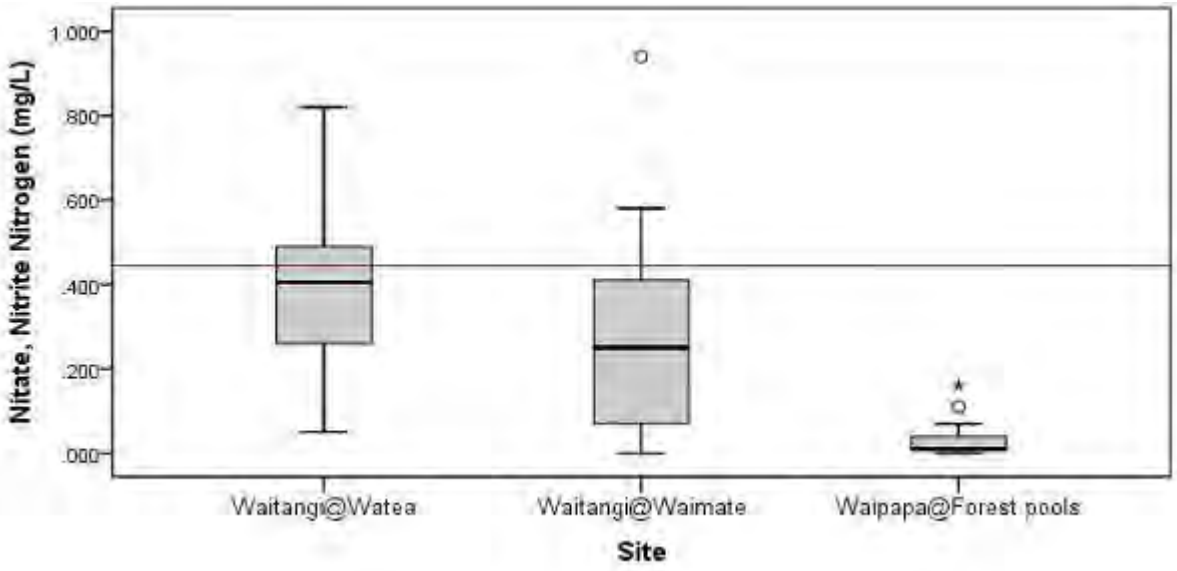
Figure 23 There is no linear regression between flow and DO at either Watea or Waimate (R^2=0.005; 0.003). Pearson's and Spearman's statistical tests showed no correlation between DO and flow respectively: Watea (P=-0.072; S=0.073); (Waimate (P=0.056; S=-0.117).

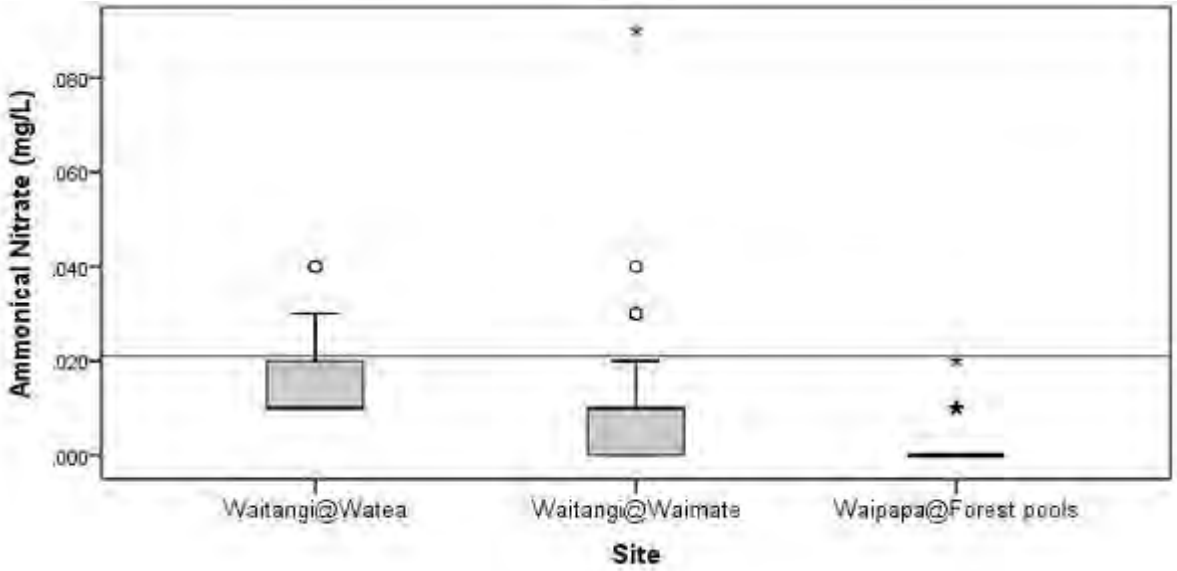
5.4 Nutrient levels

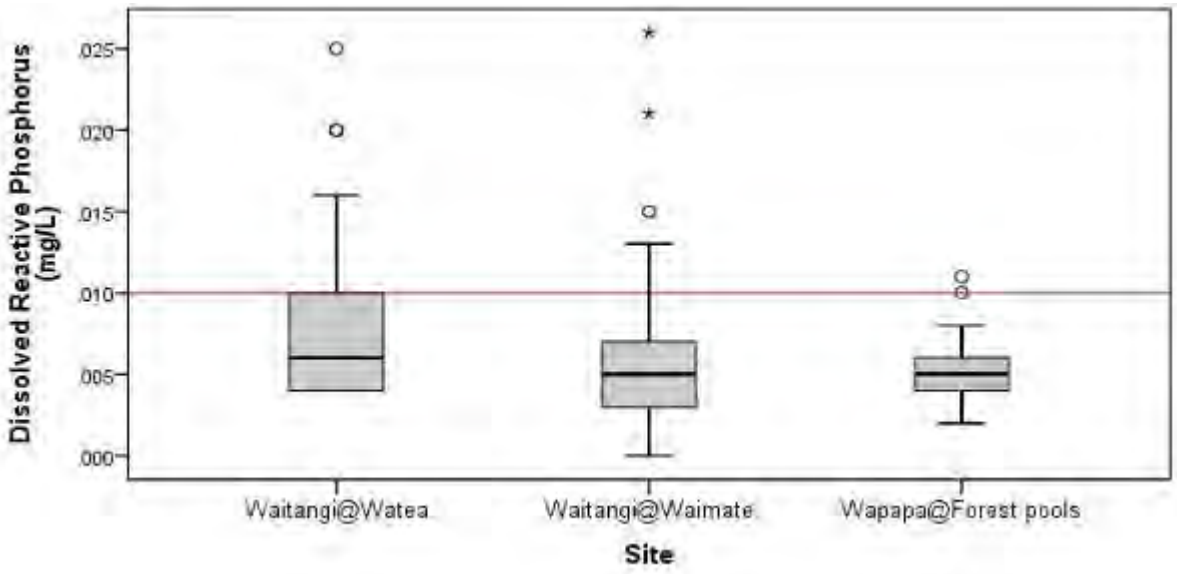
Nitrogen and phosphorus are the two main nutrients required by algae, plants and animals for metabolism and growth. They occur naturally in water as a result of natural processes, such as the erosion of soil, atmospheric deposition and the breakdown of organic matter. Nitrogen is highly soluble and can leach through soil, whereas phosphorus usually enters water in direct discharges or associated with sediment. While they are necessary for life, high levels of nitrogen and phosphorus can cause excessive growth of aquatic plants and algae.

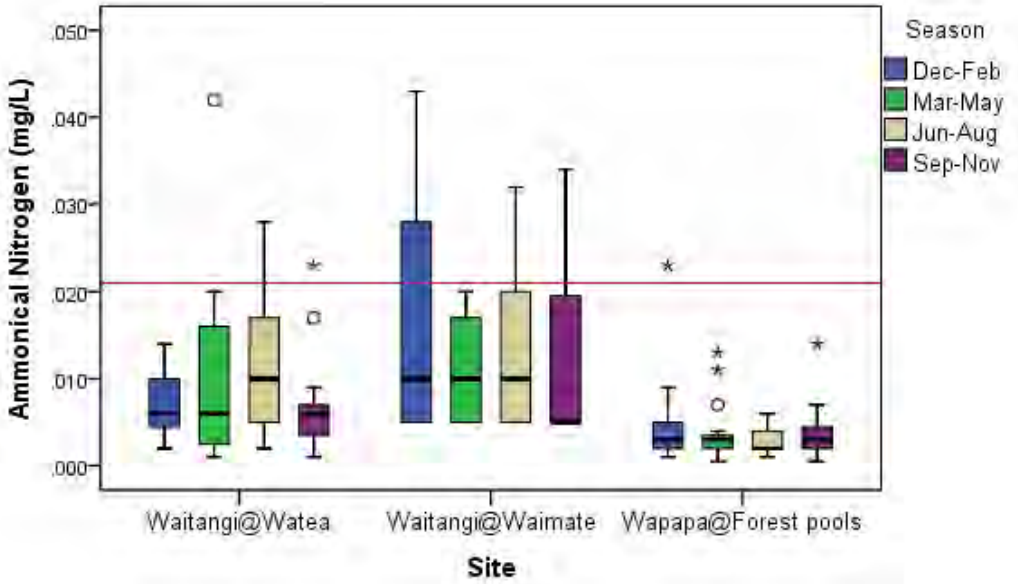
The dissolved nutrient levels in Waitangi River are reasonably low with median levels for 2007 to 2011 meeting guideline levels. While individual monthly samples of dissolved reactive phosphorous (DRP) and ammonical nitrogen (NH4) levels seldom exceed guideline levels at either site, nitrate-nitrite nitrogen (NNN) samples quite frequently exceed guidelines, particularly at the Waimate Road site where 42% of samples exceeded guideline levels. The median NNN levels for 2007 to 2011 were 0.248 and 0.407 mg/L for Watea and Waimate Road respectively and the highest results were 0.935 and 0.82mg/L.

Trend analysis on flow adjusted data detected a significant improvement in NNN levels at the Waimate North site while NH4 and DRP showed no significant change. No significant changes in nutrient levels were detected at the Watea site.






Dissolved Reactive Phosphorus (mg/L)
.025
.020
.015
.010
.005
.000
Waitangi@Watea
Waitangi@Waimate
Wapapa@Forest pools
Site


Ammonical Nitrogen (mg/L)
.050
.040
.030
.020
.010
.000
Season
Dec-Feb
Mar-May
Jun-Aug
Sep-Nov
Waitangi@Watea
Waitangi@Waimate
Wapapa@Forest pools
Site

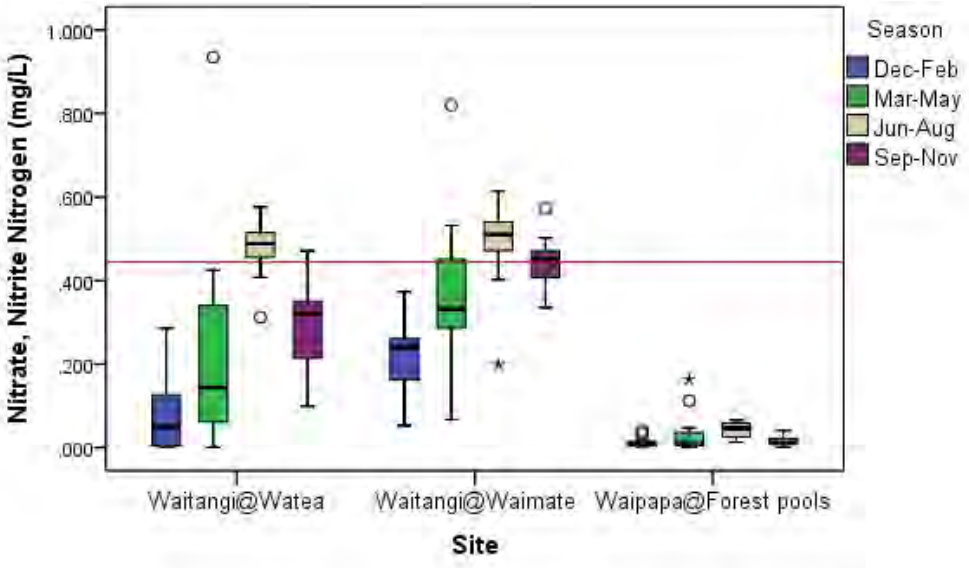

Nitrate, Nitrite Nitrogen (mg/L)
1.000
.800
.600
.400
.200
.000
Season
Dec-Feb
Mar-May
Jun-Aug
Sep-Nov
Waitangi@Watea
Waitangi@Waimate
Waipapa@Forest pools
Site

Figure 24 Ammonical Nitrogen (NH4), Nitrate-Nitrite Nitrogen (NNN), and Dissolved Reactive Phosphorus (DRP) boxplots at two monitoring sites on the Waitangi River over the 2007-2011 period. *The Waipapa site is displayed to provide a comparison with a forested monitoring site. The red lines indicate the national guideline value.*

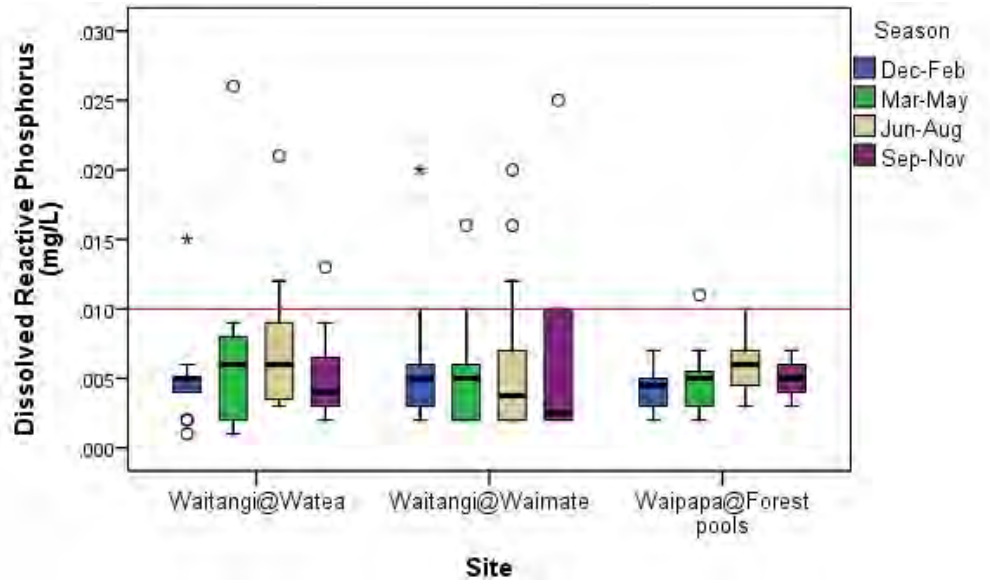


Figure 25 Seasonal variation in nutrient levels at different sites. The red line indicates the national guideline values.

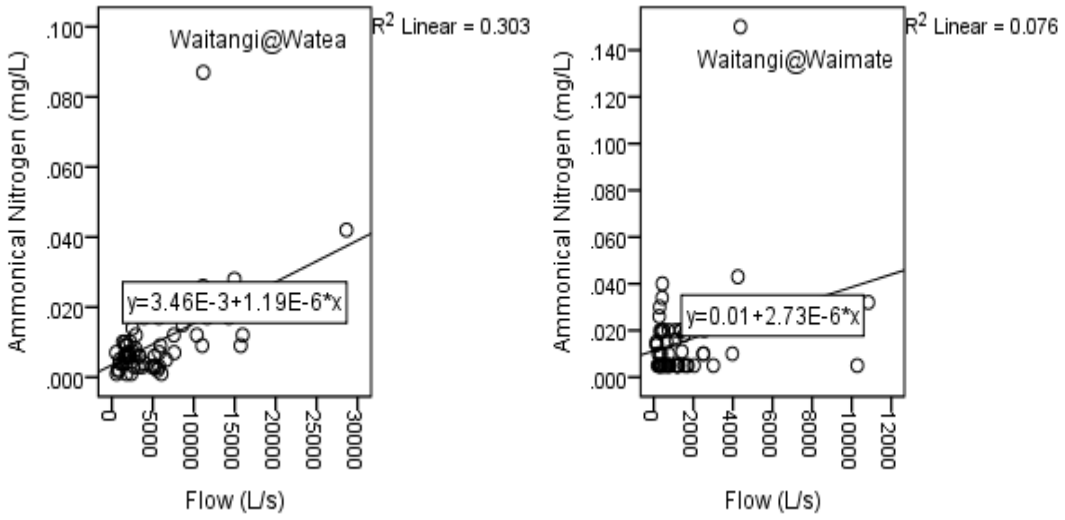


Figure 26 There is a weak linear regression between flow and NH4 at Watea (R^2=0.303), but no linear relationship at Waimate (R^2=0.076). Pearson's and Spearman's statistical tests showed moderate and weak correlations between NH4 and flow respectively: Watea (P=0.550; S=0.541); Waimate (P=-0.275; S=0.128).

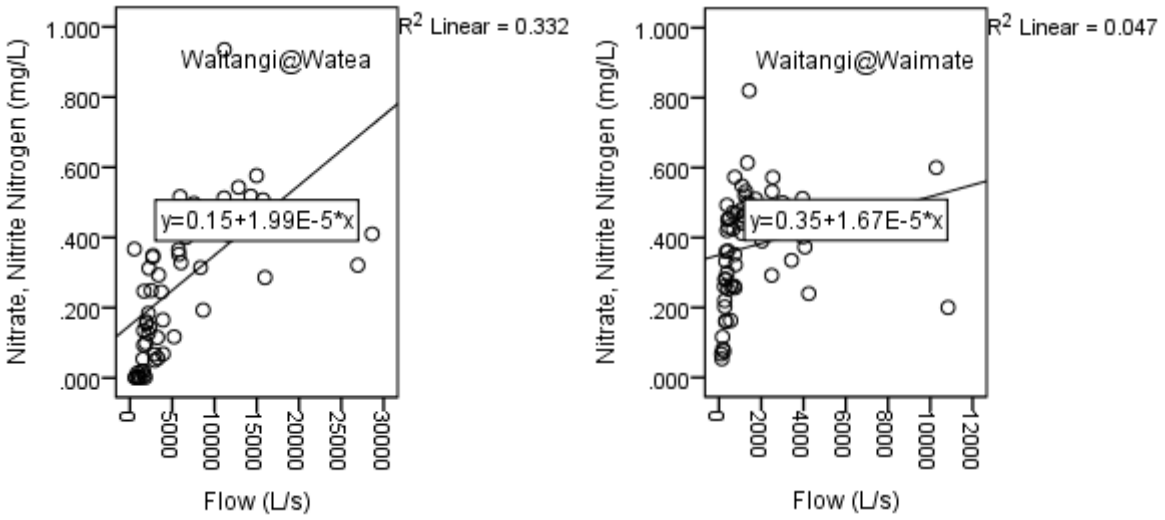


Figure 27 There is a weak linear regression between flow and NNN at Watea (R^2=0.332), but no linear relationship at Waimate (R^2=0.047). Pearson's and Spearman's statistical tests showed moderate correlations between NNN and flow respectively: Watea (P=0.577; S=0.783; Waimate (P=-0.217; S=0.593).

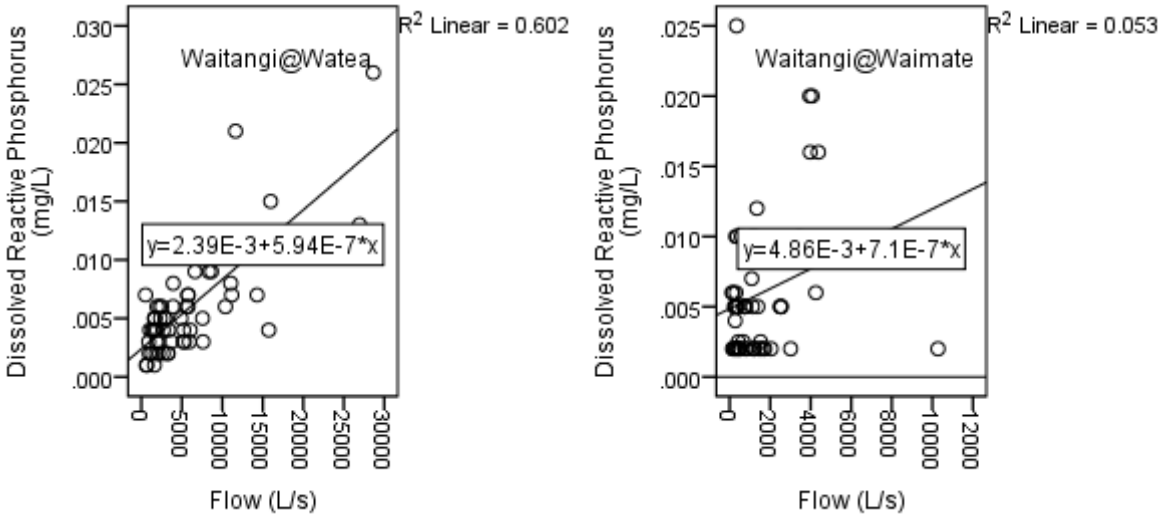


Figure 28 There is a moderate linear regression between flow and DRP at Watea (R^2=0.602), but no linear relationship at Waimate (R^2=0.053). Pearson's and Spearman's statistical tests showed moderate and weak correlations between DRP and flow respectively: Watea (P=0.776; S=0.644; Waimate (P=-0.231; S=0.121).

5.5 Faecal indicator bacteria and pathogens

Although faecal indicator bacteria and pathogens are not known to affect aquatic ecosystems they are of concern for both human and animal health. Escherichia coli (E coli) is a bacterium found in the gut and therefore faeces of warm-blooded animals. While most E coli are not harmful in themselves, they are a widely used and recognised indicator of faecal matter which can potentially contain harmful pathogens for both animals and humans. The median for E coli of 140.1 CFU/100ml and 435.5 CFU/100ml, recorded for Watea and Waimate Road sites respectively, between 2007 and 2011, are well above guideline values for stock drinking water and swimming.

The maximum score of 2419.2 CFU/100ml and 7701 CFU/100ml are very high and, probably associated with a rainfall event and run off of faecal matter from land. It should be noted that background levels of E coli tend to be higher in warm wet lowland areas so that national guidelines may not be appropriate for many of Northland's waterways (McDowell et al, 2013). Nevertheless, the excessive levels of E coli in the Waitangi River highlight the need for good land management and sewage disposal systems in protecting water quality in both the freshwater and the receiving marine environment in the Bay of Islands.

Trend analysis on flow adjusted data shows no significant change in E coli levels at either site since monitoring began.

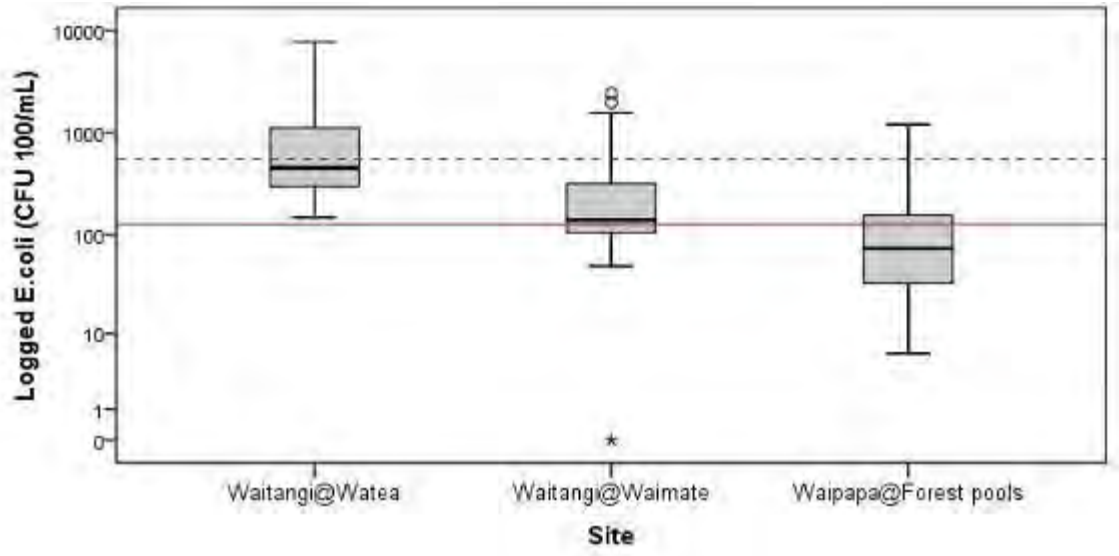


Figure 29 Escherichia coli (E.coli) boxplots at two monitoring sites on the Waitangi River over the 2007-2011 period.

Note: The Waipapa site is displayed to provide a comparison with a pristine forested monitoring site. The red unbroken line indicates the stock drinking water guideline value (<126CFU/100mL), and the dotted line indicates the national suitability for swimming guideline (<550 CFU/100mL). Note the logged axis.

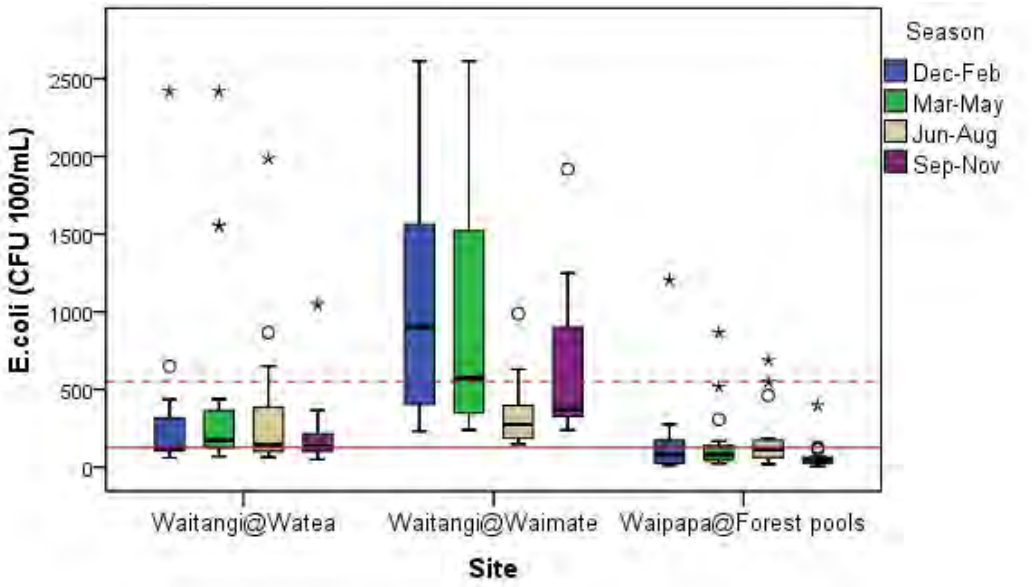


Figure 30 Seasonal variation in E coli levels at different sites. The red unbroken line indicates the stock drinking water guideline value (<126 CFU/100mL), and the dotted red line indicates the national suitability for swimming guideline (<550 CFU/100mL).

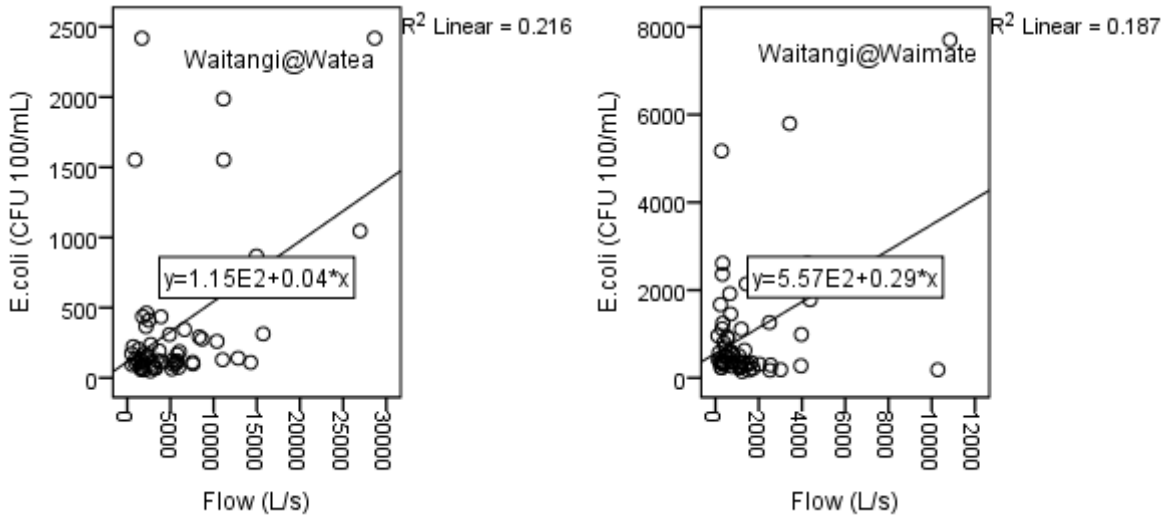


Figure 31 There is a weak linear regression between flow and E.coli at Watea (R^2=0.216), and Waimate (R^2=0.187). Pearson's statistical test showed moderate correlations between E.coli and flow while Spearman's test was weak: Watea (P=0.464; S=0.298); Waimate (P=-0.432; S=-0.109).

5.6 Water Clarity

Good water clarity is important for light availability for periphyton growth, the primary food resource for stream life. Clear water is also important for visual feeding by fish and invertebrates. Water clarity is influenced by suspended sediment and algal biomass. Suspended sediments are typically elevated following large rainfall events, causing low water clarity and high turbidity. Turbidity is one measure of water clarity.

The median turbidity scores for 2007 to 2011 were 3.65 NTU and 5 NTU for the Watea and Waimate Road sites respectively (Table 2), which are within national

guidelines (Table 1). The maximum turbidity scores recorded over this same period for the Watea and Waimate Road sites respectively were 42.3NTU and 200 NTU, associated with elevated flows. Even rivers in pristine native forested catchments have elevated sediment levels following heavy rain, being a combination of sediment being washed into the river from surrounding land and sediment being re-suspended from the river bottom due to the increased flows/flow velocities. However where there is intensive agriculture, forestry harvesting, subdivision, a lack of riparian vegetation and stock access sediment loads to waterways are often considerably increased.

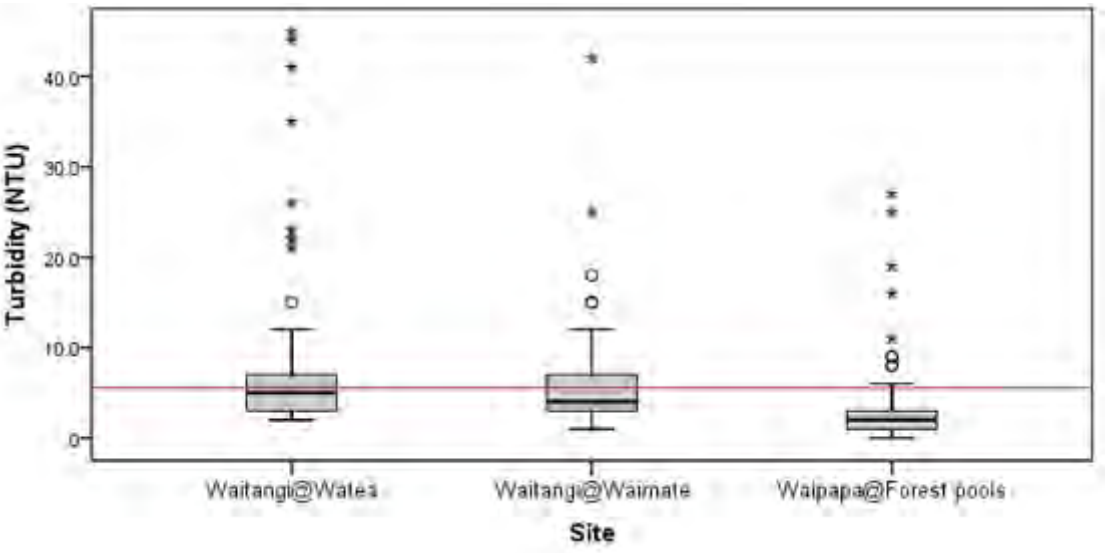


Figure 32 Turbidity boxplots at two monitoring sites on the Waitangi River over the 2007-2011 period. *Note: The Waipapa site is displayed to provide a comparison with a forested monitoring site. The red line indicates the national guideline value (<5.6).*

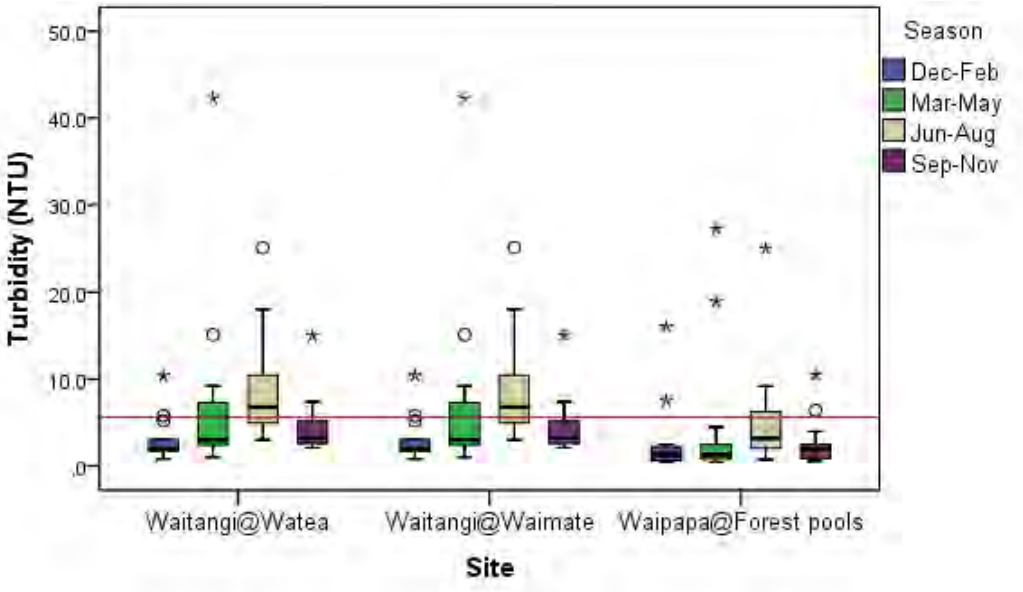


Figure 33 Seasonal variation in turbidity levels at different sites. The red line indicates the national guideline values.

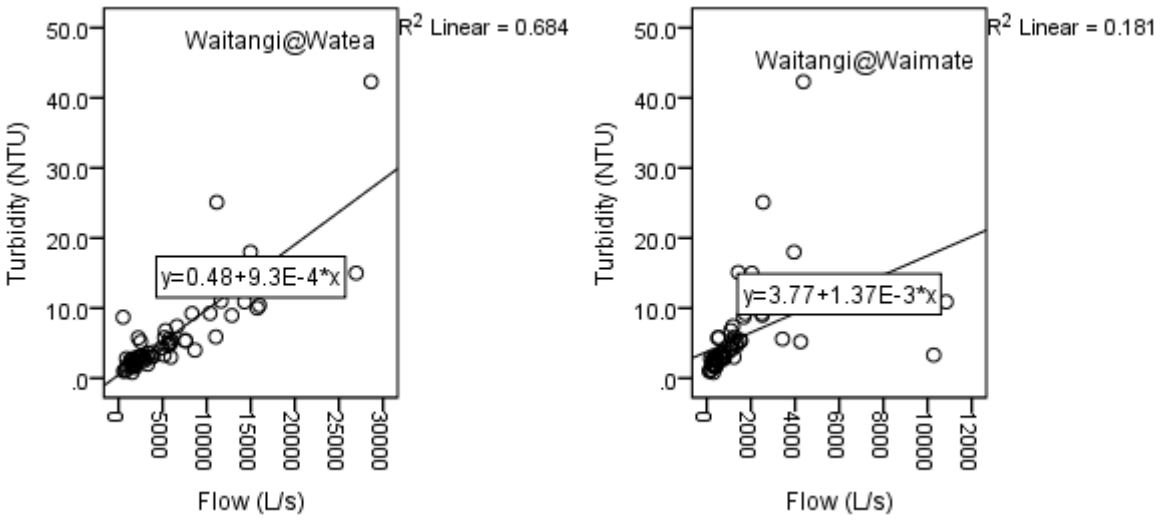


Figure 34 There is a moderate and weak linear regression between flow and turbidity at Watea (R^2=0.684) and Waimate (R^2=0.181) respectively. Pearson's and Spearman's statistical tests showed strong correlations between turbidity and flow respectively: Watea (P=0.827; S=0.848); Waimate (P=-0.425; S=0.872).

5.7 Water quality trends

Based on 10 years of data, trend analysis indicates no significant changes at the downstream Watea site. At Waimate North Road trend analysis indicates that ammoniacal nitrogen levels have **improved** while turbidity levels have **degraded**.

Table 5 Statistically significant trends based on 10 years of data. Green and red arrows indicate an improving/degrading trend respectively. A dash (-) indicates no statistical trend.

	Waimate North (upstream)		Watea (downstream)	
Parameter	**Statistically significant**	**Trend**	**Statistically significant**	**Trend**
Dissolved oxygen (%)	û	-	û	-
Nitate-nitrite nitrogen (mg/L)	û	-	û	-
Ammoniacal nitrogen (mg/L)	ü	Î	û	-
Dissolved reactive phosphorus (mg/L)	û	-	û	-
E.coli (MPN/100mL)	û	-	û	-
Turbidity (NTU)	ü	Ì	û	-

5.8 Invertebrate community health

Stream invertebrates (macroinvertebrates) can be used as biological indicators of water quality and stream health. The number of taxa (taxanomic diversity) at a site is a good indicator of the health and conservation value of a site. However, identification as part of the council's invertebrate monitoring programme is not to species level, so the diversity is likely to be higher than the data suggests.

The Macroinvertebrate Community Index (MCI) is an indicator of organic enrichment, where taxa are assigned predetermined scores on a scale of 1 to 10 depending on their sensitivity to organic pollution. The total MCI score at a site is based on the taxa present with the categories in **Table 6** used to determine the overall level of enrichment. The Semi-Quantitative Macroinvertebrate Community Index (SQMCI) is similar to the MCI but takes into account the relative abundance of each taxa present. The categories used to determine the level of organic enrichment for SQMCI are also shown in **Table 6**. "Fuzzy boundaries'" of ± 5 MCI units and ± 1.0 SQMCI unit are often used when interpreting the categories (Pohe 2012), to account for the complexity and variation in invertebrate communities.

Table 6 Categories for MCI and SQMCI (Boothroyd and Stark 2000)

Category	**MCI**	**SQMCI**
Clean water	> 120	> 6.00
Possible mild pollution	100 – 119.9	5.00 – 5.99
Probable moderate pollution	80 – 99.9	4.00 – 4.99
Probable severe pollution	< 80	< 4.00

Most mayflies (Ephemeroptera), stoneflies (Plecoptera) and caddisflies (Trichoptera) are more sensitive to changes in their environment. Therefore, like the MCI and SQMCI, the number of **E**phemeroptera, **P**lecoptera and **T**richoptera **[EPT]** taxa present as a proportion of the total number of taxa recorded can be used as a measure of likely organic pollution at a site (%EPT).

The invertebrate indices are inconsistent with the water quality data and indicate that the Waitangi River is in a degraded condition. At the Watea site the MCI consistently falls in to the 'probable severe pollution' categories with a median score of 61.2 and a range from 49.4 to 70.6. The Waimate Road site mainly falls into the probable moderate pollution category with a median of 99.3 and a range from 87.8 to 102.1.The Watea in particular is dominated by pollution tolerant taxa, with percent EPT taxa ranging from 0 to 35.5 % in the five years of sampling (**Table 7**). These poor invertebrate results, despite relatively good water quality, are likely to be linked to poor habitat quality, in particular the high levels of sediment in the substrate, smothering available habitat and food sources.

Table 7 Freshwater invertebrate data for Waitangi at Waimate Road

Year	No. of taxa		MCI		SQMCI		%EPT	
	Watea	Waimate Rd	Watea	Waimate Rd	Watea	Waimate Rd	Watea	Waimate Rd
Mar-07	10	15	50.0	99.3	2.41	6.37	0.0	33.3
Jan-08	17	29	70.6	95.5	3.33	5.08	11.8	31.0
Apr-09	20	19	49.4	102.1	1.53	5.16	0.0	47.4
Jan-10	22	21	61.2	101.0	2.13	4.18	35.5	59
Mar-11	10	20	65.8	87.8	2.96	3.42	26.1	53
Median	17	20	61.2	99.3	2.41	5.08	11.8	47.4

5.9 Fish community

The use of fish as an indicator of ecological health is complicated in New Zealand by the fact that many species are diadromous (spend part of their life cycle at sea) so their presence is influenced by factors such as barriers to migration, distance inland as well as habitat availability and water quality. They are an important part of the food web however and their absence will skew normal predator prey relationships. Their presence is an important measure of ecological stability and underpins a stream's ecological value.

Native fish diversity within the Waitangi catchment is moderate and is likely to be influenced by the Haruru Falls low down in the catchment causing a barrier to migratory fish species. Recent surveys at six sites recorded four native species (banded kokopu, longfin eel, shortfin eel and an abundance of crans bully). The introduced pest species gambusia was also recorded as well as koura (fresh water crayfish). Historical records on NIWA's New Zealand Freshwater Fish Database include the same species plus an additional four – Northland mudfish, common bully and the introduced fish species rudd and tench. Northland mudfish *(Neochanna heleios)* is threatened and nationally vulnerable[1]and range restricted, being only found in a restricted area around Kerikeri.. The Long fin eel (*Anguilla dieffenbachia*) is thought to be in gradual decline. The presence of gambusia and rudd within the catchment is a concern. Gambusia are known to attack native fish particularly in warmer water temperatures. Rudd are a voracious species which compete with native fish and destroy habitat

Table 8: Waitangi River catchment freshwater fish conservation status

Common name	Taxon (2004)	Taxonomic group	Threat classification	Notes	Status criteria	Trend criteria
Shortfin eel	*Anguilla australis*	Freshwater fish	Not threatened	Possibly declining /threatened in NSW? Concern about concentration of fisheries on females only.		
Longfin eel	*Anguilla dieffenbachii*	Freshwater fish	5: Gradual decline	Harvest, habitat loss, possibility of recruitment failure?	1, 2a,b	1
Banded kokopu	*Galaxias fasciatus*	Freshwater fish	Not threatened	Locally in decline. Not Northland (Pers. Comm. Nigel Miller)		
Crans bully	*Gobiomorphus basalis*	Freshwater fish	Not threatened	Possible cryptic diversity		
Northland mudfish	*Neochanna heleios*	Freshwater fish	2: Nationally Vulnerable'	10 populations, geographic variation, gambusia impact, habitat fragmentation, drainage, weeds,eutrophication.	D3	1

Source: Allibone R, David B, Hitchmough R, Jellyman D, Ling N, Ravenscroft P, Waters J 2010. Conservation status of New Zealand freshwater fish, 2009. **New Zealand Journal of Marine and Freshwater Research 44: 271-287**

Table 9: Definition of Conservation Status for Northland mudfish (*Neochanna heleios)*

The Revised NZ Threat Classification System lists 2008-2011

A taxon is 'Nationally Vulnerable' when evidence indicates that it fits at least One Status criterion *and* the Trend criteria as follows:

Status

1. The total population size is 5000–20,000 mature individuals; or
2. There are ≤ 15 sub-populations *and* ≤ 1000 mature individuals in the largest sub-population; or
3. The total area of occupancy is ≤ 1000 ha (10 km^2).

Trend

There is an ongoing or predicted decline of 30–70% in the total population due to existing threats, taken over the next 10 years or three generations, whichever is longer.

Source: NZ Threat Classification System lists 2008-2011, Department of Conservation 2013

Source:

Department of Conservation, New Zealand Threat Classification System manual , 2008.

Figure 35 The banded kokopu is an exceptional climber, with the ability to ascend through very steep falls, which occurs in moderate populations in Northland waterways. Photo credit: TerraNature

Figure 36 Endemic to Northland the Northland mudfish are specialised inhabitants of swamps, drains and forest ponds which may dry up in summer. Photo credit: NIWA

5.10 Periphyton community

Periphyton is an important indicator of environmental quality, as the main primary producer in stream ecosystems, but also because of its ability to respond quickly to changes in water quality and form excessive growths under ideal conditions, affecting instream values, such as biodiversity and recreational use.

There is no periphyton data for the Watea site and only limited data for Waitangi at Waimate Road. However the data suggests the Waitangi generally has low algal biomass within the guidelines for ‘clean water’ macroinvertebrates (Biggs 2000) with occasional blooms in long dry summer months.

5.11 Stream habitat quality

Where there is a diverse habitat available with a variety of flow types (runs riffles and pools) and good quality riparian vegetation, there tends to be high ecological health. Different flow types offer a variety of different habitats, encouraging greater diversity.

Riparian cover stabilizes banks, provides a sink for nutrients, traps sediment and provides shade during hot summer months as well as a source of food in the form of falling vegetation and terrestrial invertebrates.

Despite a relatively good water quality score the habitat at the Waitangi River monitoring sites consistently scores as marginal. At the Waimate North site the river is subject to frequent erosion/cutting and deposition with around half of the substrate being composed of sediment/sand. The surrounding land use is pasture, there is little riparian cover/shade and stock have access to the river. While still marginal, the habitat is slightly improved at Watea where the banks are more stable, the substrate is a little more diverse with cobble, boulder and bedrock, as well as silt and sand, and there is more cover in the form of native scrub. In addition, livestock do not have access to the river. The poor habitat is reflected in the impoverished macroinvertebrate community results.

Figure 37 Bank and channel erosion at the Waimate North Road site

5.12 Swimming water quality monitoring

Two sites are currently monitored on the Waitangi River as part of the council's Recreational Swimming Water Quality programme[8] (**Figure 38**). One site was monitored from 2004 to 2011 and located between Puketona and Haruru Falls at "Lily Pond". This site was decommissioned due to safety reasons and replaced in 2012 with the site at "Watea" (also known as "Wakelins" and located further downstream). The second site currently monitored is located at the river mouth at Waitangi Bridge.

Between 2004 and 2011, 88 samples were collected during the summer months and complied with the suitability for swimming guidelines (freshwater <550 *E. coli* CFU/100mL) 58 percent of the time with a median value of 238 *E. coli*/100mL at Lily Pond. Twenty three samples were collected between 2012 and 2014 from the site at Watea. Results complied with the suitability for swimming guidelines 78 percent of the time with a median value of 120 *E. coli*/100mL. Between 2004 and 2014, 123 samples were collected and complied with the guideline (marine <280 *Enterococci* CFU/100ml) 92 percent of the time at Waitangi Bridge.

[8] This monitoring programme focuses on health risk, therefore only water temperature and bacterial contamination is measured.

Figure 38 Swimming water quality sites at Lily Pond (top left), Watea (below) and Waitangi Bridge (top right)

5.13 Water quality summary

- The Waitangi River catchment has been monitored at Waimate North Road and downstream at Watea above Haruru Falls since 1996. Based on monitoring results (2007-2011) overall water quality is ranked as 'good' at both sites. However, some aspects of its water quality and its ecological health are not good.
- Water quality degrades slightly between Waimate Road (upstream) and Watea (downstream), with the main issues being sediment, faecal bacteria and nitrogen levels.
- Contaminant levels tend to be higher in winter and spring due to higher rainfall runoff from the surrounding land.
- Despite a relatively good water quality score the habitat at Waitangi River consistently scores as marginal. At the Waimate North site the river is subject to frequent erosion/cutting and deposition. The surrounding land use is pasture, there is little riparian cover/shade and stock have access to the river. While still marginal, the habitat is slightly improved at Watea where the banks are more stable, the substrate is a little more diverse with cobble, boulder and bedrock, as well as silt and sand, and there is more cover in the form of native shrub. In addition, livestock do not have access to the river.
- The invertebrate indices are inconsistent with the water quality data and indicate that the Waitangi River is in a degraded condition. The poor invertebrate results, despite relatively good water quality, are likely to be

linked to poor habitat quality, in particular the high levels of sediment in the substrate, smothering available habitat and food sources.

- Haruru Falls creates a significant barrier to fish migration in the catchment with only good climbers and non-migratory species found upstream. There is a moderate diversity of fish with records of six native species (longfin eel, shortfin eel, crans bully, common bully, banded kokopu and northland mudfish) and three introduced pest species (gambusia, rudd and tench). Significant to the area is the Nationally Vulnerable Northland mudfish which is found only in Northland in a restricted area around Kerikeri.
- In general, the monitored swimming spots at Lily pond and Waitangi Bridge are suitable for swimming most of the time but can occasionally exceed the suitability for swimming guideline, especially after rainfall.

6 Water Quantity: Surface and Groundwater

6.1 Surface water quantity

On paper, water is highly allocated within the Waitangi River catchment and demand is only likely to increase.

Water takes are naturally a reflection of predominant land uses which in this catchment relates to for stock drinking, dairy washdown and domestic supply. Water is exported from the catchment for use in municipal drinking water supplies and separately the Kerikeri irrigation scheme services horticulture north of the catchment.

Operation of the Ngawha Geothermal Power Station can involve significant quantities of groundwater, however, currently it involves little surface water.

A trial for modelling flows in Waitangi Catchment is underway.

CHES (Cumulative Hydrological Effects Simulator) is Arc Map based software developed by NIWA to visually display changes in flows in a catchment. CHES is based on time series data and is appropriate to be applied at catchment level.

Northland has been given the opportunity to trial this software and assist in its development. It is proposed that NRC take this opportunity and trial the tool in the Waitangi River catchment.

Aims of the modelling trial are to:

- Visually show effects of current consents in the catchment and how the takes, diversions and dam change the flow throughout the catchment;
- Understand the actual effects of dams on 'natural' run of stream in order to better calculate total allocation in the catchment; and
- Visually show the effects of imposing different limits and allocation regimes on the flows and existing consents in the catchment. (*Note this builds on the work being undertaken on "base line ecological flow assessments" and will show the effects of setting these different limits, particularly - when, where and for how long restrictions may occur under different limits and allocation scenarios in the catchment.)*

6.2 Groundwater

Aquifers in the Waitangi River catchment are indicated in Figure 39. These are complex systems that occur at different depths and may overlap.

The Ngawha geothermal aquifer extends from the north of the Kawakawa catchment into the south west of the Waitangi catchment (Waiaruhe sub-catchment). Operation of the Ngawha Geothermal Power Station Geothermal involves significant quantities of groundwater; however, most is re-injected into the geothermal aquifer. These geothermal waters and the hot springs have very high cultural value and the aquifer is categorized as 'at risk'.

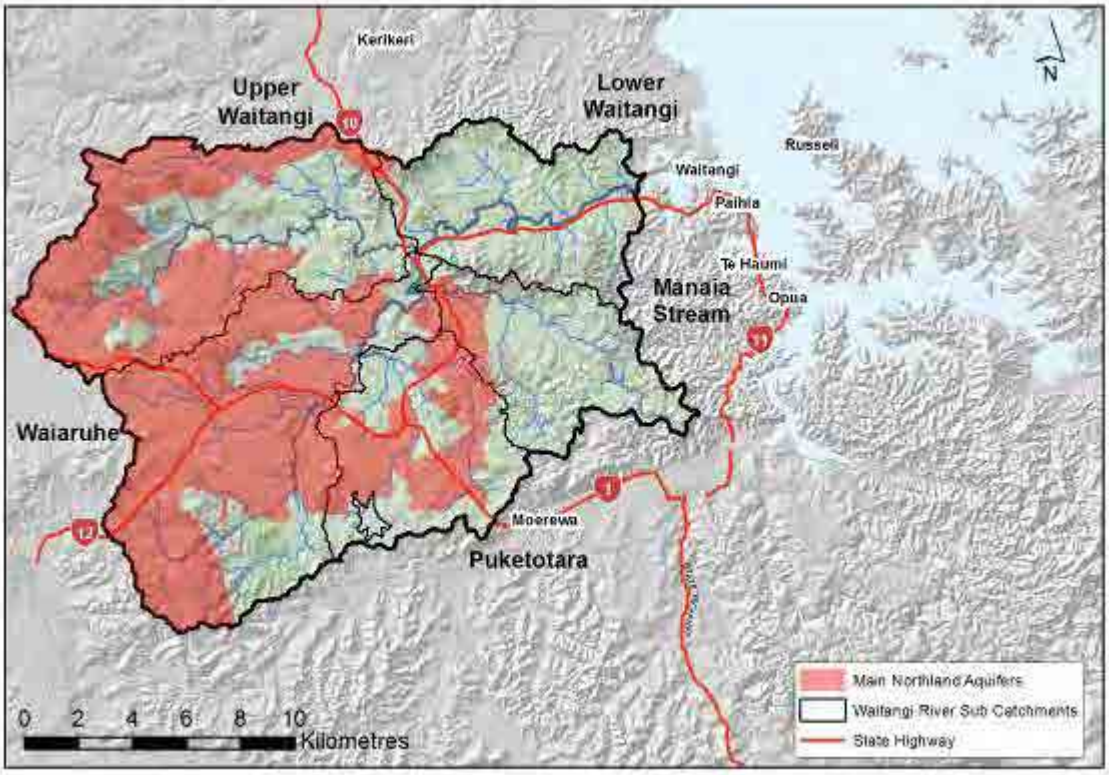


Figure 39 Aquifers in the Waitangi catchment

7 Lake ecosystem and water quality

The ecological health, or integrity, of lake ecosystems are related to a number of environmental factors including, but not limited to, the availability of suitable habitat types (e.g. diverse range of emergent and submerged indigenous plants), lack of invasive exotic species, disturbance and high water quality. It is important to note that the relationship between ecosystem health and environmental factors is often very complex and unpredictable.

Lake water quality parameters of concern in terms of ecological health are, in no particular order, temperature, dissolved oxygen, water clarity, nutrients, suspended solids and chlorophyll α levels. Faecal pathogens are not known to affect aquatic ecosystems, but do affect the suitability of a water body for swimming and drinking water.

The Trophic Level Index (TLI) can be used to determine the state of lakes (Burns et al. 2000). The TLI is calculated using four key variables: chlorophyll α (an indicator of algal biomass), water clarity, total nitrogen (TN) and total phosphorus (TP) (**Table 8**). Together, these provide an indication of a lake's overall health. The overall score is categorised into seven trophic states indicating progressively more nutrient enrichment, more algal productivity and reduced water clarity. The states of most relevance in the Northland region are:

- Microtrophic lakes, which are very clean;
- Oligotrophic lakes, which have low levels of nutrients and algae;
- Mesotrophic lakes, which have moderate levels of nutrients and algae;
- Eutrophic lakes, which are green and murky, with higher amounts of nutrients and algae;
- Supertrophic lakes are fertile and saturated in phosphorus and nitrogen, with very high algae growth and blooms during calm sunny periods; and
- Hypertropic lakes are highly fertile and supersaturated in phosphorus and nitrogen. They are rarely suitable for recreation and habitat for desirable aquatic species is limited.

Table 8 Trophic states relevant to Northland lakes and the water quality ranges that define each trophic level (Burns et al. 2000)

Lake type	Trophic level	Chlorophyll α (mg/m^3)	Clarity (m)	TP (mg/m3)	TN (mg/m3)
Microtrophic	1.0 – 2.0	0.33 – 0.82	25 – 15	1.8 – 4.1	34 – 73
Oligotrophic	2.0 – 3.0	0.82 – 2.0	15 – 7.0	4.1 – 9.0	73 – 157
Mesotrophic	3.0 – 4.0	2.0 – 5.0	7.0 – 2.8	9.0 – 20	157 – 337
Eutrophic	4.0 – 5.0	5.0 – 12	2.8 – 1.1	20 – 43	337 – 725
Supertrophic	5.0 – 6.0	12 – 31	1.1 – 0.4	43 – 96	725 – 1558
Hypertrophic	6.0 – 7.0	> 31	< 0.4	> 96	> 1558

7.1 Lake Owhareiti

Lake Owhareiti is located in the headwaters of the Puketotara sub-catchment and is 95.9 ha in area, with a maximum depth of 16 m. It was formed by a volcanic flow damming the outlet. Surrounding catchment is mostly pasture. The lake has one surface inflow (to the south east) but no outflows. It is a local recreational bathing site.

The Northland Lakes Ecological Status 2013 report ranks Lake Owhareiti 177th (low) in Northland. Its low ranking is due to severe impacts from the pest plant Egeria densa and poor water quality due to nutrient enrichment.

Owhareiti is currently a mesotrophic lake type indicating a significant improvement in water quality as demonstrated by figures below in

Table 9.

Table 9 Lake Owhareiti trophic state monitoring

Lake Owhareiti						
Lake type	**Trophic level**	**Chlorophyll α (mg/m^3)**	**Clarity (m)**	**TP (mg/m3)**	**TN (mg/m3)**	**Date**
Eutrophic	4.97	122	1.74	9	650	May-06
Eutrophic	4.972	52.4	2.3	34	455	Aug-07
Mesotrophic	3.504	4	5.1	7	400	Jun-11
	Next assessment due November – December 2013					

The lake has multiple surrounding landowners, some of the surrounding pasture land has lake frontage fencing, however, the lake does not have complete stock exclusion. There has been some in on-going fencing and riparian planting associated with NRC Environment Funding and other assistance by the Landcare Trust, Pakaraka school students and Far North District Council. These restoration and enhancement works and continued fencing can only improve the lakes water quality and ecological status over time.

Figure 42 Lake Owhareiti margin showing pasture margins and pressure from stock and emergent beds of Eleocharis sphacelata.

The lake provides valuable habitat for water birds including fernbird (*Bowdleria punctata vealeae*), dabchick (*Poliocephalus rufopectus*), Australasian little grebe (*Tachybaptus novaehollandiae*) and scaup (*Aythya novaezeelandiae*), with 6 nationally endangered bittern (*Botaurus poiciloptilus*) seen in 1990, and is home to some rare native plant species[9] and Common bullies (*Gobiomorphus cotidianus*) have been observed in the lake[10].

7.2 Ngawha geothermal area Lakes Ngamokaikai and Waiparaheka

Available monitoring data is very limited for these lakes as they were only monitored once in 2006.

Lake Waiparaheka has very high nitrogen levels which indicate a hypertrophic state. Ammonia levels are very high and are well above the national guidelines values for ecosystem protection. Total phosphorus levels are moderate. The lake is very acidic (pH 3.5) and appeared to be anaerobic at the time of sampling.

Lake Ngamokaikai has moderate nutrient levels indicating a eutrophic (relating to nitrogen) and supertrophic (relating to phosphorus) status. This lake is also very acidic (pH 3.7) with low dissolved oxygen levels.

The low pH and nutrient enrichment in both lakes is most likely associated with the localised geothermal activity in the area.

[9] Lisa Forester, NRC Ecologist
[10] Northland Lakes Ecological Status 2013 Prepared for Northland Regional Council by NIWA July 2013

8 Coastal environment

8.1 Coastal Uses and Values

The Waitangi River catchment has an influence that extends beyond the Haruru Falls into the Waitangi Estuary and the Bay of Islands.

The Regional Coastal Plan (RCP) provides for a number of activities in the Harbour based on recognised uses and values. These include cultural activities and values, aquaculture, commercial and domestic maritime activities and recreational activities such as swimming, water skiing and jet skiing, fishing, yachting, diving, sail boarding, canoeing/kayaking and waka ama.

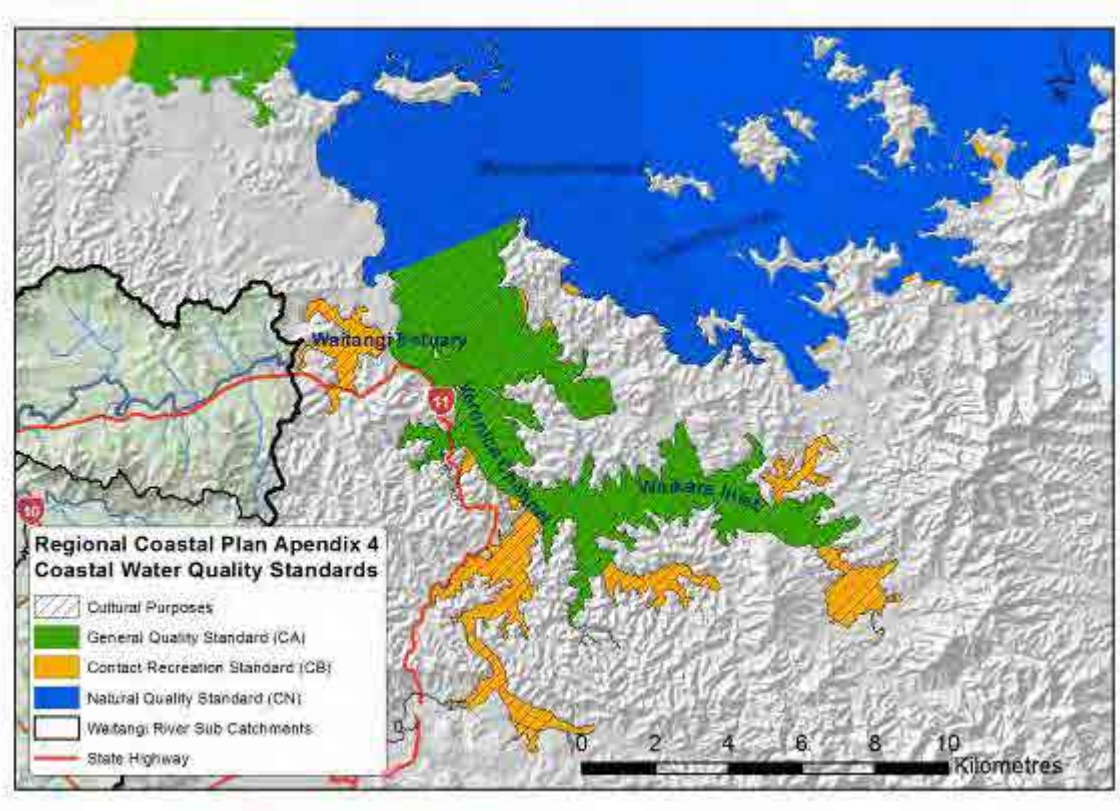


Figure 43 Waitangi River Marine Management Areas – Regional Coastal Plan

The RCP has recognised some of these uses and values by promoting assessment of existing and new activities against criteria throughout the region. **Figure 43** shows that the Waitangi Estuary and Bay of Islands waters out to Motuarohia Island have particular cultural values. The RCP has allocated a coastal water quality standard of "Contact Recreation [CB]" to the Waitangi Estuary in recognition of the range of water recreational activities undertaken in the Bay of Islands.

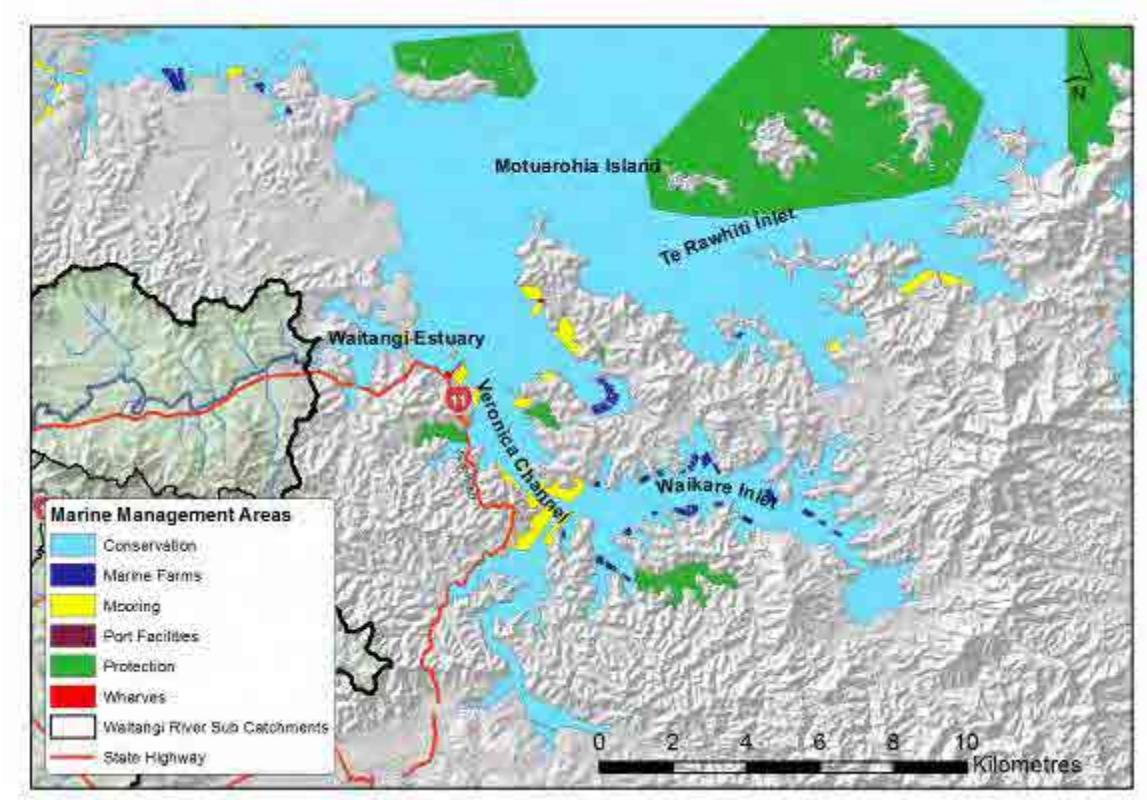


Figure 44 Regional Coastal Plan Marine Management Areas

The Regional Coastal Plan (RCP) recognises the Waitangi Estuary provides significant cultural value, and high amenity, recreational and biodiversity values. Like most estuaries it acts as a receiving environment and discharge point for freshwater bodies, primarily the Waitangi River catchment.

As discussed in Section 3.5 'Sedimentation', the sediment originating from the Waitangi River catchment is deposited in the coastal marine area. While the Waitangi catchment provides a significant (15%) source of sediment into the wider Bay of Islands system, the majority of sediment deposited in the Bay originates from the Kawakawa catchment (79%).

The Waitangi catchment is likely to be the primary source of deposited sediment within the Waitangi Estuary. Because the estuary is relatively enclosed, monitoring in this area is likely to provide a good correlation between the input of sediment (and other contaminants) from the Waitangi catchment and sedimentation. It is for this reason that the baseline monitoring described in Section 8.4 has been undertaken in the estuary.

8.2 Coastal Monitoring Sites

The Council has undertaken routine state of the environment water quality monitoring in the Bay of Islands since May 2008. This summary only includes data from 2009-2012 to avoid any bias caused by seasonality.

A total of 16 sites are currently monitored bi-monthly (January, March, May, July, September and November) in the Bay of Islands (Figure 45 **State of the Environment water quality sites in the Bay of Islands**). These sites have been selected in order to capture the main freshwater inputs (rivers and streams) to the

system and to ensure a good geographical spread throughout the Bay.

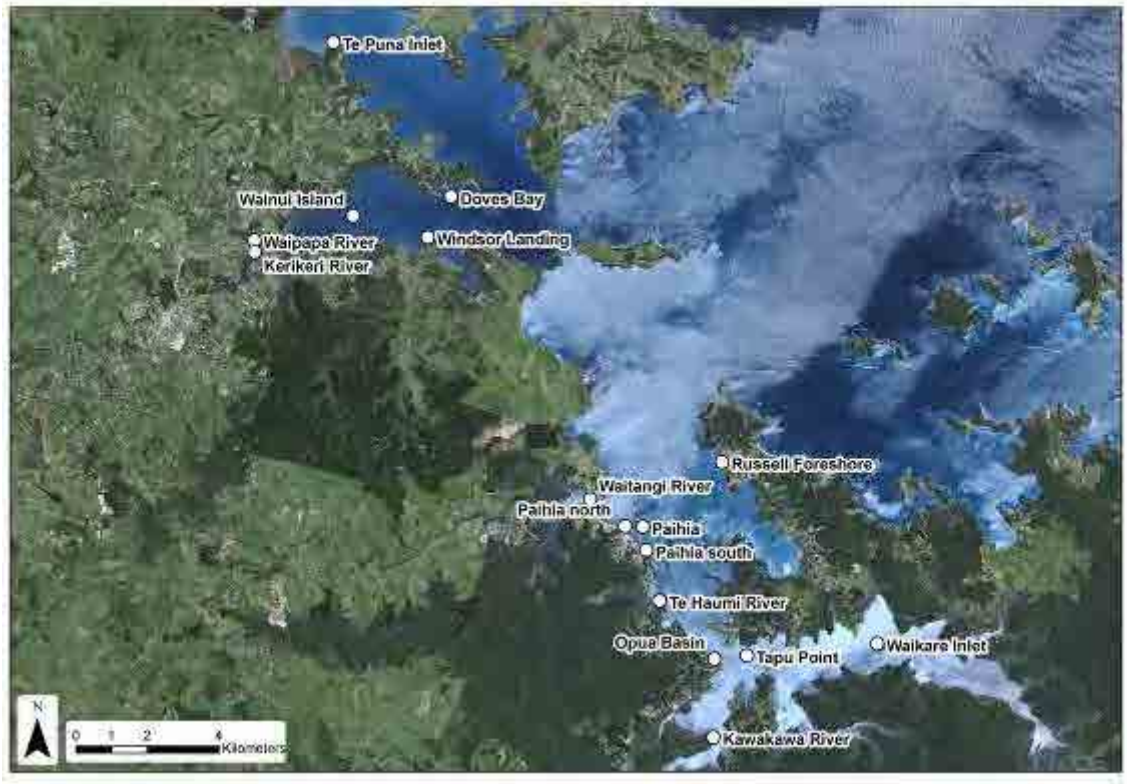


Figure 45 State of the Environment water quality sites in the Bay of Islands.

Water samples are analysed for physical parameters (dissolved oxygen, temperature and salinity), faecal bacteria (enterococci and faecal coliforms), nutrients (dissolved reactive phosphorus, total phosphorus, ammonium and nitrate-nitrite nitrogen) and water clarity (turbidity and secchi depth).

The results have been assessed against the Australian New Zealand Environment Conservation Council (ANZECC) interim trigger values and MfE Microbiological Water Quality Guidelines (MfE). The data was also analysed for any trends.

8.3 Coastal Monitoring Results

8.3.1 Nutrients

While nutrients are essential for all forms of life, nutrients that enter the environment from anthropogenic (human activity) sources, such as fertilizer, stormwater runoff and treated wastewater discharges may exceed the needs of an ecosystem. Too much nutrients can cause excessive plant growth leading to algal blooms, lowered levels of dissolved oxygen and reduced clarity. This can reduce the life-supporting capacity of the ecosystem, as well as posing a human health risk both through contact with toxic algal blooms and the health effects of eating contaminated shellfish.

The current scientific consensus is that nitrogen is the main limiting nutrient in coastal waters, particularly in the summer and where bacterial denitrification rates are high, but that phosphorus limitation may be important in spring. Consequently it is important to monitor and manage the levels of both nitrogen and phosphorus.

Table 10 Median nutrient concentrations at Waitangi and the percentage (%) of samples which were within ANZECC guideline limits.

	DRP (mg/l)	TP (mg/l)	NH4 (mg/l)	NNN (mg/l)
ANZECC	**0.005**	**0.03**	**0.015**	**0.015**
Median	**0.0075**	**0.018**	**0.018**	**0.0425**
% compliance	**21**	**96**	**33**	**33**

Key: DRP= Dissolved Reactive Phosphorus; TP= Total Phosphorus; NH4= Ammonium; NNN= Nitrate-Nitrite Nitrogen

When compared to other sites in the Bay of Islands, which are close to freshwater inputs, the median concentrations of nutrients at Waitangi were typically higher than the values at Te Puna, Te Haumi and the Waikare Inlet but below the values at Kawakawa River, Kerikeri River and Waipapa River (**Table 11**). The exception to this was the median value for total phosphorus at Waitangi which was lower than the other sites (**Table 11**).

Table 11 Median nutrient concentrations at selected sites in Bay of Islands.

	DRP (mg/l)	TP (mg/l)	NH4 (mg/l)	NNN (mg/l)
ANZECC guideline	0.005	0.03**0**	0.015	**0.015**
Waitangi	0.008	0.018	0.018	0.043
Waikare Inlet	0.011	0.029	0.010	**0.009**
Kawakawa River	0.011	0.026	0.020	**0.051**
Waipapa River	0.006	0.022	0.028	**0.138**
Te Haumi River	0.010	0.020	0.010	**0.016**
Te Puna	0.007	0.020	0.010	**0.004**
Kerikeri River	0.005	0.019	0.028	**0.204**

8.3.2 Faecal Indicator Bacteria

Enterococci and faecal coliforms are bacteria that indicate faecal contamination. The New Zealand Marine Bathing Study found that *Enterococci* is the indicator most closely correlated with human health effects in New Zealand marine waters. However, faecal coliforms are a useful indicator in environmental circumstances, such as brackish or estuarine environments where mangrove forests are present and *Enterococci* may be naturally occurring.

The median values for both faecal coliforms and enterococci at Waitangi were within their respective guideline limits (**Table 12**) and the percentage of samples within the guideline limits was 88% and 83% respectively.

Table 12 Median faecal coliforms and enterococci concentrations at Waitangi River and the percentage (%) of samples which were within ANZECC guideline limits.

	FC/100ml	ENT/100ml
Guideline limit	**150**	**140**
Median	**12**	**10**
% within	**88**	**83**

The median values for faecal indicator bacteria at Waitangi were generally lower than Kerikeri River, Waipapa River and Kawakawa River (**Table 13**).

Table 13 Median faecal indicator bacteria concentrations at selected sites in Bay of Islands.

Site Name	FC/100ml	ENT/100ml
Guideline limit	150	140
Kerikeri River	82	31
Waipapa River	58	20
Kawakawa River	18	10
Waitangi	12	10
Te Haumi River	4	10
Waikare Inlet	2	10
Te Puna	2	10

8.3.3 Water clarity

Both secchi depth and turbidity are a measure of water clarity. Water clarity can be reduced by the growth of phytoplankton and human activities and land use practices that increase levels of suspended solids entering the coastal environment.
There is currently no ANZECC guideline limit for secchi depth but the ANZECC guideline limit for turbidity is 0.5-10 NTU. The median turbidity value at Waitangi was within the ANZECC guideline limit and 95% of samples were within also within the limit (**Table 14**).

Table 14 Median turbidity and secchi depth at Waitangi and the percentage (%) of samples which were within ANZECC guideline limits.

	Turbidity (NTU)	Secchi depth (m)
Guideline limit	**10**	**N/A**
Median	**5.7**	**1.45**
% compliance	**95**	**N/A**

The median turbidity at Waitangi was higher than Kerikeri River, Waipapa River and Te Puna but lower than at Waikare Inlet and Kawakawa River. Interestingly the secchi depth at Waitangi was higher than at any other site (**Table 15**).

Table 15 Median turbidity and secchi depth at selected sites in Bay of Islands.

Site Name	Turbidity (NTU)	Secchi depth (m)
Waikare Inlet	8.5	0.9
Kawakawa River	7.2	1
Waitangi	5.7	1.45
Te Haumi River	5.7	1.2
Kerikeri River	4.95	1.2
Waipapa River	4.65	1.1
Te Puna	4.45	1.3

8.3.4 Trend analysis

The trend analysis found that there had been a decrease in dissolved reactive phosphorus at Waitangi, which is a positive (improving) trend and an increase in dissolved oxygen concentrations (mg/l), which is also a positive trend (**Table 16**). No other trends were found.

Table 16 Water quality trends at Waitangi 2009-2012.

Parameter	Trend
Dissolved oxygen (mg/l)	↑
Dissolved oxygen (%)	**No trend**
Total phosphorus (mg/L)	**No trend**
Dissolved reactive phosphorus (mg/L)	↑
Ammoniacal nitrogen (mg/L)	**No trend**
Nitrate-nitrite nitrogen (mg/L)	**No trend**
Faecal coliforms (CFU/100ml)	**No trend**
Enterococci (MPN/100ml)	**No trend**
Turbidity (NTU	**No trend**
Secchi depth (m)	**No trend**

8.3.5 Sediment Quality Monitoring

In 2010 the council started monitoring metal concentrations in sediment at 16 sub-tidal sites in the Bay of Islands (**Figure 46**). The sediment samples were analysed for sediment grain size and concentrations of total cadmium, total chromium, total copper, total lead, and total zinc. Sediment samples were also collected in 2012 and analysed for the same metals and also for total nitrogen, total phosphorus and ash free dry weight.

All the metal concentrations measured in sediments collected from Waitangi were within the Australian and New Zealand Guidelines for Fresh and Marine Water quality (ANZECC guidelines) in both 2010 and 2012 (**Table 17**) and are not currently at levels which indicate that there may be an issue with metal contamination.

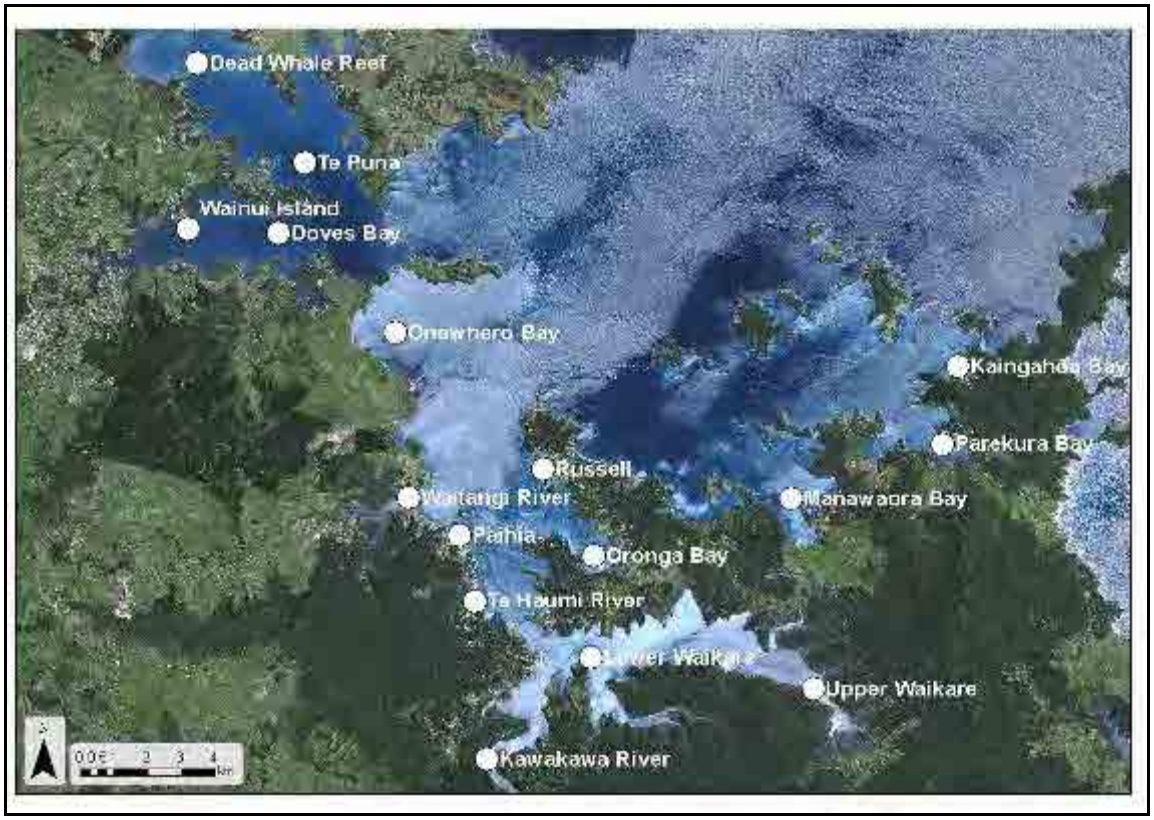


Figure 46 Location of state of the environment sediment sampling sites in Bay of Islands

Table 17 Sediment metal and nutrient concentrations at Waitangi.

	2012	2010	ANZECC
Cadmium (mg/kg)	0.099	0.13	1.5
Chromium (mg/kg)	12	9.5	80
Copper (mg/kg)	13	6.3	65
Zinc (mg/kg)	50	46	200
Lead (mg/kg)	7.8	6.1	50
Nitrogen (mg/kg)	530	Not measured	No limit set
Phosphorus (mg/kg)	530	Not measured	No limit set
Ash free dry weight	3.6	Not measured	No limit set

8.4 Waitangi Estuary Monitoring

The NRC recently conducted a baseline survey of estuarine ecology and sediment quality within the Waitangi Estuary. The survey will help us to assess the health of representative sites throughout the estuary and provide baseline data, which can be used to track changes in the health of these sites over time.

The survey has been adapted from the “Estuary Monitoring Protocol”, which was developed by Cawthron for use by regional councils. This protocol has been adopted by a number of regional councils and there are now a number of similar estuarine

monitoring programmes throughout New Zealand. The adoption of this standardised method ensures that the results are scientifically credible and comparable with those collected across New Zealand.

This survey involved analysing the sediment to determine the sediment grain size (the proportion of sand and mud), the concentrations of metal contaminants (copper, zinc, lead, cadmium, nickel and chromium) and nutrient levels (nitrogen and phosphorus). In addition the estuarine animals that live in the sediment, such as cockles, pipis and crabs were identified and counted. This will enable us to relate the health of the sediment (the habitat) to the ecological communities present in the estuary.

In 2013, Northland Regional Council (NRC) sampled 10 sites throughout the Waitangi Estuary in order to survey the sediment quality and ecological status of the estuary. This survey will also provide baseline data to track changes in the health of the estuary over time. This survey involved analysing the sediment to determine the sediment grain size (the proportion of sand and mud), the concentrations of metal contaminants (copper, zinc, lead, cadmium, nickel and chromium) and nutrient levels (nitrogen and phosphorus). In addition the estuarine animals that live in the sediment, such as cockles, pipis and crabs were identified and counted.

All of the metal concentrations were well below the ANZECC ISQG-Low effect trigger values and the threshold effect levels developed by MacDonald et al. (1996). This suggests that the concentrations of metals in the estuary are unlikely to be having an adverse effect on the ecology. However, concentrations of nutrients were generally higher than levels recorded in other Northland estuaries. Using criteria developed by Robertson and Stevens (2007), six sites were classified as enriched for total organic carbon (TOC), one site was classified as enriched for nitrogen and eight sites were classified as enriched for phosphorus.

The species identified in the Waitangi estuary appeared to be similar to other sheltered tidal creek estuarine environments surveyed in Northland. The most abundant taxa were oligochaeta worms, and the polycheata worms Prionospio aucklandica, Cossura consimilis, Paraonidae and Capitella capitata. Bivalves were the other main taxonomic group found with the invasive window shell Theora lubrica and the cockle Austrovenus stutchburyi the most abundant taxa.

A distance-based linear model (DISTLM) was used to model the relationship between the ecological data and the sediment data. The DISTLM showed that nitrogen, fine sand, coarse sand and zinc all had a significant relationship to the intertidal ecological community structure. This suggests that the sediment characteristics measured in this survey have influenced the ecological community.

The results from this programme should provide resource planners, politicians and the public with information regarding the health of the Waitangi estuary, identify environmental issues impacting this system and enable informed decision making relating to human activities and land use which impact the estuary.

Figure 47 Waitangi Estuary estuarine ecology and sediment quality survey site locations

8.5 Summary of coastal water quality

Coastal water quality has been monitored since at Waitangi 2008.

- Faecal indicator bacteria concentrations in the water at Waitangi were generally below guideline values.
- Nutrient concentrations in the water generally exceeded guideline values. The trend analysis found that there had been a decrease in dissolved reactive phosphorus and an increase in dissolved oxygen concentrations (mg/l) at Waitangi, which are both positive trends.
- All the sediment metal concentrations measured in sediments collected from Waitangi were within ANZECC ISQG low trigger values in both 2010 and 2012 and are not currently at levels which indicate that there may be an issue with metal contamination.

9 Consented Discharge And Land Use Activities In The Waitangi Catchment

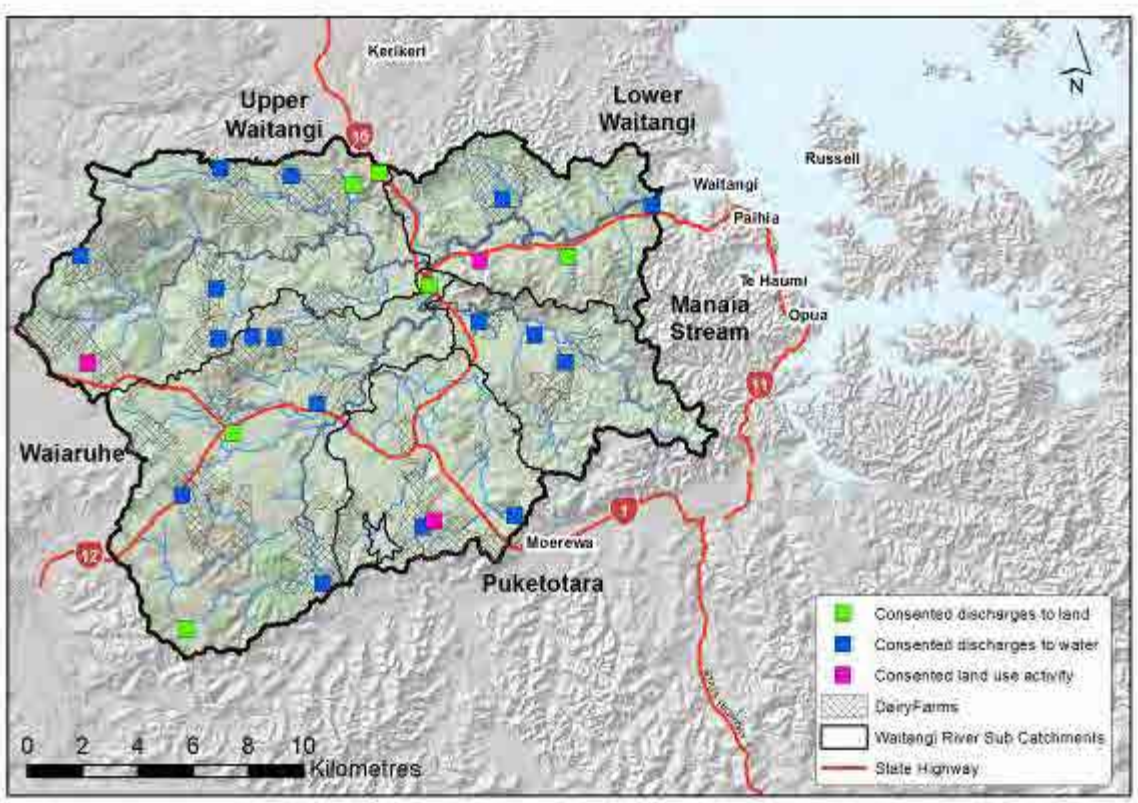


Figure 48 Consented discharges and land use activity

There are 29 consented discharge and land use activities within the catchment which are broken down into three groups:

- discharges to land;
- discharges to water; and
- land use.

Of the discharges to land five are treated human effluent and two are industrial discharges (Mt Pokaka Timber Products Ltd and the Ngawha Geothermal Company Ltd).

Discharges to water include 16 consented Farm Dairy Effluent discharges (discussed below), an industrial and a water discharge.

The NRC has granted land use consents for three quarries:

- Puketona Quarry – Transfield Services (NZ) Ltd;
- Bulman Road Quarry - E J Reed & Company Ltd; and
- Smith's Road Quarry – Owhareiti Farms Ltd.

See section 9.5 Mineral extraction activities for discussion that includes these quarries. Nevertheless, the likelihood of these having significant adverse effects on water quality is considered low.

Gravel extraction also occurs sporadically at two sites within the catchment (Lily Pond and a Top Energy site at Puketona).

Consent was also granted in September 2013 for works involving gravel extraction that are located at a site off Wharf Road immediately down stream of Haruru Falls. The proposed works involve an initial (capital) dredging of up to 10,000m^3 of gravel and periodic maintenance dredging as needed thereafter (up to 7,500 m^3). While some of this material may be used to replenish a gravel beach on the river banks, a large proportion is likely to be extracted and mostly consists of silts and grits. This may therefore reduce downstream erosion and build-up of sediments in the Waitangi Estuary.

9.1.1 Farm dairy effluent compliance

Compliance monitoring records from 2013/14 found that of the 26 active farms in the compliance was as follows:

Fully compliant – 12
Non-compliant – 8
Significantly non-compliant – 6

All the significantly non-compliant farms have had follow up inspections and actions agreed.

There was one farm which was temporarily out of supply, but is now active again.

There are also 11 dairy farms in the catchment which operate under the permitted activity criteria in the Regional Water & Soil Plan for Northland. These farms all dispose of all effluent to land.

9.2 Permitted water take activities

The Regional Water and Soil Plan for Northland (RWSP) provides rules for the taking and use of water without consent. In the Waitangi River catchment these rules permit the taking of water for reasonable domestic and stock drinking uses. In addition 10 m^3/d of water may be taken for any purpose (refer to Section 24 of the RWSP).

Permitted water use for stock drinking and non – consented dairy use in the Waitangi catchment is estimated to be 1201 cubic metres per day (m^3/day), based on stock numbers and allowing for drinking water and dairy shed washdown. Based on land use capabilities it is estimated that 1149 m^3/day is taken for other types of stock use . Additional water may also be taken for domestic use.

The majority of permitted water takes within the Waitangi River catchment are for stock drinking water.

An estimate of water use that has been accepted by the Environment Court for a dairy shed is 70 litres of water per cow per day for milk cooling and shed wash-down. Based on this, dairy farms with an average herd size of 143 cows or more may exceed the permitted take volume of 10 m^3/d and therefore should have a resource consent.

9.3 Consented water takes

There are 23 water takes within this catchment that have resource consents, being 19 surface water (including 4 dam/weir and takes), 3 groundwater, and 1 geothermal water take. These range in purposes from pasture / horticultural /recreational irrigation, geothermal electricity and public and private drinking water.

A list of all consents is provided below:

Table 18 Water take consents within the Waitangi Catchment

NRC Ref. Number	Who	What	Purpose	Daily take (m^3)
201001	FNDC	SWT	Drinking - Public Water Supply	4233
488307	Ngawha Geothermal	SWT	Electricity - Geothermal	3000
488323	Ngawha Geothermal	SWT		3000
488309	Ngawha Geothermal	SWT	Electricity - Geothermal	1726
507601	Mr G T Stanners	SWT	Irrigation - Pasture	1470
488311	Ngawha Geothermal	SWT	Electricity - Geothermal	864
2868801	Kauri Point Farm Park	SWT	Irrigation - Horticulture	288
1719901	Ohel Orchard	SWT	Irrigation - Horticulture	180
120002	BOI Holiday Park	SWT	Drinking - Private Domestic W/S	150
186901	Mr A S Menary	SWT	Irrigation - Horticulture	87
742201	P A Curtin	SWT	Irrigation - Pasture	50
1752001	Mr P J Hendriksen	SWT	Irrigation - Horticulture	25
104701	Puketona Properties	SWT	Drinking - Private Domestic W/S	20
244801	Okaihau Golf Club	SWT	Irrigation - Recreational/Sports	20
291701	G B Phillip	SWT	Irrigation - Horticulture	20
399101	Mr S C Hutton	GWT		100
275001	P B Milsom	GWT	Irrigation - Horticulture	75
1545901	Mr H Z Park	GWT	Irrigation - Horticulture	43
467606	Kerikeri Irrigation	DWT	Drinking - Public Water Supply	53568
467602	Kerikeri Irrigation	DWT	Drinking - Public Water Supply	22464
488312	Ngawha Geothermal	DWT	Electricity - Geothermal	8640
511302	Wiroa Holdings/ Baxter	DWT	Irrigation - Pasture	3430
488301	Ngawha Geothermal	Geo	Electricity - Geothermal	0

SWT = Surface Water Take, GWT = Groundwater Take, DWT = Dam Water Take, Geo = Geothermal Water Take

The above table is arranged in take type with the each take ranked in ascending order from the largest to smallest daily take volume.

The largest 6 ‘active’ water takes are those shaded in grey in **Table 18**.

A brief description of each consent is provided below, along with a location map of the point of take within the catchment.

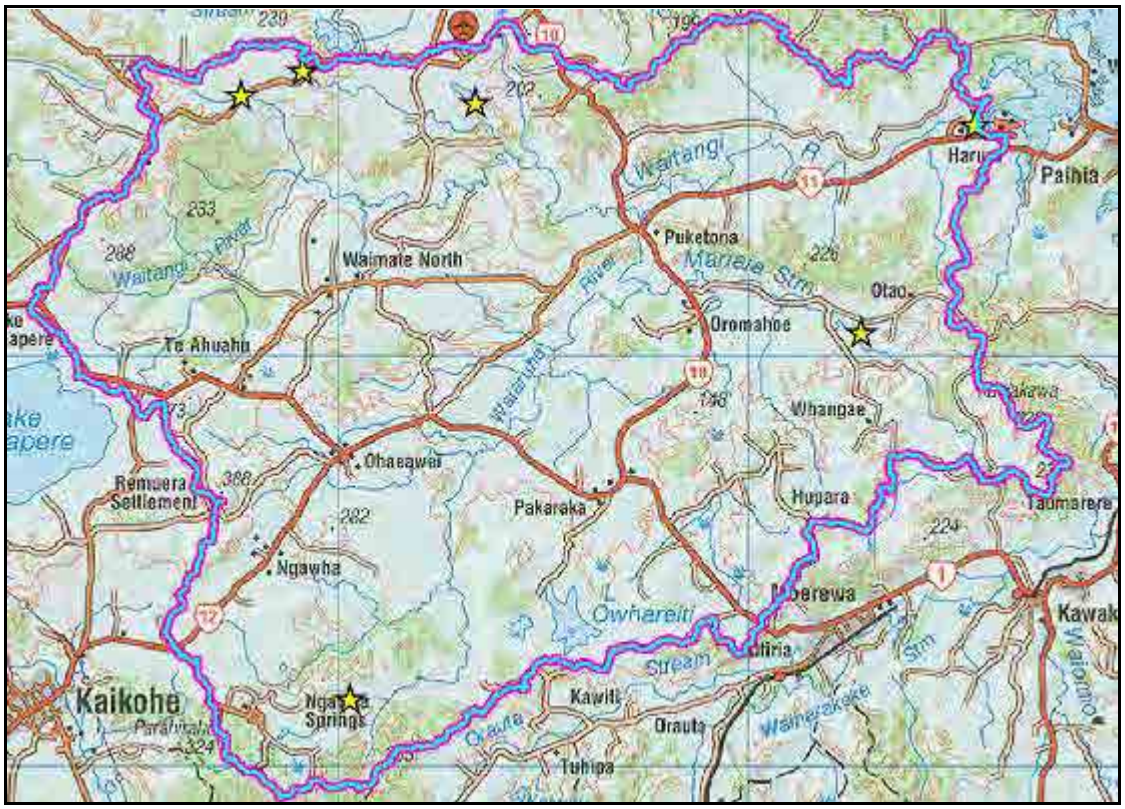


Figure 40 Locations of the six largest 'active' water take consents in the Waitangi River catchment

Of the two major surface water takes, a maintenance flow has only been imposed on one of these, being that one to the south east of the catchment (Stanners). It was considered unnecessary to impose a maintenance flow on the other (FNDC) take due to its proximity to the falls and its relatively small size compared with the flow of the Waitangi River at this point.. It is noted that the Stanners consent has a step reduction condition imposed, meaning that abstraction rates are restricted (decreased) with reduced flows.

The cumulative take within the catchment equates to approximately 6543m^3/day (75.7 l/s) at the top of the falls, just below the lowest take point.

This comprises the two major surface water takes (5703m^3/day) plus the additional minor surface water takes not addressed within this report (840m^3/day). This does not take include the dam takes, which have been calculated to increase this cumulative take by 26.6m^3/day (0.3/s).

9.4 River management – liaison committee and gravel extraction

River management plans have been developed by Northland Regional Council for the 27 river catchments identified as having the highest flood risk in Northland through the council's priority rivers flood risk reduction project. The river management plans are being used to guide the prioritisation and implementation of river flood risk reduction measures. The Waitangi River is one of these 27 rivers.

Submissions on the council's 2011/12 annual plan requested formation of a Waitangi River liaison committee. The committee was established in 2011 and consists of Council Rivers Team Staff, a regional councilor and public who attend meetings to discuss Waitangi River management and the Waitangi River Management Plan.

The Waitangi River Management Plan covers the following:

- Catchment description/soil conservation
- Flood modelling and mapping
- Flood risk management
- Flood risk reduction options

There are three consented gravel extraction sites associated with the Waitangi catchment:

- Capital and maintenance dredging (involving volumes of up to 10,000m^3 and 7,500m^3 respectively) for navigation channel maintenance, flood and erosion control, and beach replenishment in the Waitangi River adjacent to Old Wharf Road, Haruru Falls (Resource Consents AUT.029683.02.01 and AUT.029683.03.01) granted 3 September 2013.

9.5 Mineral extraction activities

Minerals are important natural resources being used for a range of agricultural, building and infrastructure purposes. They are by their very nature non-renewable and limited in their distribution. The fixed locational nature of minerals means that consideration needs to be given to land uses which may restrict or prevent their utilisation.

Northland has a well-established aggregate industry which serves not only the region but also the Auckland metropolitan area. The region's greywacke and volcanic rocks serve as a source of aggregate. Limestone is also extracted for producing cement and agricultural lime.

Mineral production statistics indicate that around 2.3 million tonnes of building and roading aggregate and sand is produced annually in the region. Puketona Quarry is one of approximately 6 in the region that regularly produce between 100,000 and 500,000 tonnes annually. There are two quarries that exceed this range (located in the Brynderwyn's) and the remaining produce less than 100,000 tonnes annually.

The extraction of land based minerals generally involves disturbance to the landscape. Such operations can also have significant effects on water and other natural resources.

The five main quarry sites within the catchment mostly coincide with scoria cone sites as can be seen by comparing the three consented land use activities (quarries) with scoria cone locations (Figure 4). The largest is Puketona quarry adjoining State Highway 11 from which both greywacke and basalt are extracted. Largely due to the scale of this quarry and proximity to the Waitangi River, there is moderate potential for sediment discharge, however monitoring records indicate compliance with consent conditions and a low likelihood of more than minor adverse effects on water quality.

With the exception of Smith's Road scoria quarry, the remaining quarries (Hupara, Bulman Road and Baxter quarries) extract basalt. All four of these quarries are either inactive or operating within permitted activity rules under the Regional Water and Soil Plan for Northland. The potential discharge to water from these quarries is either very low or negligible.

Please also refer to 9.4 River management – liaison committee for details of river gravel and silt extraction.

The overall risk of existing quarry sites adversely affecting water quality in the catchment is low.

10 Environmental management

10.1 Iwi environmental management

In the 1800s, more than 100 Maori villages lined the banks of the Haruru River which flows down to the sea at Waitangi. Maori legend says that a taniwha (water monster) lives in the lagoon below Haruru (big noise) Falls.[11]

Within the Waitangi catchment there are considered to be two mandated / recognised Iwi authorities (for the purposes of the 1992 Fisheries Settlement), Ngapuhi and Ngatiwai[12] to whom a number of hapū and marae in the catchment affiliate to.

The following link refers to a map set up under the RMA by central government to show areas associated with iwi http://www.tkm.govt.nz/region/te-tai-tokerau/.

Of these iwi and hapū, five have compiled environmental statements or plans:

- Ngatiwai (takes in Waikare inlet)
- Ngati Hine – takes in most of the catchment
- Kororareka – takes in most of catchment
- Ngati Kuta (Rawhiti) – takes in inner harbour out to Cape Brett
- Ngati Rehia – from Kerikeri down to Waitangi

An Iwi/hapū/whānau environmental management plan is a vision of how the management and protection of the natural and physical resource can be achieved based on cultural and spiritual values of tangata whenua[13].

Maori have a living relationship with freshwater that is founded in the respective cultural values of each iwi and that has spanned, and will continue to span, the full breadth of cultural, environmental, social and commercial interests.

Providing for Te Mana o te Wai requires maintaining the integrity and mana of the water resource (and consequently all connected resources including land). For Māori and many in the community, this is a primary outcome for managing water and is seen as an overriding goal.

Māori have a close relationship with their ancestral lands and resources which comes from their belief in a common origin (people and resources). They take a holistic approach to managing the environment including natural resources..

This relationship is depicted by Ngati Hine in their environmental management plan, Ngā Tikanga mo te Taiao o Ngati Hine;

"..To Ngati Hine water, soils, minerals and air are all integral elements of the life-supporting nature of the environment. Water, soils, minerals and air must be considered in conjunction with all living things as everything is

[11] New Zealand Northland First web site
[12] Refer to http://www.tkm.govt.nz/region/te-tai-tokerau/ for maps of mandated iwi authorities
[13] Mfe (2000) Te Raranga A Mahi

interconnected…..Ngati Hine recognise that the quality of the water, soil and air is the fundamental basis for the quality of the environment, therefore it is imperative that these elements are sustainable management in an integrated manner" [14]

Likewise, the Kororareka Marae Environmental Management Plan also reflects this common whakapapa and interconnectedness

"…E hono ana ngā mea katoa"

"all things, including humans, are connected and interdependent in the Māori world"[15]

For Ngati Hine in particular, they say that water holds special significance for them. That it is a living entity and that everything comes from water. [16] They explain this further;

'…*Water, in all its many forms – rain, springs, wetlands, streams, lakes, estuaries and the sea itself – is central to our existence as Ngati Hine, It is used to feed, sustain, transport, cleanse and purify all those that inhabit our ecosystems including people. Significant puna were named, some were tapu, some were associated with pa, and some were association with gardens. Ngati Hine history, strength and mana steam from water –water is a sacred resource and a toanga.'*[17]

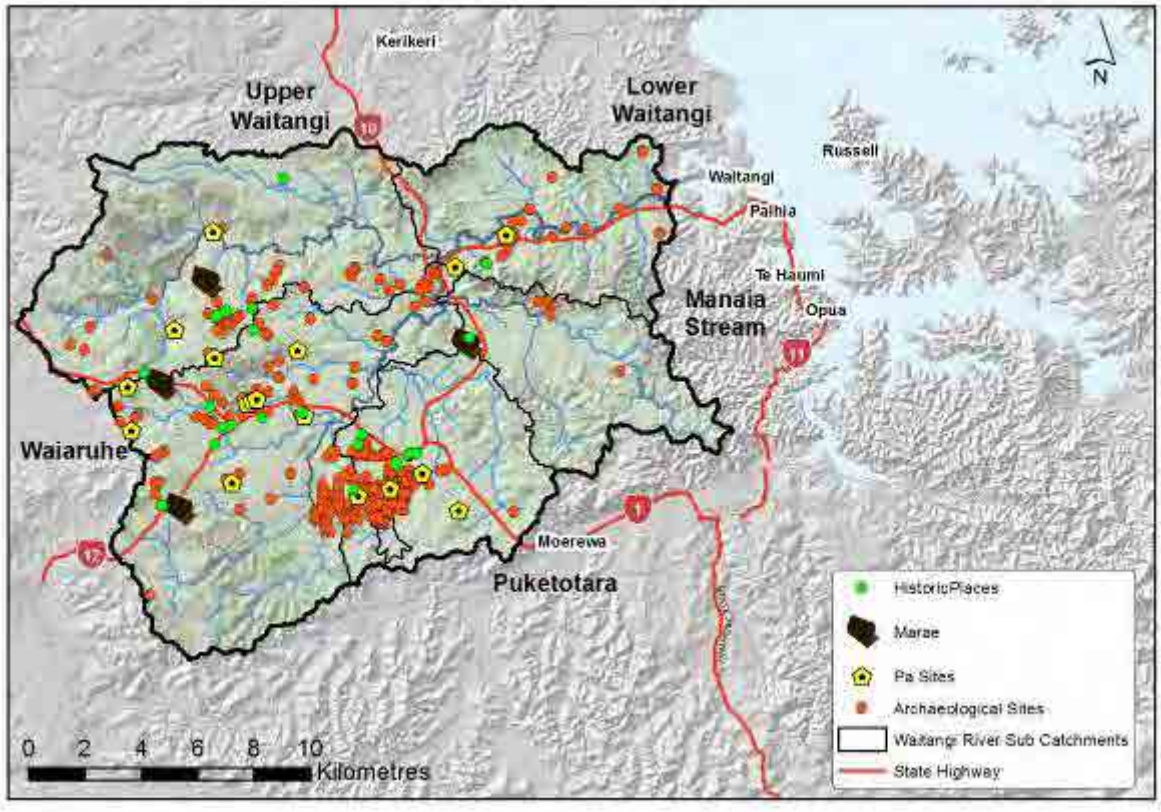


Figure 41 Waitangi catchment marae, pa and archaeological sites

[14] Ngā Tikanga mo te Taiao o Ngati Hine (Ngati Hine Environmental Plan 2008) pg 33
[15] Kororareka Marae Environmental Plan pg 5
[16] Ngā Tikanga mo te Taiao o Ngati Hine (Ngati Hine Environmental Plan 2008) pg 32
[17] Ngā Tikanga mo te Taiao o Ngati Hine (Ngati Hine Environmental Plan 2008) pg 32

Main marae in the wider area and receiving environment (there may be additional interested groups) include:

Waitangi Te Tii (Waitangi)
Kororareka (Russell)
Waikare – Waikare
Karetu – Karetu
Rawhiti – Cape Brett

10.2 Farm water quality improvement plans

Farm Water Quality Improvement Plans (FWQIPs) help Northland Regional Council promote sustainable land management and reduce the impact of land use on water quality.

Given the number of farms in Northland and the number of rivers for which water management plans must be prepared under the National Policy Statement for Freshwater Management 2011, three priority catchments are being initially targeted – Whangarei Harbour, Mangere Stream and Waitangi River. Two Land Management Advisers have been assigned to each priority catchment since October 2012. These staff and other Land Management Advisors also provide advice over the rest of the region.

In support of Fonterra's programme requiring landowners to fence streams, install culverts, prevent runoff from races into streams and to fence off regionally significant wetlands, letters were sent out in December 2012, first to dairy farmers. The letter briefly explained the service the Council can provide and how; should the landowner so request, a FWQIP could be prepared for their property. This letter has been followed up by a phone call.

Because all Environment Fund grants are now being made only within the context of FWQIPs, landowners with projects approved before the FWQIP process began, are now being invited to have a FWQIP completed for their entire property.

As of June 2014, 16 FWQIPs have been completed within the Waitangi catchment and a further four are in progress.

10.3 The New Zealand Landcare Trust

The Landcare Trust is two years into a three years project based in the Waitangi catchment that aims to:

- Improve water quality in the river and the receiving environment through encouraging farm-based actions to reduce contaminant run-off from productive land and where possible increase the biodiversity values on private land; and
- Enhance farm and catchment-scale resilience to climate change and associated adverse weather events through encouraging farm-level strategies; and
- Optimize production and farm profitability through the provision of expert information (in partnership with farm owners).

For more detail see http://www.landcare.org.nz/Regional-Focus/Whangarei-Office/Waitangi-River-Project.

10.4 Waitangi River liaison committee

Regional Council established the Waitangi River liaison committee as a tool to both mange flood risk and engage with the local community.

New maps showing the likely extent a “one in a century” flood would have on the Waitangi catchment have been released by the Northland Regional Council.

The maps are part of the Regional Council's Priority Rivers Programme, which focusses on reducing flood risks, raising awareness of where flood hazard areas are and helping inform public and district council decision-making.

Information about flood mapping and how to use council's website is available at: www.nrc.govt.nz/floodmaps.

10.5 Living Waters

Living Waters is a group of volunteers and professionals within a Charitable Incorporated Society formed in 2006. In April 2011, the previous working title of "BayCare" for the group was dropped and the group name "Living Waters Bay of Islands – Wai Ora" was adopted.

It covers the wider Bay of Islands catchment and also focuses on specific rivers. In the greater Bay of Islands catchment Living Waters supports interested and engaged landowners into waterway and watershed restoration and resilient land management.[18]

http://livingwatersboi.org.nz/riparian-restoration-bay-of-islands.html

[18] Living Waters website

11 Regional Council Initiatives

Northland Regional Council monitors and provides advice, incentives and regulations to protect our environment while balancing the economic needs of the community. Ultimately, the state of the environment is determined by the people who live in and use it. Ongoing monitoring helps the council to keep abreast on what's happening to the environment but it's a joint effort, and council looks forward to continuing to work with communities to set and meet environmental expectations.

11.1 Education

The Enviroschools programme is available to all schools in Northland and is funded by and operated through the Northland Regional Council, with support from The Enviroschools Foundation and the Department of Conservation.

In Northland, 70 schools and three kindergartens are currently on the pathway towards creating sustainable communities. They are all working at their own pace to achieve a range of sustainability actions.

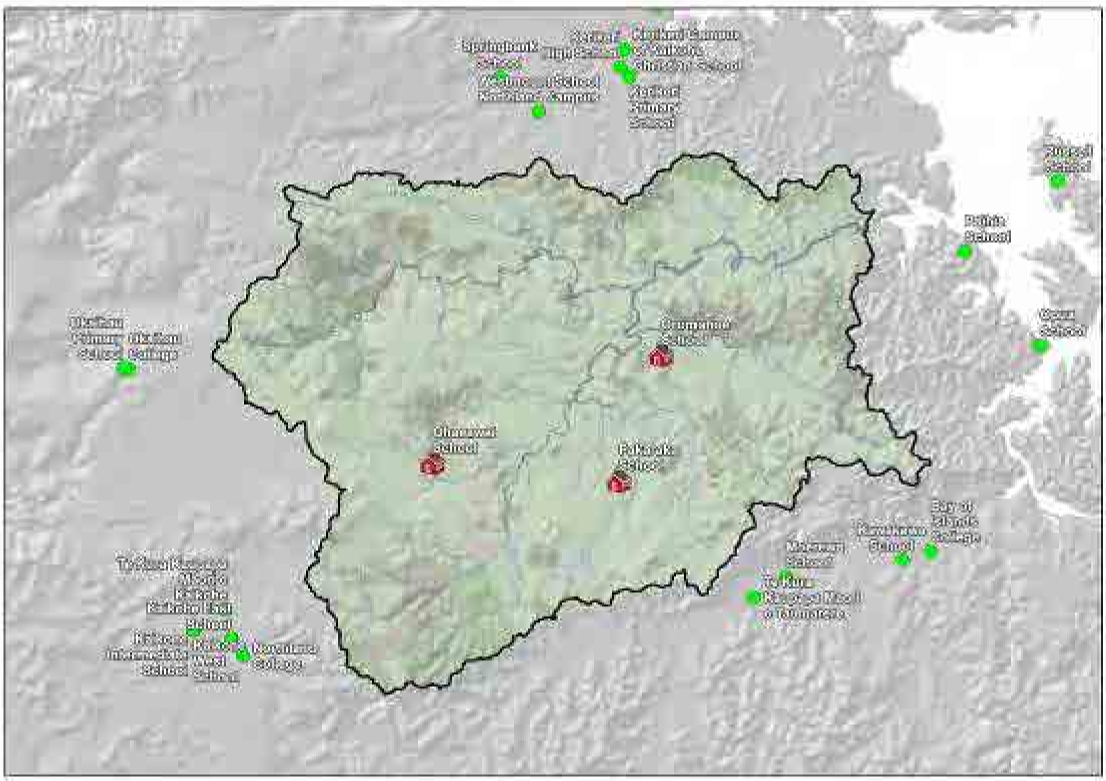


Figure 52 Schools within the Waitangi River catchment and surrounding area

The following schools have been involved in water quality themed work within the Waitangi River Catchment and have also received support through facilitation, resources, professional development and a nationwide network of schools:

- Ohaewai School – Taiamai Frogs project to help restore native frogs to local waterways.

- Pakaraka School – Planted about 120 native trees and flax along the school's southern boundary to add to the district's reduced native vegetation habitats and to form a critical stepping stone for native birds that feed in the district (also working in with the efforts of the local Hupara District Landcare Group to increase local biodiversity).
- Oromahoe School – Wai Restoration project participant and currently involved in year-long waterways investigation and monitoring programme on the adjacent farm, with a long term goal of growing riparian plants in schoolground shadehouse for planting out along local waterways.

11.2 Environment Fund

The Northland Regional Council Environment Fund has provided around $4 million to help people enhance and protect Northland's natural environment since 1996.

The Regional Council recognises the effort and commitment that Northlanders are putting into addressing their environmental issues and the continuation of funding reflects this. The fund is provided through five different funding streams with projects funded at up to 50% of their total costs.

The following Priority Funding Streams have been identified to ensure that recipients of funding are proposing activities aligned with Regional Council Land Management priorities:

Soil conservation – Targeting the maintenance and control of erodible soils, e.g. erodible land soil stabilisation via tree planting, fencing to exclude stock, pest control and other suitable means.

Biodiversity – targeting the restoration and protection of wetlands and lakes, e.g. fencing to keep out stock, riparian planting, pest control.

Coastal – targeting the restoration, protection and maintenance of estuaries, dunes and salt marsh, e.g. the planting of spinifex and pingao for dune stabilisation, pest control, fencing to exclude stock and riparian planting.

Water quality – targeting dairying and clean stream accord targets, dry stock exclusion from waterways and similar projects within recreational bathing site catchments e.g. fencing to exclude stock from waterways, riparian enhancement.

12 Conclusions

12.1 Freshwater summary

While current monitoring results rank freshwater water quality as 'good' at both sites the Waitangi does have problems with some aspects of water quality (particularly in higher rainfall-runoff conditions) and ecological health.

The main water quality issues are sediment, bacteria, and nitrogen levels. . Typically water quality is better upstream than downstream due to increasing levels of runoff the further downstream you go. However, in the Waitangi, water quality is slightly better at Watea (downstream) than Waimate Road (upstream). This could be due to tributaries from the southern sub-catchments (Waiauhe, Puketotara and Mania sub-catchments), which join the Waitangi River between the two sample sites, and may provide a dilution effect.

The monitoring sites consistently score river habitat as marginal due mainly to sediment deposition, stock access little riparian cover. The invertebrate indices are consistent with the marginal habitat, indicating that Waitangi River is in a degraded condition, particularly due to high levels of sediment in the substrate, smothering available habitat and food sources.

Haruru Falls creates a significant barrier to fish migration in the catchment with only good climbers and non-migratory species found upstream. There is a moderate diversity with records of six native fish species (longfin eel, shortfin eel, crans bully, common bully, banded kokopu and northland mudfish), koura (freshwater crayfish) and three introduced pest fish species (gambusia, rudd and tench). Northland mudfish are acutely threatened and only found in Northland in a restricted area near Kerikeri therefore this population is of particular significance.

In general, the monitored swimming spots at Lily pond and Waitangi Bridge are suitable for swimming most of the time but can occasionally exceed the suitability for swimming guideline, especially after rainfall.

Based on monitoring results, particularly regarding river habitat and invertebrate indices, sediment is likely to be the main contaminant influencing water quality (including associated nutrient and bacteria levels) within the catchment and receiving environment.

The Bay of Islands 20/20 report found that the current sediment deposition rate is approximately ten times that of pre-colonisation. Analysis of present day sediment sources, using the compound specific stable isotope method, indicates that pasture farming land is the source of more than 60% of the sediment entering the Bay of Islands.

12.2 Marine / Receiving environment summary

Faecal indicator bacteria and sediment metal concentrations in the water at Waitangi are generally below guideline values.

Nutrient concentrations in the water generally exceed guideline values. Recently a positive trend has been identified that shows a decrease in dissolved reactive phosphorus and an increase in dissolved oxygen concentrations (mg/l) at Waitangi

River long term monitoring site.

Sediment monitoring of nitrogen in Waitangi indicted the sediment is ‘low to moderately enriched’ and monitoring of phosphorus indicated the sediment is ‘enriched’.

Waitangi catchment is likely to be the primary source of deposited sediment within the Waitangi Estuary while sedimentation effects beyond the Waitangi Estuary are not without significance.

APPENDIX 1 FURTHER SOURCES OF INFORMATION

1 Northland Regional Water and Soil Plan

2 Northland Regional Coastal Plan

3 Northland State of the Environment Report

4 Northland Lakes Strategy

5 Northland Wetlands Strategy

6 Intertidal and subtidal habitats of Waitangi River

Websites

1. www.nrc.govt.nz/waiora
2. www.qualityplanning.org.nz

APPENDIX 2 MAORI CULTURAL VALUES AND FREQUENTLY USED TERMS

To Iwi/ Maori, wai (water) in all its forms is descended from Papatuanuku and Ranginui. Tangata whenua value water for the life giving force it is and for food resources it provides, including watercress, eels (tuna), and whitebait. Awa (rivers) represent the tupuna (ancestors) of the tangata whenua. Water and river therefore have their own mana (integrity). Water also has its own life force (mauri) and spirit which are linked to mana. Spiritual qualities (mauri and wairua) can be adversely affected by the taking, use or diversion of water and discharges of contaminants to water[19].

Te Mana o te Wai is a value that represents the innate relationship between te hauora o te wai (the health and mauri of water) and te hauora o te taiao (the health and mauri of the environment), and their ability to support each other, whilst sustaining te hauora o te tangata (the health and mauri of the people).

Some common cultural values[20] and term associated with freshwater include:

Cultural health index – see Ministry for the Environment document 'A Cultural Health Index for Streams and Waterways: A tool for nationwide use' [21]

Kaitiakitanga – The obligation of Iwi/ Maori to be responsible for the well-being of the landscape. This is inter-generational in nature. Kaitiakitanga has been given effect over the generations in many ways and differs amongst iwi and across differing circumstances.

ki uta ki tai (mountains to the sea) - Maori holistic philosophy for looking after water resources.

Mahinga kai – food gathering places

Maoritanga – Water bodies and water ways frame Iwi/ Maori identity – tribal traditions are transmitted across generations by continuing customary practices with water bodies and visions for the future of iwi turn on the health and wellbeing of freshwater.

Mauri - The obligation is to protect freshwater and to maintain its ecological bio diversity and express the spiritual connectedness with freshwater so as to leave a worthy inheritance for future generations is fundamental to iwi/ Maori.

Rimurehia - New Zealand seagrass (Zostera muelleri)

Taonga – Freshwater is recognised by iwi as a taonga of paramount importance.

Te Mana o te Wai - a wide-ranging value or outcome that covers the health of the people, the environment, and the water body itself. The value encompasses, but is not exactly translated by, concepts such as ecosystem integrity and natural state.

Whakapapa - The relationship between iwi Māori and freshwater is founded in whakapapa, which is the foundation for an inalienable relationship between iwi and freshwater that is recorded, celebrated and perpetuated across generations.

Wai – river, creek, water
Wai maori – Freshwater, mineral water

[19] NRC (2007) State of the Environment Report
[20] Witana A (2013) Default Regional Cultural Values and Uses paper
[21] http://www.mfe.govt.nz/publications/water/cultural-health-index-for-streams-and-waterways-tech-report-apr06/cultural-health-index-for-streams-and-waterways-tech-report-apr06.pdf

Wai ora – healthy, sound water
Wai mate – slack, spiritless water
Wai takoro – Recreation
Wai whakaika – ritual waters where rites are performed.
Wai tapu – scared water, restricted access and or uses

APPENDIX 3 EROSION SITES

Plate 1: Ngawha gullies – area outlined in blue. The meandering section of river alongside Bedggood's property and opposite Puketona junction through which sediment from the Ngawha gullies has been deposited but is now being re-worked by streambank erosion.

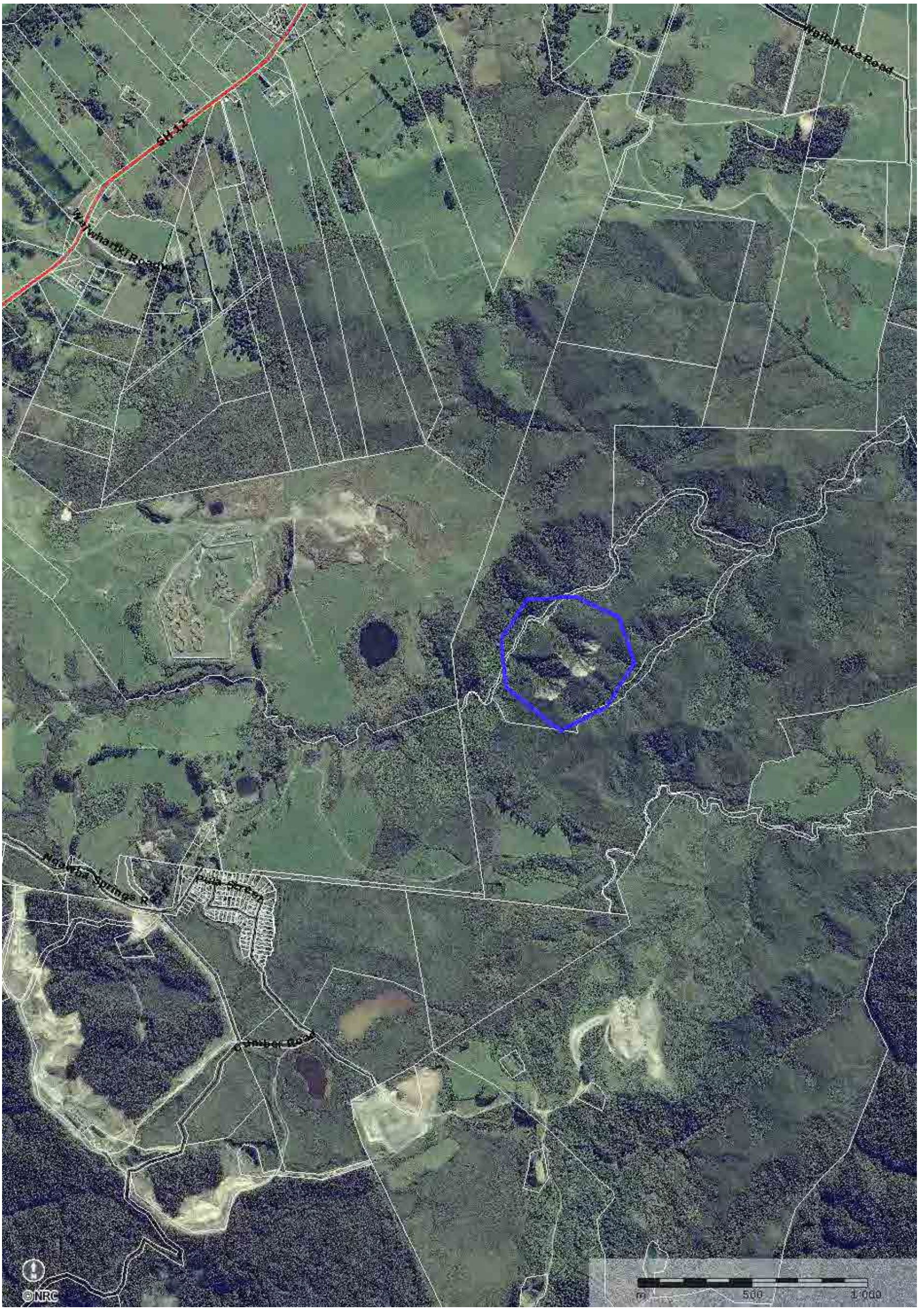
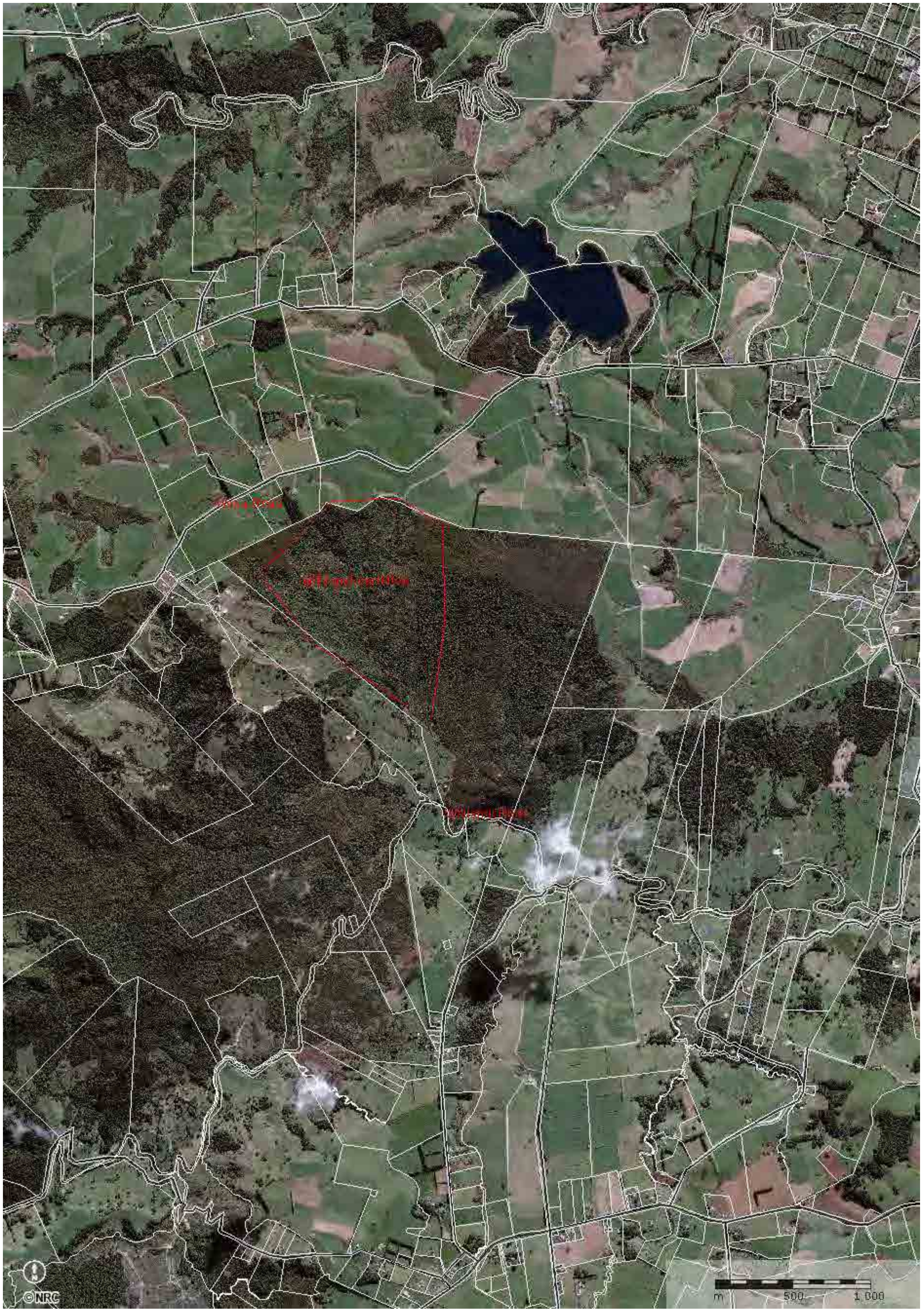


Plate 2: Ngawha gully erosion – circa 1973 (For scale note the two seated figures at the base of the gully)

Plate 3 - The large gully and associated landslides northeast of Waimate North, which is now the largest source of sediment in the Waitangi River catchment.



WAIORA NORTHLAND WATER

NORTHLAND REGIONAL COUNCIL

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