# **10 - SURFACE WATER QUANTITY**



# **Summary**

# **RPS** Objectives

- The maintenance of the flows and levels in significant streams, rivers, lakes and wetlands to preserve their natural character and to protect high ecological, cultural or scenic values.
- The maintenance of water flows and levels in natural water bodies that are sufficient to preserve their life-supporting capacity, natural character, intrinsic values and associated or dependent values.
- The efficient use and conservation of water resources.
- To protect property and other values from adverse effects due to the diversion of water from its natural drainage pattern.

# Pressures

- Northland's water resources are under increasing pressures to meet demands from a variety of consumptive users including agriculture, horticulture, public and private water supply and industry sectors and the effects of land use change.
- Surface water takes, both consented and permitted, affect water flows. There is an increase in the number of permitted takes in Northland, as well as a large number of 'permitted' takes that are likely to exceed the volume allowed in the permitted activity rules.
- Currently there are 381 consents allocated up to 500,000 m<sup>3</sup>/day of water from streams, rivers and dams in Northland (excluding diversions). A review of consented water takes indicates many catchments in central and southern areas of Northland are highly allocated.

# State

- Annual rainfall ranges from 900mm in low-lying coastal areas to over 2900mm at higher altitudes.
- Flows vary greatly between catchments, which can be largely attributed to rainfall patterns, catchment size and catchment geology. In Northland, catchment geology greatly influences low flows during drought conditions.
- Northland's climate is such that it will experience a regional drought, on average, once every three years at east coast and inland locations, and once every four years at west coast and high altitude locations.

# **Doing well**

- The Regional Water and Soil Plan contains policies relating to the maintenance of flows and levels in water bodies.
- The Northland Regional Council (NRC) operates a hydrometric network consisting of 60 sites throughout Northland, which collects continuous data for 30 river level sites, six tidal monitoring sites and 24 rainfall sites.
- During periods of drought, water levels are monitored and when a low threshold is reached a low flow-gauging programme is undertaken in affected rivers. The NRC holds more than 11,700 flow-gauging records for 1503 Northland sites.
- New flow measuring equipment, an Acoustic Doppler Current Profiler has improved the council's ability to gather more accurate information on Northland rivers, in both low flow and flood conditions.

# Areas for improvement

- Ensure accurate water metering of consented takes and water use analysis to enable a better understanding of the volume of water abstracted within catchments and the effects on water resources.
- Encourage all water users to register their 'permitted takes' with the Council to enable greater understanding of the 'actual' water taken in catchments.
- Establish design minimum flows (minimum flow required to be maintained) for a greater number of catchments.
- Include in Northland's plans maximum total volumes allocatable for water bodies in Northland, to provide water use securities for users and sustainable allocation of water resources. Also include rules to ensure assessment of cumulative effects of subdivision on water resources.

# **10.1** Introduction

The Northland Regional Council has responsibilities under the Resource Management Act 1991 (RMA 1991) to control water use, and to monitor the level and flow of water bodies. Successful management of the water resources will stem directly from informed resource management decisions. This can only be achieved from accurate knowledge of the environment itself, including climate, water quantity, present water use and potential demand for water in Northland. The Council may also control the use of land for the purpose of maintaining sufficient water flows for human uses and aquatic life.

Natural water quantities are directly related to rainfall, soils, vegetation and groundwater. Some rain seeps into the ground and becomes part of the groundwater system, while the rest flows over the land to our streams and rivers that discharge into the coastal environment.



The Waipoua River.

# **Regional Policy Statement objectives**

The Regional Policy Statement for Northland (NRC 2002a) contains a range of objectives relating to the quantity of Northland's surface water resources. These objectives seek to maintain flows, conserve water resources, and protect the natural environment from adverse effects.

The Regional Policy Statement (RPS) objectives are:

- The maintenance of the flows and levels in significant streams, rivers, lakes and wetlands to preserve their natural character and to protect high ecological, cultural or scenic values.
- The maintenance of water flows and levels in natural water bodies that are sufficient to preserve their life-supporting capacity, natural character, intrinsic values and associated or dependent values.
- The efficient use and conservation of water resources.
- To protect property and other values from adverse effects due to the diversion of water from its natural drainage pattern.

# **Environmental results anticipated**

The following is the anticipated environmental results after the implementation of the water quantity policies in the RPS:

- Protection of important freshwater habitats, particularly natural wetlands from reductions in surface water and ground water levels.
- Preservation of the natural character, intrinsic, ecosystem and amenity values of natural water bodies to the extent that these depend on water levels and flows.
- Protection of the values of water bodies held by tangata whenua.
- Sustainable and efficient use of the water resources of Northland
- Increased awareness of water conservation and the greater implementation of water conservation practises.
- Minimisation of actual and potential damage to property from damming, diversion and discharge of run off.

# **10.2** What are the pressures on water resources?

# Demand for surface water

Northland's water resources are under increasing pressure to meet demands from a variety of consumptive users. These users include the agriculture, horticulture, domestic water supply and industry sectors. Taking water for these sectors must be considered against the ability of the water to maintain its life-supporting capacity for aquatic life, aesthetic value and the spiritual and cultural value of water to tangata whenua. Lower water levels can result in increased water temperatures, depleted dissolved oxygen levels, increased algal growth and general degradation of water quality. Low water levels also reduce the ability of water bodies to assimilate waste.

Different uses and values are not always compatible, particularly during summer months when there is less water available. To ensure that conflict between the use of water resources and the potential for adverse effects from excessive uses are decreased, efficient use of water must be promoted. Water resources are managed through the RMA 1991, regional plans and resource consent process.

Surface water availability within the region is affected by consumptive water use, including surface water takes, dams and diversions, and culverts and fords. Pressures are also placed on lakes and wetlands, with land use change having an impact on most aspects of water quantity.

There are more consents for surface water takes than groundwater takes in Northland, with a much higher volume of water allocated from surface water as shown in table 1 (below). For more information on groundwater takes refer to the groundwater chapter of this report.

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	Rivers, lakes and springs	Dams	Groundwater
Percentage of consents	46	10	44
Percentage of allocated daily volume (m <sup>3</sup> /day)	50	25	25

Table 1: Source of water allocated in Northland. Note: figures are approximates.

# **Consented surface water takes**

Northland Regional Council requires resource consents for most major surface water takes, with the exception of farm water supplies which have traditionally been authorised as permitted activities. There are 381 consents allocating approximately 500,000 m<sup>3</sup> of water per day from streams, rivers and dams in Northland (excluding diversions). This excludes the Wairua Power Station take, as this is a consent to take, divert and discharge up to 2,592,000 m<sup>3</sup> per day.

Over 60 of these consents are for the expansive Wairua River Catchment as shown in figure 1 (below). This does not include surface water takes authorised as permitted activities under the Regional Water and Soil Plan (RWSP) for Northland (NRC 2007) such as smaller takes for farms, lifestyle blocks and domestic supplies.

The number of consents has decreased by about 35 with a reduction in total water allocated of 60,000 m<sup>3</sup>/day since the 2002 SOE report (NRC 2002b). However, errors in calculating total allocation in 2002 are likely to have occurred due to inconsistent recording of total volumes of water allocated. In addition more efficient allocation has

occurred over the past five years, which is likely to have resulted in decreased 'on paper' allocation. It is important to note that the total allocated does not represent the actual volume of water taken.



Figure 1: Number of surface water take consents in Northland at 30 May 2007 by catchment

The Wairua Catchment has the highest allocation by far with over 140,000 m<sup>3</sup>/day allocated by water take consent as shown in figure 2 (below). This catchment has a mean annual low flow (MALF) of approximately 7600 L/s. Kerikeri catchment has the second highest volume of water allocated at over 50,000 m<sup>3</sup>/day.



Figure 2: Water allocated by surface water take consents at 30 May 2007 by catchment

Many sub-catchments in central and southern areas, particularly in the Wairua Catchment, are highly over-allocated, as shown in red in figure 3 (below).

Figure 3: Percentage of estimated MALF allocated by consented water take for the main sub-catchments (right).

When interpreting figure 3 it is important to consider the following:

 Percentage allocation is based on total consented volume compared to 15% of estimated MALF as recommended by NIWA for assessment of allocation (NIWA. *pers. comm.*). Therefore this allocation assessment has no scientific basis or policy basis for surface water catchment allocation in Northland.



- NRC currently has no policy on total allocation (limit) for surface water resources. Each consent is assessed on a case-by-case basis and conditions imposed to require design minimum flows to be maintained.
- The estimated MALF for many catchments has a large degree of uncertainty due to limited naturalised gauging data.
- Allocation is based on consented surface water takes and dam water takes registered on the NRC database within the catchments specified by NIWA. This does not include consents to divert water, or takes that are allowed for as a 'permitted activity' and therefore don't have consent.

Agriculture is the greatest user of water in Northland as shown in figure 4 (right). However this has decreased over the last five years from approximately 52% to 38% (NRC 2002b).

This water is mainly used for irrigation. Please note figure 4 does not include water taken as a "permitted activity" (reasonable domestic and stock drinking needs), as very few permitted takes are registered with the Council. It also excludes the Wairua Power Station take, as this is a consent to take, divert and discharge up to 2,592,000 m<sup>3</sup> per day.

Figure 4: Total water takes by use, excluding Wairua power station diversion (right).



Horticulture accounts for 34% of the total volume of water allocated. Most of the horticulture activities take place on the fertile volcanic soils near Maungatapere, Maungakaramea, Kerikeri, Aupouri Peninsula and on the sandy clay loam soils on the west coast, near Dargaville.

Water supplies to towns and cities account for 23% of the total allocation of water for Northland. The District Councils are the main suppliers of water, taking from streams, rivers, springs and dams. As increased development occurs near urban and coastal areas, demand for water supply in these areas will increase and additional sources of water will have to be found. Historically and currently some towns are facing problems finding additional water sources to supplement existing supplies, and provide for future development (such as Kaikohe and Russell).

Water use for industrial needs is low, comprising only 4% of total surface water allocation in Northland. Some of the largest water users include dairy factories, meatworks and cement works. Notably, some of the major, and many minor industries in the region utilise urban public water supplies (for example in Whangarei and Kaitaia).

## 'Permitted' surface water takes

Under the rules of the RMA 1991 and section 9 of the RWSP for Northland (NRC 2007) water can be taken from surface water resources provided specific criteria are met.

Under the RMA water may only be taken and used for stock drinking water and domestic purposes "as of right" (S14). Other purposes usually require a water permit. The RWSP has policies and rules controlling, amongst many other activities, the taking and use of water from bores, streams, lakes and dams.

In most catchments surface water can be taken at a rate up to 10 cubic metres per day for any purpose provided specific criteria are met and water user information is supplied to the Council upon request.

It is likely that many farms exceed the daily water take limit to meet the permitted activities rule for their farm water supplies and therefore should have consents for these takes. It is also highly likely that the number of permitted takes has increased significantly over the past 10 years as a result of an increased number of lifestyle blocks.

During the relatively dry summers experienced in 2004 and 2005, several incidents relating to low flows raised awareness of the cumulative effect of many permitted water takes from small streams. During these dry periods reductions in flows in catchments were noted. The cause of these reductions in flows is likely to be permitted takes in the catchments.

The Council currently has no knowledge of the locations and volumes of water taken as permitted takes. The absence of this information is likely to influence consented design minimum flow requirements and sustainable management of the water resources.

## Groundwater

In some areas of Northland, groundwater discharges to the surface as discrete springs and/or along the base of streams. During periods of low rainfall these groundwater discharges are particularly important as they maintain flows within the streams and rivers. This is referred to as groundwater base flows.

The main areas in Northland where groundwater base flow is an important component of surface water flows are the areas surrounding fractured basalt fields such as Whangarei, Kaikohe and Kerikeri. In such areas low groundwater levels result in low groundwater base flows in the streams and rivers.

Where a consent application to take groundwater is likely to affect springs or stream flows, a condition of any subsequent consent granted restricts the groundwater take

during low-flow conditions and ensures that the downstream flows are sufficient to protect existing users and instream values.

For more information on groundwater refer to the groundwater resources chapter of this SOE report.

# Dams and diversions

Northland has an increasing number of dams, of which 144 are consented activities. Dams range in size and purpose. Dams smaller than 0.5 m in depth are primarily used on farms for stock water, and rely solely on runoff for replenishment. Dams greater than 0.5 m and less than 3 m deep are generally used as small storage dams for recreational parks, wetlands, and agricultural needs. Larger dams are used for a range of activities including agriculture, horticulture and public water supply.

Most of Northland's oldest dams were built for municipal water supply. The early 1980s saw the development of the Kerikeri Irrigation Scheme and the creation of two large irrigation dams, associated supply dams and weirs to provide water for horticultural purposes. The occurrence of the 1986-1987 and 1990-1992 droughts prompted the then Northland Dairy Company to promote dam construction for pasture irrigation to dairy farmers.

Dams can affect fish passage, sediment transport, water quality and the natural flow regime.

There are 383 consents for diversions in Northland. Diversions can occur when the existing river channels are straightened, meanders removed, channels created to divert water from the natural watercourse or stop banks are built to contain floodwaters. Despite helping to reduce the impact of floodwaters on life and property, diversions can lead to erosion of river beds and banks, inhibit fish passage, disrupt aquatic environments and affect water quality.

# Land use

Land use changes have had a direct effect on river flow and water balance. Trends in land use over the last 30 years are listed in table 2 (below). Land use trends over the past five to 10 years indicated increased subdivision and urbanisation. Future use trends suggest that this development particularly in the coastal areas and surrounding urban areas are likely to continue.



The cumulative effect of urbanisation increases water demand and, where development is not supported by a reticulated water supply, there is the potential for an increase in the number of small ('permitted' takes).

Urbanisation also changes the flow regime for both surface and groundwater by increasing runoff into surface waters and decreasing recharge to groundwater.

Land use change	Effects
Countryside to urban	<ul> <li>Changed hydrological flow regime</li> <li>Potential increase in stormwater runoff</li> </ul>
	Potential increase in stormwater runoi     Potential for increased water demand through "permitted takes"
	<ul> <li>Potential for increased contamination of water resources</li> </ul>
	<ul> <li>Potential for decreased recharge of groundwater aquifers</li> </ul>
Pasture to scrub/weeds	• Water yield expected to decrease slowly until similar to a natural scrub, then bush catchment
Pasture and	<ul> <li>Water yield expected to decrease</li> </ul>
scrub/weeds to pines	<ul> <li>Frequency of bank-full flows decrease</li> </ul>
	<ul> <li>River regimes adjust to a lower supply of sediment from the land</li> </ul>
	• Observed increases in stream bank erosion as rivers adjust from a "pastoral stream" to a "bush stream". Expected to stabilise in a new regime after 20+ years
Intensifying of land use on pastoral land	• Land grazed more intensively, but can be improved by pasture management to offset any effects of heavier stocking (increased rate of sediment runoff following pugging, compaction and reduced infiltration).
	• More surface and subsurface drainage, smoothing of paddocks during cultivation and fodder crop rotation to reduce water ponding, all of which result in more rapid runoff.

Table 2: The effects of land use change

## Lakes and wetlands

There are only a few surface water takes for lakes in Northland. However, as most lakes are relatively small and shallow, they have a sensitive water balance and a limited capacity to assimilate any contaminants. They are prone to nutrient enrichment from stock and fertiliser, particularly where lakeside vegetation has been grazed or removed, and where there is direct stock access to the lake.

The drainage of wetlands has resulted in many wetland species now being rare or endangered. Drainage has other adverse effects, such as loss of buffer storage for flood waters, which leads to increased flood peaks and reduced summer flows, as well as loss in the capacity of wetlands to trap and reduce sediment, nutrients and other contaminants.



# Climate change

In August 2006, the National Institute of Water and Atmospheric Research Ltd (NIWA) carried out a comprehensive assessment on the impact of climate change and climate variability on Northland's water resources based on all available literature. The assessment considered natural climate variability in the Northland region and the potential effects of predicted climate changes over the next 50 to 80 years.

The main points of the assessment should be noted:

- All predictions suggest an increase in temperature, particularly during the winter;
- Overall annual rainfall may not change, although rainfall trends for the next 30 to 80 years are for increased dry periods (drought and low flows) and increased high intensity rainfall events (floods); and
- The change in rainfall trends and temperature is likely to result in decreased recharge to groundwater resources, and increased potential for saltwater intrusion in coastal aquifers.

Additional work is required to assess the potential effects of increased drought frequencies and extreme rainfall events on surface water flows i.e. low flows and environmental responses.

# 10.3 What is the state of surface water resources?

# Rainfall

Northland's rainfall distribution pattern results from the region's narrow shape and topography. Northland is 260 kilometres long, extends in a north-westerly direction and at

its narrowest point, in the Aupouri Peninsula, is only 10km wide. The Tutamoe and Waima ranges, on the west coast, are the highest points in Northland reaching an altitude of only 770 and 781 metres respectively.

Telemetered rainfall station in Te Puhi River catchment, Far North (right).



The topographical variation across Northland causes rainfall distribution patterns to vary considerably over relatively small areas. Annual rainfall ranges from 900 mm in low-lying coastal areas to over 2900 mm in higher altitudes. Generally, the higher altitude areas of the west and east coast receive more rainfall, while low-lying areas receive less as shown in figure 5 (below).

Due to the seasonal movement of high pressure belts, seasonal influences on rainfall are well defined. Rainfall is highest in winter and lowest in summer. However, Northland does experience high-intensity rainfall, associated with the passage of tropical or sub-tropical storms (refer to Case study 1: Flood event 29 March 2007), which pass over Northland in summer from November through to March. Summer cyclones also occur infrequently during periods of La Nina weather phases. Modified tropical cyclonic depressions from the north may affect Northland on average once every five years. These events produce

very high rainfall of up to 100 mm per hour and can cause widespread flooding, especially when they coincide with extreme high tides. Isolated thunderstorm cells dump vast amounts of rain over very small areas causing extreme flash flooding.

Monitoring and obtaining information about Northland's rainfall resource is important so that short and long term changes in rainfall, which have the potential to severely affect distribution and quantity of water resources in the region, can be detected.

Figure 5: Mean annual rainfall (mm) for Northland (right).



The Northland Regional Council, NIWA and the MetService collect rainfall data at various locations in Northland. Mean monthly

and annual rainfall figures are available for these sites in table 15 in Appendix A. Historical rainfall data with records greater than five years are available for over 260 Northland stations, of which 88 have records greater than 30 years. The 114-year record for a station still operating in Kaitaia, is the longest for the region, followed by 102 years at Puhipuhi.

Annual rainfall (mm) for Puhipuhi from 1906 to 2007 is shown in figure 6 (below). The annual rainfall (blue line) shows the departure from the mean annual rainfall of 2002 mm (red line) as a percentage. A 10-year moving mean was used to smooth the rainfall time series data (black line).



Figure 6: Annual rainfall versus mean annual rainfall for Puhipuhi rainfall site from 1906 to 2007

The rainfall data for Puhipuhi shows several decreasing and increasing trends as presented in table 3 (below). The decreasing trends are associated with a succession of drought periods, for example, 1915 to 1950 and 1970 to 1998. In contrast the period throughout the 1950s and 1960s was very 'wet'.

Increasing trend
1935 to 1960, peaking around 1960
From 1984 peaking around 1991
1999 to 2001 (slight)

Typically rainfall trends will vary from each other due to different location and altitude characteristics. Rainfall trends at Ohaeawai as shown in figure 7 (below) are different to Puhipuhi, with the following trends in rainfall over the last 39 years:

- Average rainfall to 1991.
- Decreasing trend through the strong El Nino period from 1991 to 1999.
- Increasing trend to 2003.
- Currently a decreasing trend.



Figure 7: Mean annual rainfall versus annual rainfall for Ohaeawai rainfall site from 1967 to 2006.

# Droughts

Northland experiences two types of drought, regional and localised. Northland's climate is such that it will experience a regional drought, on average, once every three years at east coast and inland locations, and once every four years at west coast and high altitude locations (NRC 2002b). Droughts result in significantly greater evapo-transpiration rates, severe soil moisture deficits and lower than average river flows which ultimately affect water supplies and in-stream ecosystems.

Northland's water resources are already limited, compared to other regions in New Zealand, due in part to the short lengths of many Northland rivers (excluding the Wairua Catchment). With the potential increase in demand for water combined with the possibility of global warming, drought problems in the future could become prevalent and the effects far reaching.

The effects of low rainfall include:

- Very little recharge of ground water resulting in abnormally low spring flows (base flows to rivers and streams) and low ground water levels.
- The major water storage dams and lakes throughout Northland will reach very low levels.
- In some coastal areas, heavy summer use of limited groundwater resources combined with the lack of recharge lead to saltwater intrusion into aquifers, contaminating bores.
- Water supplies from shallow bores, springs and small streams can dry up.
- Costly transport of water to rural residents.
- Public water use restrictions imposed by District Councils.
- · Restrictions imposed on consented water takes by the Regional Council
- Minimal grass cover, early drying off of dairy herds, low milk production, low calving rates and loss of income from selling stock.
- Reduced stream habitat caused by lowered water quality and quantity (low water levels in streams and rivers, high water temperatures and increased aquatic weed growth).



Mangakahia River at Titoki Bridge at normal flow



Mangakahia River at Titoki Bridge at flood flow.

# Flooding

Flooding tends to occur during winter months when flows are higher and soils are already saturated but can occur in summer when remnant cyclones, usually down-graded to tropical depressions, make their way far enough south to the Northland Peninsula. However, there is generally a broad seasonal pattern of higher flows during winter, and lower flows during summer. Most rivers have 10-20% of the yearly flow in summer months, and flow is largely maintained by groundwater base flow.

Flooding is the most common reason for civil defence emergencies in Northland. Major floods have been recorded in Northland, by various sources, since 1917.

There are several factors which contribute to flooding in the region which tends to be 'flashy' and can occur at any time. Some factors include:

- High intensity rainfall generated from cyclonic or remnants of cyclonic storms.
- Small steep catchments.
- Relatively impervious clay soils.
- Low river gradients and growth of willow trees.
- Tidal influence which backs up the flood waters in many of Northland's drowned river systems.
- Raised sea levels caused by storm surge and/or low pressure associated with storms.
- Heavy exotic weed infestation in many drainage areas.
- Reduced forestation and urban development in catchments.

## **River flows**

Northland has a dense network of rivers and streams, many of which are relatively short with small catchments. Catchments on the east coast tend to be smaller than those on the west coast. Most of the major rivers have their outlets into harbours with few discharging directly to the coast.

Many Northland rivers show 'drowned valley' characteristics with large harbours and estuaries at their mouths. The Kaipara Harbour represents the sunken lower reaches of Northland's largest river (the Northern Wairoa), draining a catchment area of some 3650 km<sup>2</sup>, or 29% of the land area of Northland.

Differences in flows between catchments can be attributed to rainfall patterns, catchment size and catchment geology. In Northland catchment geology greatly influences low flows during drought conditions. Fractured basalt rock readily absorbs rainfall and slowly releases it through springs. This slow release sustains the flow during dry periods at more than 3.5 l/s per km<sup>2</sup>. Examples of rivers flowing through basaltic and greywacke geology are the Punakitere, Waipao, Waipapa and Ngunguru Rivers.

Catchments with less pervious geology absorb less rain and therefore have less water available in storage. Flows from these catchments tend to recede quickly during dry summers, with little sustaining baseflow. Many streams in the Aupouri Peninsula have little or no baseflow and in catchments where there is underlying mudstone-sandstone geology, less than 1 l/s per km<sup>2</sup> is released during drought months. Examples of rivers in Northland that flow through catchments of mudstone-sandstone geology are Selwyn Swamp and the rivers of the Awanui catchment.

Waipoua River in normal flow conditions (right).

Table 16 in Appendix B shows information such as minimum, maximum, median, mean and annual flood flows from various rivers in Northland. Six stations are operated by NIWA.



# **Tidal monitoring**

Northland's sea level monitoring stations play an important role in the investigation of such effects as storm surges, tsunami, seasonal and annual variations as well as sea level responses to climate patterns. Data from the coastal network also assists the Northland Regional Council to address the coastal hazard requirements of various statutes and plans.

The Regional Council operates six automatic water level recorders located in tidal environments. Three are located on the East Coast at Marsden Point, Opua and the mouth of the Awanui River in the Rangaunu Harbour and three on the West Coast at Pouto Point, Dargaville and the Kaihu River at Parore. Water levels are recorded at one-minute intervals at Marsden Point, every five minutes at Pouto Point and 15 minutes at Awanui, Opua, Dargaville and Parore. The Awanui and Kaihu stations have been installed to capture tidal information for the Awanui and Kaihu River flood protection schemes. All stations are radio or cellphone telemetered.

Barometric pressure is measured at Pouto Point and Dargaville (additionally wind speed, direction and rainfall are measured at the Dargaville station). Two tidal stations are operated by NorthPort, Whangarei, and these supplement the Council's tidal network.

Both stations are within the Whangarei Harbour, at Port Whangarei and Marsden Point. Data from these stations is used by the Royal New Zealand Navy Hydrographic Office for tide predictions.

Tide gauge and rainfall equipment installed in the navigational aid building in the Kaipara Harbour at Pouto Point (right).



# Lakes and wetlands

Northland has a large number of small and generally shallow lakes and associated wetlands, most of which have been formed between stabilised sand dunes along the west coast. These dune lakes generally have little or no continuous surface inflows or outflows, being primarily fed by rainfall directly on to their surfaces and surrounding wetlands. As a result, their levels fluctuate considerably with climatic patterns.

The Council manually monitors water level on 16 lakes monthly. The following graphs show water level trends for two dune lakes, Lake Heather on Aupouri Peninsula and Lake Rototuna on Pouto Peninsula. Water levels peaked in 1990 in Lake Heather, as shown in figure 8 (below). The water levels in 1994 and 1995 were low due to a strong El Nino weather pattern resulting in low rainfall during the 1994 summer and autumn.



Figure 8: Monthly water level data for Lake Heather, Aupouri Peninsula from April 1987.

Water levels were highest in Lake Rototuna in 1998 and 1999 and lowest at the start of 2007, since monitoring began in December 1994 (figure 9).



Figure 9: Monthly water level data for Lake Rototuna, Pouto Peninsula from December 1994.

The region also has several inland lakes which were formed through the damming of valleys by lava flows, such as Lakes Omapere and Owhareiti near Kaikohe. These lakes have special spiritual and cultural significance to tangata whenua.

Water levels are manually recorded on a monthly basis. There has been a steady increase in water level in Lake Owhareiti from 1995 to 2004 as shown in figure 10 (below). This increase in water level corresponds to an above average rainfall occurring during this period.



Figure 10: Lake Owhareiti water level trends since 1989.



Lake Owhareiti.

For more information on lakes refer to the lake quality chapter of this SOE report.

Wetlands can make a significant contribution to water quality and natural hazard mitigation. There are many remnant wetlands in Northland, including some relatively large inland wetlands. These include Hikurangi Swamp, the Motatau Wetlands, and other wetlands in the mid catchments of larger rivers such as the Manganui/Tauraroa catchment. Wetlands associated with dune and gumland areas and adjoining the coast are also important; a number of those on the Pouto Peninsula, Kaimaumau and in the Bay of Islands being considered habitats of international significance.

The original area of wetlands has been greatly reduced due to drainage and conversion to agricultural uses. In just five years between 1978 and 1983 there was a 14.4% reduction in freshwater wetlands. The remaining wetlands tend to be small and scattered, and continue to be vulnerable to changes in hydrologic regimes and to the effects of stock grazing and further land development.

There has been little monitoring of the hydrology of remaining wetlands in the region.

For more information on wetlands refer to the indigenous biodiversity chapter of this report.

# **10.4 What is being done?**

# Policy documents

The Regional Policy Statement for Northland (NRC 2002a) sets out to provide an overview of the resource management issues of the region, and contains policies and methods to achieve integrated management of the region's natural and physical resources. In Northland there are many significant problems and potential conflicts between use, development and protection of the region's water resources.

The Regional Water and Soil Plan for Northland (NRC 2007) sets standards for allowing, restricting or prohibiting activities, and contains policies and rules that the Regional Council uses for deciding on applications for water-related consents. These include setting minimum water quality standards or minimum levels of water flows.

# Water shortage and drought response guidelines

In response to a serious temporary water shortage in Northland the Council can issue a water shortage direction to allow continued water takes (pursuant to Section 329 of the RMA). Based on the current pattern of water use, the application of a water shortage direction to large areas of Northland at any one time is unlikely. It is most likely that the need would be confined to a few sub-catchments at any one time.

Compliance with resource consents, efficient use of water and voluntary reductions are important prerequisites to the implementation of a water shortage direction. Only when these are insufficient to prevent a severe shortage of water is a water shortage direction necessary. The maintenance of people's health is given the highest priority of water use.

The main policy on drought response emphasises the data collection network, publicity and early warning of potential drought problems. This includes the notification of pending water shortages and dissemination of information; modification of water use; and compliance.

# Minimum flow criteria

There is currently no policy or objectives in our regional plans on the total maximum volume of water that can be allocated from water bodies in Northland. However there are policies relating to the maintenance of flows and levels in water bodies in section 9 of the RWSP.

Research has emphasised the need to maintain minimum flows that protect the functioning and non-extractive uses of rivers. These functions include the life- supporting capacity and waste assimilation potential of the water bodies and also meeting the needs of recreational, amenity and cultural uses.

Generally, smaller rivers are more sensitive to the potentially adverse effects of flow reduction on their life-supporting capacity than larger rivers. The mean annual low flow (MALF) is the flow required to be maintained in flow-sensitive rivers (rivers of high ecological value sensitive to the potentially adverse effects of flow reduction). The MALF is obtained by averaging the lowest daily flow for each year of record. This average estimates a natural minimum, which generally occurs in summer.

Minimum flow requirements, when MALF does not apply, are rivers or parts of rivers that are less sensitive to flow reduction and therefore lower minimum flows are acceptable to avoid adverse effects on the aquatic ecosystem. The continuous "7 day" one in five-year return period low flow is the flow required to be maintained in these rivers. The "7 day"

value is used, as it is considered to be a more reliable and meaningful measure of flow. Table 17 in Appendix C shows the MALF and '7 day' one in five-year return period in various Northland rivers with a long-term record.

# Hydrometric network

The NRC operates a hydrometric network consisting of 60 sites throughout Northland, which collect continuous data at intervals of between five and 15 minutes. This includes 30 river level sites, six tidal monitoring sites and 24 rainfall sites, as shown in figure 11 (below) and tables 18 and 19 in Appendix D. This is an increase of 20 automatic stations in the network since the last report (NRC 2002b). The hydrometric network also consists of 55 daily rainfall stations, operated by voluntary readers and 16 lake level sites recording monthly water levels. This network is also supplemented by five MetService automatic rainfall sites and seven NIWA sites (one rainfall site and six water level sites) collecting continuous five or 15-minute data.



Ruakaka at Flyger Road.

Of the 60 continuous data recording sites, 54 are part of a telemetry system where data can be sent via radio or cellular phone to a base station at the NRC office in Whangarei. These telemetered sites provide a real-time picture of the state of the region's water resources, while the tidal station at Marsden Point acts as part of the Pacific Rim tsunamimonitoring network.

During periods of extreme rainfall, the telemetered sites play an important role, ensuring that both the Civil Defence and the general public are kept informed, via media releases, of flooding in Northland.

### **10 – Surface Water Quantity**



Figure 11: Water level, rainfall and groundwater sites on the automatic hydrometric network.

# Flow gauge monitoring

During periods of drought, water levels are also monitored and when a low threshold is reached a low flow-gauging programme is undertaken in affected river catchments. These manual flow measurements enable the flow to be accurately determined and are used to monitor water usage. There are over 11,700 flow gauging records for 1503 Northland sites held by the NRC. Since 2001, a total of 1500 flow measurements were carried out, primarily for state of environment, consent compliance and flood monitoring.



Standard method of low flow gauging on the Opouteke River using a mechanical flow meter (left) and low flow measurement using the ADCP and laptop on the Ahuroa River (right).

New flow measuring equipment has improved the council's ability to gather more accurate information on Northland rivers. The Acoustic Doppler Current Profiler (ADCP) is an electronic instrument that is used to measure water velocities and is transforming the way flow measurements in rivers are being carried out. The current methods of measuring flows with width measurement lines, current meters, sounding weights are fast becoming redundant. Data is transferred from the ADCP to the laptop computer via radio communications. The ADCP provides fast, accurate information resulting in more productive, diverse and cost effective river surveys; reduced lifetime equipment costs; and high quality data sets.



Old mechanical equipment being used for flood measurements on the Awanui River (left), and the use of the ADCP on the Punakitere River during elevated flows (right).

# **10.5 Where to from here?**

The following are areas that are currently not being addressed, which will be looked at in more detail in the future:

- Ensure accurate water metering of consented takes and water use analysis to enable a better understanding of the volume of water abstracted within catchments and the effects on water resources.
- Encourage all water users to register their 'permitted takes' with the Council to enable greater understanding of the 'actual' water taken in catchments.
- Establish design minimum flows (DMF, which is the minimum flow required to be maintained) for a greater number of catchments by:
- (a) Increasing the coverage of flow measurement stations during periods of low flow periods; and
- (b) Naturalising flows, which is making sure that the total volume of water taken for consented and permitted takes is included in the assessment to ensure the DMF is in fact the <u>natural</u> flow.
- Increase the number of telemetered rainfall and water level stations to enhance coverage of Northland to aid in flood protection and SOE monitoring.
- Increase monitoring of flows and water levels in pristine water rivers and lakes for SOE information.
- Include defined water allocation limits (i.e. maximum total volumes allocatable for water bodies) in the NRC's Northland Plans to provide water use securities for users and sustainable allocation of water resources.
- Include rules in Northland's plans to ensure assessment of cumulative effects of subdivision on water resources and to avoid inappropriate development.
- Undertake flow measurement of springs in volcanic areas, coinciding with groundwater level measurements to gain a better understanding of surface and groundwater interaction. Refer to the groundwater chapter for more information.

In response to drought severities local authorities should promote:

- Public awareness of the drought and associated water resource problems such as water conservation measures.
- Intensified monitoring of water resource availability.
- Where necessary, the use of temporary emergency measures, available under the RMA, to protect water resources and/or restrict use of water.

# **10.6** What can you do to help?

You can help the council better manage Northland's water resources by registering your "permitted" take with the Council. This helps the Council to sustainably manage water resources now and in the future and ensures your take is protected in the event of any future development in your catchment.

Make sure you obtain resource consent if your water take exceeds the volumes allowed by the permitted activity rule of RWSP. This will also help the Council sustainably manage Northland's water resources and ensure your take is legally protected in the future.

You can also help by ensuring efficient use of water. The Council has a number of pamphlets available with tips on how to conserve water. For more information refer to the *'conserve water'* brochure on the regional council website at the following link:

http://www.nrc.govt.nz/upload/1798/Conserve%20water.pdf

# 10.7 Case study 1: Flood event 29 March 2007

On Tuesday 27 March at 11.10 am the MetService issued a Severe Weather Watch for Northland. This indicated the development of a low pressure system in the northern Tasman blocked by a high further to the east. Together these would bring a strengthening, humid north-east flow on to the North Island with rain spreading south. This watch was upgraded to a full warning at 8.40am on Wednesday 28 March with an

expectation that 100 - 150mm of rain may fall and that heavy falls in the order of 50mm over 2 - 5 hours may occur through Thursday and into Friday.

MetService satellite image of the weather system over Northland on the 29 March 2007 (right).



As a result, a north to north-easterly flow spread on to Northland bringing with it widespread rain. Areas first affected were the Far North and particularly Kaeo and the Bay of Islands. Rivers were starting to rise on Wednesday evening. By midnight Wednesday NIWA's Maungaparerua rain gauge, in the western hills of Kerikeri, had received 175mm and NRC's gauges at Kaeo, Ohaeawai and Ngunguru had all recorded falls exceeding 100mm. Many other NRC gauges exceeded 50mm.



MetService Auckland radar images from 0600 to 1830 hours on the 29 March 2007 (above).

NRC released a media report on Thursday morning indicating the potential for widespread flooding, particularly in the Kerikeri area. The Kaeo River was severely swollen and other rivers in the Bay of Islands and further south were rising rapidly. Also, the Mangakahia, Opouteke and Hikurangi Rivers showed rapid rising water levels and

together with a predicted four-metre flood peak from the Wairua River, extensive flooding was expected on the lower flats of the Mangakahia, Wairua and Northern Wairoa Rivers (Tangiteroria). Flood warnings were issued for these areas.

By Thursday morning the MetService expected another 30 – 50mm in the Bay of Islands and up to 90mm further south. The event was larger than anticipated with rains falling over a longer duration as the moist north-easterly continued funnelling into the eastern coast and with only a slow movement southwards.

Figure 12: Rainfall over the period 28 to 29 March 2007 (right).



Rain had cleared in the Far North early on Thursday but eastern areas from Kaeo south continued to receive significant falls. By midnight on Thursday Ngunguru and Puhipuhi gauges had received over 330mm each on top of Wednesday's falls with two day totals exceeding 430mm. Along with these two gauges four other gauges exceeded 300mm (Maungaparerua, Oakura Bay, Kaeo and Tara near Mangawhai). Heavy rains finally cleared the Bay of Islands by late afternoon on Thursday and from our southern parts in the early hours of Friday.



As a consequence rivers rose to very high levels in parts of the region. Rivers around the Kaeo/Bay of Islands area were some of the first to rise late on Wednesday 28 March and continued to rise through most of Thursday. Many rivers flowed out of their channels, including Kaeo, Waipapa, Waitangi, Waiharakeke, Whakapara, Hatea, Ruakaka and Waipu, all resulting in road closures and large areas of farmland inundated with floodwater. There was also significant surface flooding and subsidence affecting many residential areas.

High water levels in the Whakapara River (above) resulted in severe flooding on SH1 by Puhipuhi Road intersection (top right) and a vehicle being swept off the road (bottom right).



Based on 24-hour rainfall totals as shown in table 4 (below) and the tables of return period assessments for selected sites, this storm was equivalent to a 1:150-year rain event.

Table 4: Daily rainfall (mm) from midnight to midnight for 28 and 29 March 2007 and from midnigh
until 0630 hours on 30 March, total rainfall for this period and maximum hourly rainfall.

Location	Wed 28 March (24 hours)	Thu 29 March (24 hours)	Fri 30 March	Total	Max mm/br
	(27 110ul 3)	(27 110013)	10 0000 1113	(,,,,,,)	
East Whangarei (Glenbervie Hills)	104	332	2.5	438.5	36
Puhipuhi Hills	99	335.5	1.5	436	46
Western Hills Kerikeri (Maungaparerua)	175	229	0.5	404.5	46
Oakura Bay	85.5	285	0.5	371	33.5
Tara (Mangawhai)	43.5	280.5	16.5	340.5	40
Kaeo	131	190.5	0.5	322	36.5
Marsden Point (Port)	42	251	2	295	37.5
Whangarei City	45.5	222	3	270.5	42.5
Ohaeawai	110.5	153	0	263.5	19
North Brynderwyn Hills	34	195.5	4.5	234	30
East Mangamuka (Mangakawakawa)	99	65.5	0	164.5	21.5
Tutamoe	78.5	76.5	0.5	155.5	17.5
Maungaturoto	20.5	130.5	1	152	23.5
Opouteke (Eastern Tutamoe)	63	79	0	142	16
Twin Bridges	51	68.5	0.5	120	15
Paparoa	17.5	97.5	0	115	20.5
West Mangamuka (Te Rore)	54	37.5	0	91.5	12
Opononi	36.5	43.5	0.5	80.5	10.5
Kaitaia	53.5	25.5	0.5	79.5	13.5
North Hokianga (Rotokakahi)	43.5	27	1	71.5	11
Dargaville	15	46.5	0.5	62	10.5
Pouto Point	7.5	32	0.5	40	8

# **Rainfall return periods**

The following tables show the estimated return period for the rainfall amounts recorded at various rainfall sites calculated using NIWA's software program High Intensity Design Rainfall System (HIRDS).

The following areas all had at least one estimated return period of 1:150 years: Kaeo, Maungaparerua, Oakura Bay, Puhipuhi, Ngunguru and Mangawhai (tables 5 to 10 respectively). There are three areas that do not have 1:150-year estimated return period: Ohaeawai (table 11), Whangarei City (table 12) and Marsden Point (table 13). However, the latter did have estimated return periods of 1:140 years and 1:120 years respectively.

Period (hours)	Rainfall (mm)	Estimated return period (yrs)
6	135.5	1:75
12	179.5	1:65
24	291.5	1:150
48	306.0	1:80

Table 5: Rainfall return period for Kaeo

Table 6: Rainfall return period for Maungaparerua (Western Hills Kerikeri)

Period (hours)	Rainfall (mm)	Estimated return period (yrs)
6	144.5	1:140
12	201.0	1:150+
24	359.5	1:150+
48	386.5	1:150+

## Table 7: Rainfall return period for Oakura Bay

Period (hours)	Rainfall (mm)	Estimated return period (yrs)
6	120.5	1:50
12	228.5	1:150+
24	310.5	1:150+
48	360.0	1:150+

## Table 8: Rainfall return period for Puhipuhi

Period (hours)	Rainfall (mm)	Estimated return period (yrs)
6	192.0	1:150
12	281.5	1:150+
24	383.5	1:150+
48	428.5	1:150+

Table 9: Rainfall return period for Ngunguru (Glenbervie hills)

Period (hours)	Rainfall (mm)	Estimated return period (yrs)
6	143.0	1:60
12	242.0	1:150+
24	382.0	1:150+
48	438.0	1:150+

Period (hours)	Rainfall (mm)	Estimated return period (yrs)
6	144.5	1:130
12	215.5	1:150+
24	293.5	1:150+
48	340.5	1:150+

#### Table 40. Daisfall riad for Tara (Ma . ..

## Table11: Rainfall return period for Ohaeawai

Period (hours)	Rainfall (mm)	Estimated return period (yrs)
6	89.0	1:10
12	135.5	1:18
24	238.5	1:60
48	251.0	1:30

## Table 12: Rainfall return period for Whangarei City

Period (hours)	Rainfall (mm)	Estimated return period (yrs)
6	153.5	1:140
12	197.0	1:110
24	246.0	1:80
48	268.0	1:55

|--|

Period (hours)	Rainfall (mm)	Estimated return period (yrs)
6	143.0	1:110
12	198.0	1:110
24	268.5	1:120
48	293.0	1:100

# Hourly rainfall plots

The following plots (Figures 13 to 18) show one-hourly rainfall data (mm/hr) from 25 March to 30 March 2007 for various rainfall sites throughout Northland.



Figures 13 and 14: Hourly rainfall (mm/hr) for Kaeo (left) and Maungaparerua (right).



Figures 15 and 16: Hourly rainfall (mm/hr) for Puhipuhi (left) and Ngunguru (right).



Figures 17 and 18: Hourly rainfall (mm/hr) for Whangarei (left) and Mangawhai (right).



Whangarei Falls during normal summer flows (left) compared to the flood on 29 March (right).

# River height in relation to historic records

For many rivers around Northland the height recorded in March 2007 is the highest on record, as shown in table 14 (below).

Table 14: Peak water level recorded in March storm for several Northland Rivers and where this water level peak height is ranked in site record.

Water level station	Years of record	Recorded peak height	Rank
Waitangi at Haruru Falls (NIWA)	28	6.939m	1 <sup>st</sup>
Waipapa at Puketi Forest (NIWA)	29	5.524m	1 <sup>st</sup>
Rangitane at Waipapa	30	5.137m	1 <sup>st</sup>
Maungaparerua at Puketotara Rd (NIWA)	40	3.102m	2 <sup>nd</sup> *
Waiharakeke at Moerewa	40	4.563m	8 <sup>th</sup>
Waiotu at SH1	20	8.690m	1 <sup>st</sup>
Whakapara at SH1	48	9.444m	1 <sup>st</sup>
Mangahahuru at Kauri	39	4.185m	1 <sup>st</sup>
Wairua at Pipiwai Rd	47	7.548m	15 <sup>th</sup>
Wairua at Wairua Bridge	46	4.788m	4 <sup>th</sup>
Hikurangi at Moengawahine	32	9.054m	8 <sup>th</sup>
Mangakahia at Gorge (NIWA)	47	4.219m	29 <sup>th</sup>
Mangakahia at Titoki	24	11.293m	13 <sup>th</sup>
Ngunguru at Kaikatia rd	38	2.914m	7 <sup>th</sup>
Ruakaka at Flyger Rd (SH1)	23	4.699m	1 <sup>st</sup>
Ahuroa at Braigh Flats (SH1)	24	5.826m	2 <sup>nd</sup>

\* The Kerikeri flood in 1981 is ranked first for Maungaparerua at Puketotara Rd.

The water level recorded on the 29 March at the NIWA station Waitangi at Wakelins station above Haruru Falls is the now the highest on record as shown in figure 19 (below). The red line indicates the previous maximum water level recorded at this station during the Kerikeri flood in March 1981.



Figure 19: Water level in Waitangi River at Wakelins (NIWA site) above Haruru Falls.

The Northland Regional Council acknowledges the MetService for the images presented and NIWA for the information supplied from their water level and rainfall stations during this event.

For more detailed information on the March 2007 floods refer to the detailed reports available at the following link:

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

# 10.8 Case study 2: Awanui River flood management scheme

# Background

The Mangamuka range has 20,000ha of catchment that drains towards Kaitaia through three rivers: Takahue, Victoria and Fairburn. These three rivers join to form the Awanui River, which flows through Kaitaia and then Awanui, before discharging into the Rangaunu Harbour. Along the way, the Awanui River drains an additional 14,000ha of hill country and floodplain. A further 6000ha of catchment in the flood management scheme discharges into the Rangaunu through the Waipapakauri Cut or the Paeratahi Stream.

# Operation

The successful operation of the scheme relies on two flow diversion points from the Awanui River, an overflow point across State Highway One at Larmer Rd, and the Whangatane Spillway, towards the northern end of Kaitaia. In large events, as little as a third of the original flow remains in the Awanui River after these flow diversions.

The operation of these overflow points has wider implications: The upper Whangatane channel bisects several dairy farms and can isolate herds from dairy sheds and there are no straightforward detours available once State Highway One becomes impassable. In addition, during larger events, the Awanui River will overtop its stopbanks, particularly on some reaches between Kaitaia and the Awanui township.

## Management

Responsibility for the scheme passed from the Far North District Council to the Northland Regional Council (NRC) in July 2005. Since then, significant channel works have been undertaken to increase the capacity of the scheme, hydraulic modelling of the scheme has commenced, and the NRC hydrology team has been engaged to improve the ability of the council to monitor, log, and provide warning for events affecting the scheme.

## Monitoring equipment and data capture

Three rain gauges were already installed to observe rainfall in the ranges near the upper

catchment of the Awanui. An additional NIWA rain gauge in Kaitaia provides urban rainfall information. Together, these gauges provide the first indication of how severe an event might be in the Awanui catchment.

Water level gauges have also been installed into each of the three upper rivers. These gauges indicate how the catchments have responded to rainfall, which can vary widely depending on the antecedent conditions. Based on long experience, the hydrology team can use these gauges to estimate what the water level will be through Kaitaia, some 12 hours before it gets there.

Water level recorder instrumentation on Victoria River including gas purge system, pressure transducer and data logger with cellular phone communications to Whangarei (above).



The flows through urban Kaitaia are monitored on the Awanui River, Tarawhataroa, and Whangatane Spillway. As flows peak and levels become critical, this data provides real-time feedback of how the scheme is performing.



Whangatane Spillway in normal flow conditions (left) and flood conditions (right)

In addition to these gauges, which can all be monitored in real time from Whangarei, Council hydrology staff members also carry out high flow river gaugings. This requires a team in the field to measure water flows through a river cross section. For the urban gauges with established rating curves, this provides a check for changes in the channel capacity against the previous gaugings. For the level gauges in the upper catchment, these gaugings are still needed, to provide a rating curve to convert level information into flow rates. These recent purchase of an ADCP gauging system has the potential to reduce the time to complete a river gauging from over an hour to around 30 minutes.

The last gauge is located near the mouth of the Awanui River and provides tide level information, indicating the degree of storm surge occurring from the wind fetch and barometric pressure changes. The performance of the lower reaches of the scheme depends on the prevailing tide conditions.

A schematic map of the Awanui River Flood Management Scheme is presented in Appendix E.

## Long-term value

The main application for this data has been focused on real-time monitoring of individual events. In the future, this data will also provide a valuable tool for understanding the way the catchments respond to rainfall and an insight into the long-term effects of any changes to land use or scheme developments.

As most of the gauges have only been installed for a few years, the data record is currently too brief for this application. In addition, ratings need to be developed for the upper catchment gauges so that flows, rather than just levels, can be estimated. Over time, it is expected that the big picture understanding provided by this monitoring programme will become just as important as the hazard management it currently assists with.

# Overview

The flood management scheme has been developed over some 60 years. Early works in the 1900s focused on bringing land near the harbour into production by preventing tidal flooding by salt water. Stopbanks and floodgates gradually extended upstream to provide flood management for more productive floodplain land. The flood of 1958, which flowed through urban Kaitaia, prompted a comprehensive upgrade to the scheme. Stopbanks

were constructed around Kaitaia and the Whangatane Spillway was enlarged. Large areas of highly productive land and the main service centre for the Far North now benefit from a significant level of reduction to the flood hazard present on the Awanui River flood plain.

More information on the scheme is available in the Awanui River Flood Management Plan available on the Regional Council website at the following link:

http://www.nrc.govt.nz/Resource-Library-Summary/Plans-and-Policies/Hazards/

# 10.9 References

NRC. (2002)a. *Regional Policy Statement for Northland.* Produced by the Northland Regional Council. Whangarei: New Zealand. Latest version and current plan changes are available on the Regional Council's website at the following link:

http://www.nrc.govt.nz/Resource-Library-Summary/Plans-and-Policies/Regional-Policy-Statement/

NRC. (2002)b. *State of the Environment Report*. Published by Northland Regional Council. Whangarei: New Zealand. Available on the Regional Council's website at the following link:

http://www.nrc.govt.nz/Resource-Library-Summary/Environmental-Monitoring/State-of-the-Environment-Monitoring/2002-State-of-the-Environment-Report/

NRC. (2005). *Awanui River Flood Management Plan.* Published by Northland Regional Council, Whangarei. Latest version available on the Regional Council website at the following link:

http://www.nrc.govt.nz/Resource-Library-Summary/Plans-and-Policies/Hazards/

NRC. (2007). *Regional Water and Soil Plan for Northland*. Published by Northland Regional Council. Whangarei: New Zealand. Latest version and current plan changes are available on the Regional Council's website at the following link:

http://www.nrc.govt.nz/Resource-Library-Summary/Plans-and-Policies/Regionalplans/Regional-Water-and-Soil-Plan/

# 10.10 Appendix A: Rainfall figures for Northland

Table 15: Mean monthly and mean annual rainfall (mm) for all rainfall sites in Northland

Sito	<b>Z</b>		NZ	MG			ľ	Mean	mo	nthly	/ raiı	nfall	(mm	)			Annual	A 1+	Pariod of	Year
number	Site name	Auth	Е	N	J	F	М	Α	м	J	J	Α	s	0	Ν	D	rainfall (mm)	(m)	record	of data
424601	Cape Reinga	Met	2481618	6753424	60	65	63	98	99	114	120	108	81	66	56	55	990	191	1919-1987	69
424602	Cape Reinga EWS	Met	2481618	6753424	53	50	44	58	70	77	97	78	78	66	47	77	795	191	1983-	24
425801	Te Paki Stn, Te Hapua	Met	2492681	6744839	92	97	90	143	144	159	171	162	120	96	86	78	1436	64	1931-1973	43
425902	Paua Blk Parengarenga	Met	2501207	6736838	70	85	84	108	104	148	148	127	110	86	75	78	1223	55	1970-	37
437001	Cape View	Met	2514007	6722604	70	69	81	106	94	156	136	138	117	85	78	70	1221	37	1967-1996	30
439110	Longgrass	NIWA	2525800	6688500	59	60	108	89	108	129	92	135	111	74	92	70	1123	35	1964-1973	10
439111	Sandhills	NIWA	2525500	6697900	53	77	111	96	105	125	114	135	101	78	95	65	1154	39	1964-1973	10
439201	Waiharara	Met	2529173	6694804	68	79	78	95	112	141	136	129	109	92	72	79	1190	30	1956-	51
439202	Waiharara	Met	2530551	6696351	69	71	73	98	129	143	140	117	111	90	72	83	1196	18	1983-	24
439301	Rangiputa	Met	2541358	6700285	75	72	79	101	104	145	146	128	111	96	69	71	1197	8	1970-2004	34
439501	Mangonui	Met	2559564	6690946	85	84	91	117	142	153	155	156	123	104	85	81	1371	11	1901-1996	95
530101	Ninety Mile Beach	Met	2526117	6685609	69	83	84	109	134	141	155	134	121	75	68	83	1236	18	1959-1968	9
530201	Kaitaia Aero	Met	2536682	6681783	82	105	84	117	134	163	143	155	114	107	102	91	1395	80	1949-1985	37
530202	Waipapakauri	Met	2533692	6685572	83	92	73	106	114	148	136	132	109	93	85	87	1253	6	1955-1987	33
530204	Aupouri	NRC	2528900	6687900	76	69	74	109	112	154	138	128	106	101	83	82	1232	10	1967-	40
530205	Wiessing	NRC	2534200	6681700	92	75	77	110	139	161	143	116	116	114	77	97	1317	69	1993-	14
530206	Kaitaia Aero EWS	MET	2536682	6681783	98	94	95	102	170	102	126	96	83	117	65	103	1251	80	2000-	7
530301	Kaingaroa North	Met	2541255	6683642	83	89	84	110	116	161	162	156	128	102	95	82	1371	30	1962-1995	34
530601	Oruaiti	Met	2570213	6687081	92	121	114	128	202	176	214	210	163	144	88	116	1754	91	1952-1967	16
530602	Oruaiti 2	Met	2565666	6689008	64	120	112	150	123	207	148	180	148	115	97	78	1495	14	1968-1980	13
530701	Kaeo	Met	2577752	6683347	94	86	121	134	159	172	192	171	160	124	101	97	1611	25	1987-	20
530710	Giesbers	NRC	2575600	6672100	120	91	123	124	158	177	201	187	174	131	113	123	1722	52	1983-	24
530801	Matauri Bay	Met	2591459	6685085	75	102	108	137	109	185	156	161	119	118	90	80	1452	183	1964-1987	24
530810	Matauri Bay	NRC	2592634	6681365	120	107	126	146	175	201	210	207	191	166	146	126	1921		1986-	21
531101	Ahipara	Met	2524501	6670747	69	71	79	96	109	137	132	135	106	87	84	72	1181	5	1961-1997	37
531201	Kaitaia	Met	2535192	6676243	91	88	82	107	138	156	153	143	123	108	90	90	1369	8	1893-	114
531205	Kaitaia Observatory	Met	2534726	6674248	87	88	83	92	137	146	159	138	122	105	90	101	1348	85	1985-	22
531207	, Kaitaia EWS	Met	2536682	6681783	102	93	93	110	163	163	132	102	96	109	83	112	1358	80	1999-	8
531301	Rangitihi	Met	2541221	6678094	93	100	85	124	152	161	161	163	128	126	99	95	1486	73	1913-1979	67
531302	Rangitihi Sub Stn	Met	2541210	6676208	93	97	90	118	128	169	171	175	130	108	113	91	1510	37	1961-1992	32
531303	Fairburn	Met	2545781	6678065	58	139	96	146	151	195	154	251	142	107	139	109	1754	76	1967-1974	8
531310	Te Rore	NRC	2544800	6669200	111	101	110	135	154	196	195	193	162	141	130	119	1747	91	1966-	41
531410	Te Puhi Vallev	NIWA	2550900	6672700	104	120	96	163	152	202	148	228	153	120	136	96	1754	91	1966-1976	10
531411	Top of Victoria Vallev	NRC	2548200	6672900	113	106	109	138	161	203	191	191	159	141	124	124	1760	80	1966-	41
531413	Stanton. Te Puhi	NIWA	2550100	6673100	112	130	112	139	120	207	192	176	154	125	116	128	1764	106	1977-1987	11
531501	Honeymoon Valley	Met	2555970	6674885	100	116	119	141	166	197	203	196	168	133	128	116	1778	58	1962-1998	37
531610	Otangaroa HQ	NIWA	2571300	6670900	166	116	170	131	166	185	213	272	192	149	159	171	2114	115	1983-1990	7
531701	Kaeo	Met	2582255	6677752	127	108	105	151	204	193	203	189	147	138	105	101	1777	37	1918-1952	35
531711	Paitu	NRC	2583500	6675500	108	127	133	155	150	208	205	199	160	136	120	104	1805	45	1963-	44
531713	Waihuka	NIWA	2579800	6671900	115	164	159	163	149	246	186	230	174	166	126	92	1988	107	1970-1981	11
531715	Bramleys	NRC	2582900	6670600	133	114	144	163	156	219	229	211	184	153	135	117	1958	137	1971-	36
531716	Kaeo	NRC	2586600	6673000	.00 90	<del></del> 99	130	170	187	205	255	198	215	172	173	146	2040	20	1991-	16
531811	Insley (Sinton)		2592200	6670600	106	140	175	145	145	200	186	203	163	187	116	Q1	1962	152	1970-1980	10
531001	Kerikeri Ewe	Mot	2594385	6670182	105	114	120	146	184	200	167	162	147	120	112	112	1710	70	1981-	26
531901	Kerikeri Ews	Met	2594385	6670182	112	93	120	134	132	182	186	190	184	144	131	101	1750	79	1981-	20 21
531903	Rangitane	Met	2596626	6669910	145	142	105	149	170	115	158	149	140	77	87	108	1545	. 5	1984-	23
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531910	Laurensons, Kerikeri	NRC	2597200	6666900	105	102	140	110	111	191	184	179	147	122	103	82	1575	6	1977-1995	18
531911	Kiakaha	NRC	2597300	6666900	109	89	117	129	164	199	215	171	163	130	113	108	1707	61	1987-	20
532202	Herekino	Met	2530551	6659622	102	103	93	129	157	183	170	172	136	132	110	96	1584	34	1917-1992	76
532311	Takahue Top	NRC	2544000	6665300	120	95	118	135	168	211	212	194	164	159	137	125	1838	122	1971	36
532402	Broadwood	Met	2547206	6659525	114	128	115	164	174	202	210	196	155	147	130	118	1856	85	1929-1988	60
532501	Mangamuka bridge	Met	2559340	6663208	80	133	95	134	187	195	173	189	135	137	123	113	1684	30	1949-1971	23
532503	Omahuta 2	Met	2563907	6664945	113	95	112	127	154	221	221	190	180	139	117	130	1799	30	1977-	30
532510	Mangamuka	NIWA	2561100	6661300	102	100	120	109	124	185	193	172	150	114	103	112	1612	61	1977-1992	15
532601	Omahuta 1	Met	2565440	6663156	81	141	115	152	194	197	181	198	147	141	117	117	1794	70	1949-1975	26
532610	Huatau	NIWA	2567300	6656300	60	103	98	84	74	197	167	89	81	89	63	90	1217	30	1976-1985	9
532611	Waihou Valley	NRC	2574200	6656900	107	100	120	120	148	187	203	170	154	132	108	117	1666	30	1979-	28
532710	Puketi Road	NRC	2579200	6659600	135	150	158	187	192	251	250	237	206	174	148	148	2236	259	1963-	44
532711	Puketi R/V	NIWA	2578500	6664600	166	131	161	148	170	205	229	280	214	159	159	145	2248	381	1983-1994	11
532801	Taus Falls	Met	2585174	6661077	136	168	180	192	207	246	242	249	200	180	142	147	2289	308	1951-	56
532802	Puketi	Met	2583666	6664755	77	244	180	254	208	300	216	314	185	170	152	132	2492	347	1967-1974	8
532810	Tyrees	NIWA	2591100	6662300	123	135	159	162	143	224	196	217	170	149	128	115	1916	168	1966-1992	26
532811	Black Poll	NIWA	2589100	6663600	119	165	176	185	158	256	193	224	180	153	132	120	2050	210	1966-1987	21
532812	Airstrip	NIWA	2590900	6664200	91	124	196	178	172	235	185	211	251	151	132	103	1978	213	1967-1982	15
532813	Flats	NIWA	2586200	6662500	86	167	210	208	170	258	186	258	189	190	160	116	2228	305	1967-1977	10
532814	Roadside	NIWA	2588300	6664000	103	173	214	180	163	258	194	221	164	160	152	117	2177	244	1967-1985	18
532815	Jensens	NIWA	2585200	6662200	82	217	182	243	198	290	188	301	231	192	162	147	2438	335	1966-1976	10
532816	Bare Ridge	NIWA	2586500	6663700	94	154	208	197	179	274	195	241	195	181	138	121	2183	299	1969-1977	8
532817	Fence Line	NIWA	2587800	6662900	91	147	208	193	175	267	200	261	208	196	147	125	2236	250	1969-1977	8
532820	Puketi State Forest	NIWA	2583100	6665200	104	218	205	227	203	254	228	289	174	192	121	139	2350	338	1970-1985	8
532821	Tyrees weir	NIWA	2591200	6662400	133	90	112	142	149	175	229	211	187	154	146	126	1820	162	1984-	16
532901	Kerikeri 1	Met	2597303	6662823	79	129	124	146	175	175	172	202	139	119	93	96	1670	73	1945-1973	29
532903	Kerikeri Aero 2	Met	2594254	6659087	121	113	155	140	158	200	207	178	160	137	114	119	1802	150	1978-	29
532910	Carver, Kerikeri	NIWA	2597400	6663200	96	118	151	130	116	225	172	150	144	134	107	86	1627	73	1974-1987	13
532913	Waikimiha, Kerikeri	NRC	2599600	6664300	105	97	116	111	113	197	175	176	161	127	87	91	1563	4	1977-1998	21
533201	Puhata	Met	2530533	6655960	99	93	105	103	130	173	168	149	133	119	99	105	1476	137	1979-	28
533301	Rotokakahi Adams	NRC	2539600	6654200	120	90	89	119	172	219	208	173	156	144	120	137	1747	30	1996-	11
533501	Kohukohu	Met	2560765	6648326	95	95	91	116	162	169	168	150	121	129	92	89	1494	15	1905-1961	57
533502	Umawera	Met	2562373	6655748	76	82	88	140	119	162	130	158	125	115	106	88	1445	9	1967-1985	18
533503	Kohukohu	Met	2560765	6648326	50	89	62	112	156	161	125	243	116	119	104	88	1430	12	1968-1974	5
533601	Rangiahua	Met	2571469	6655667	112	102	100	130	167	173	182	168	140	128	102	93	1598	21	1902-1950	49
533602	Horeke	Met	2566872	6650161	90	100	98	96	84	163	141	119	107	83	81	114	1272	20	1978-1985	7
533610	Crawford Rangiahua	NRC	2570800	6654400	92	76	89	107	103	152	153	160	129	98	81	95	1321		1976-1995	19
533710	Sawards, Rototira	NIWA	2580200	6650900	100	120	131	152	156	188	172	176	150	149	93	118	1742	244	1969-1985	13
533810	Conelley	NIWA	2583800	6652700	102	150	150	155	148	245	132	201	157	136	101	104	1879	244	1969-1979	10
533812	Lake Acres	NRC	2585600	6648600	112	138	136	147	143	199	184	191	163	138	108	117	1803		1965-1997	33
533813	Ohaeawai Woods	NRC	2590100	6649000	102	112	127	147	141	217	223	233	184	137	111	103	1844	122	1967-	34
533814	Highrisings	NIWA	2585700	6655900	156	130	178	137	152	235	223	208	183	150	141	128	2041	335	1976-1991	15
533815	Faithfull	NIWA	2584800	6651400	151	134	162	122	140	177	188	180	155	136	116	132	1794	244	1979-1990	11
533817	Waitangi Ohaeawai	NRC	2590100	6649000	102	112	127	147	141	217	223	233	184	137	111	103	1844	122	1967	40
533911	Puketona	NIWA	2598700	6654200	116	99	162	106	119	151	176	184	152	118	132	112	1625	76	1981-1992	12
533912	Pakaraka	NIWA	2595500	6649200	100	100	121	101	118	132	162	181	143	118	106	90	1473	71	1981-1994	13
534402	Opononi	Met	2550040	6635535	77	76	83	105	127	157	141	142	114	97	92	90	1301	12	1967-	40
534503	Rawene 2	Met	2556193	6644701	84	71	88	96	123	151	158	137	115	91	83	94	1291	15	1977-	30
534701	Kaikohe	Met	2581866	6640805	100	117	99	145	171	180	172	166	134	128	99	104	1614	162	1922-1971	50
534711	Norwest Corner	NIWA	2577300	6645400	112	127	146	148	158	193	153	186	157	145	125	95	1789	244	1967-1978	11
534716	Auto Site	NIWA	2577500	6644300	103	111	115	145	132	189	153	163	142	127	104	110	1587	198	1966-1985	20
534717	Long Valley	NIWA	2578800	6643400	108	132	135	143	153	206	156	178	149	136	116	92	1768	213	1967-1982	15

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534720	Howe's Poplars	NIWA	2579700	6643900	103	115	121	130	155	187	152	171	155	152	112	90	1660	204	1969-1978	9
534721	Eunice	NIWA	2577900	6644900	110	112	118	128	141	178	144	162	150	148	102	84	1650	198	1969-1978	9
534722	Cocksfoot R/V	NIWA	2576300	6643600	106	92	106	106	124	156	152	167	142	120	100	102	1456	189	1969-1993	25
534724	Kaikohe Hill	NRC	2582100	6643100	109	81	95	116	148	149	206	175	157	125	117	117	1595	265	1986-	21
534801	Kaikohe Aero	Met	2584933	6638885	93	122	106	132	145	177	163	168	145	135	93	100	1556	204	1956-1978	23
534802	Kaikohe D.S.I.R.	Met	2584973	6642547	109	122	134	139	119	219	158	140	138	122	99	105	1619	201	1973-1986	14
534807	Kaikohe Edr	Met	2584973	6642547	108	90	88	102	118	124	168	155	138	106	104	108	1409	204	1986-	21
535401	Waiotemarama	Met	2548562	6631772	108	109	119	116	133	179	177	166	152	113	123	128	1615	229	1977-1992	16
535412	Tooremburg	NRC	2550550	6629628	119	109	106	130	176	225	166	145	129	128	127	131	1691		1999-	8
535413	King, Whirinaki	NRC	2651800	6634800	106	77	108	133	149	189	195	143	137	127	100	111	1575		1993-	14
535501	Wekaweka	Met	2560584	6626133	165	155	149	207	286	291	307	282	214	234	186	156	2617	259	1908-1957	50
535510	Waiora Farm	NRC	2565100	6625500	160	150	188	213	254	332	335	302	265	229	211	188	2827	335	1976-	31
535512	Waimamaku	NRC	2559223	6625979	152	130	171	191	253	292	315	271	248	224	194	173	2614		1981-	26
535611	Loggers Camp	NIWA	2572600	6624700	184	192	193	258	295	360	325	333	290	265	186	179	3051	549	1962-1980	18
535712	Gammon's Road	NIWA	2581200	6626000	114	132	108	135	147	196	169	181	141	121	121	127	1691	152	1965-1986	21
535811	Awarua Block R/V	NIWA	2586200	6626800	109	90	107	89	129	112	185	184	141	94	88	110	1465	91	1984-1993	9
535812	Awarua Block	NIWA	2586300	6626800	95	123	91	140	119	137	145	166	151	97	122	119	1520	91	1966-1987	14
535813	Awarua Tokawhero Rd	NIWA	2591600	6625200	100	135	111	165	127	188	154	201	151	125	127	111	1749		1965-1976	11
535901	Kauana Downs	Met	2593924	6631348	89	149	124	143	161	196	175	177	141	122	111	133	1735	177	1956-1970	15
536501	Waipoua Forest	Met	2560509	6616923	89	101	104	133	160	188	188	174	138	132	111	102	1629	88	1928-1999	72
536601	Whatoro	Met	2572521	6613155	158	177	143	198	276	288	278	269	202	196	158	151	2516	427	1914-1953	40
536610	Tutamoe	NIWA	2569300	6614300	107	136	140	199	224	303	263	284	227	203	161	151	2419	390	1962-1979	17
536611	T Y Ranch	NRC	2568900	6618600	147	152	181	227	256	318	324	320	270	216	194	184	2785	445	1966-2000	35
536702	Waimatenui 2	Met	2576836	6619105	111	134	119	162	205	238	239	223	174	158	126	124	2013	213	1914-	93
536710	Waimatenui	NIWA	2576900	6619000	103	125	118	163	171	250	228	222	187	149	120	119	1987	183	1965-1984	19
536711	Roudershoure	NIWA	2579000	6620800	73	141	109	169	176	206	190	216	167	129	147	128	1898	213	1965-1976	11
536712	Glenoban	NIWA	2575100	6620400	107	170	137	191	223	275	262	275	227	163	167	142	2363	335	1962-1972	10
536713	Sledge Hut	NIWA	2580000	6614300	126	119	153	236	205	333	283	274	219	198	143	149	2384	445	1972-1980	8
536811	Froggatt, Kingsclear	NRC	2584400	6613200	119	112	131	153	172	217	219	194	163	130	127	130	1867	120	1967-	37
536814	Nukutawhiti	NIWA	2587600	6617800	90	101	99	151	135	198	180	177	140	120	109	107	1604	55	1962-1978	16
536901	Pipiwai	Met	2599727	6616518	77	116	115	126	142	178	161	166	123	120	109	115	1558	76	1948-1985	38
537410	Donnellys Crossing	NIWA	2562500	6611700	77	101	95	136	182	220	175	178	136	139	122	98	1566	207	1962-1971	9
537510	Katui	NIWA	2563300	6639200	79	88	87	132	147	188	170	173	146	128	113	97	1557	344	1962-1983	21
537611	Trounson Park, Kaihu	NRC	2570000	6608800	85	87	119	137	170	197	206	201	171	138	122	102	1713	244	1968-1995	27
537612	Whatoro Crossing	NIWA	2572400	6606200	67	114	93	138	161	199	183	187	123	124	107	110	1613	116	1962-1971	9
537613	McLeod, Kai iwi Lakes	NRC	2569000	6597900	86	67	88	94	135	105	133	148	120	92	80	79	1226		1986-7993	7
537614	Coates at Whatoro	NRC	2572155	6606020	116	94	100	122	158	225	210	166	141	128	124	126	1710		1995-	12
537712	Aomarama	NIWA	2577800	6609500	107	136	147	213	234	298	261	266	204	193	158	147	2368	427	1962-1975	13
537801	Glenmont, Pakotai	Met	2584612	6609259	83	129	116	152	166	219	189	191	138	135	107	111	1739	183	1949-1985	37
537814	Pukenui	NIWA	2585600	6607000	85	128	139	140	154	272	204	172	158	138	106	113	1879	107	1977-1983	6
537815	Kereru	NRC	2586500	6606700	97	106	115	124	161	198	197	192	155	125	107	111	1688	110	1978-	29
537901	Parakao	Met	2596919	6609117	89	102	107	116	140	166	166	157	119	109	91	102	1464	55	1951-	56
538610	Omamari Block	NIWA	2572300	6597400	66	93	57	95	130	136	132	109	88	78	79	87	1102	61	1962-1970	8
538710	Maropiu	NIWA	2577600	6600200	97	83	109	143	160	172	157	178	131	138	119	86	1527	46	1965-1976	11
538801	Mamaranui	Met	2582896	6592630	77	87	93	104	128	154	144	138	107	97	84	88	1301	49	1951-	56
538810	Nash, Waihue	NRC	2586600	6596200	80	84	97	113	123	164	151	141	113	95	85	92	1342	4	1962-1996	35
538811	Booths	NIWA	2587000	6599900	88	76	100	134	109	177	160	148	133	114	90	94	1410	53	1971-1981	9
539710	Baylys Beach	NRC	2578100	6583100	77	69	81	87	105	128	123	113	96	80	74	78	1111	60	1976-	31
539801	Dargaville	Met	2587331	6585257	86	86	77	98	131	146	139	125	99	97	85	81	1253	46	1905-1990	86
539802	Dargaville	Met	2585776	6583387	68	80	85	98	124	146	136	123	101	97	77	82	1218	15	1943-1999	57
539803	Dargaville N.Z.E.D.	Met	2590309	6585223	77	82	84	96	112	128	129	123	104	90	77	84	1196	14	1965-1988	24
539806	Dargaville EWS	Met	2587531	6585282	88	45	55	93	99	122	155	105	62	70	94	79	1067	46	1997-	10

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539807	Dargaville 2 EWS	Met	2587531	6585282	55	85	65	70	145	170	94	64	83	108	62	67	1068	46	2003-	4
539811	Dargaville County	NRC	2588400	6584300	85	74	92	89	117	115	132	131	110	78	60	92	1166		1981-1989	8
539910	Hoanga	NRC	2594000	6588100	82	89	78	113	117	169	147	145	118	110	97	85	1380	1	1965-1987	19
541001	Purerua Aws	Met	2603555	6675475	69	55	102	80	118	108	118	147	101	88	63	78	1127	82	1983-	24
541301	Cape Brett lighthouse	Met	2632390	6668888	69	77	77	106	112	124	120	119	82	82	70	64	1101	40	1934-1978	45
542001	Waitangi Forest	Met	2607928	6660800	76	110	116	118	102	186	163	156	130	100	85	81	1417	55	1963-1986	24
542010	Wakelins Block	NRC	2606500	6657800	106	95	120	112	125	178	177	159	139	112	97	98	1518	31	1979-	28
542101	Russell	Met	2613935	6660718	95	98	106	122	149	161	166	159	121	99	86	89	1451	2	1919-	88
543001	Kawakawa WTP	Met	2607731	6646044	100	106	105	124	156	170	170	158	125	109	88	95	1506	8	1918-	89
543010	McDonald Rd, Waitangi	NRC	2604509	6651733	99	57	92	96	110	124	175	140	153	107	84	94	1358	91	1986-	15
543012	Whangae	NRC	2604700	6649700	114	97	127	133	144	148	193	145	144	115	98	101	1559	180	1981-	26
543110	Opua	NRC	2612300	6652400	99	78	91	120	135	162	189	136	130	109	89	118	1456	45	1993-	14
543310	Russell State Forest	NIWA	2629900	6646600	104	124	124	135	118	230	191	156	138	140	109	83	1689	15	1973-1986	13
543311	Murphy	NRC	2632800	6644700	106	106	118	143	164	172	193	152	131	118	102	125	1630	3	1993-	14
544002	Opahi Stn, Motatau	Met	2603045	6635008	80	117	109	132	143	161	148	166	129	114	93	107	1506	58	1948-1977	30
544101	Towai	Met	2613572	6634867	98	99	132	160	135	182	180	189	136	130	90	103	1627	122	1958-1981	24
544110	Coynes	NIWA	2620500	6636500	76	195	163	194	141	243	149	221	173	173	102	87	1866	137	1969-1975	6
544210	Reeds	NIWA	2627700	6636800	105	223	219	284	202	377	268	343	197	175	161	125	2767	244	1967-1975	8
544211	Hills	NIWA	2624300	6638200	134	257	242	267	204	286	226	293	155	152	122	144	2515	396	1964-1972	8
544310	Teal Bay	NIWA	2634700	6639300	86	169	178	119	150	223	172	160	140	115	93	91	1705	4	1979-1986	8
544311	Peach Orchard Rd	NRC	2628600	6635100	155	153	189	186	208	230	271	235	208	167	151	155	2308	120	1982-	25
545013	Motatau at Okaroro	NRC	2604054	6630730	104	92	103	118	150	146	184	142	134	113	91	127	1504		1995-	12
545111	Dawson, Needhams	NRC	2615000	6632800	117	106	128	121	130	167	184	163	135	114	96	107	1568	120	1978-	29
545201	Puhipuhi Auto	NRC	2626500	6632000	126	145	165	167	201	215	234	212	165	143	120	117	2010	215	1905-	102
545210	Forsythe Rd	NIWA	2621000	6624600	92	117	114	131	120	208	161	185	143	132	99	86	1592	100	1968-1982	14
545212	Waiotu	NRC	2622300	6632500	100	166	176	172	147	233	198	209	166	158	121	106	1917	12	1965-1988	23
545213	Morgan	NRC	2619700	6630300	119	99	130	119	130	170	185	166	148	121	104	101	1592	122	1974	33
545310	Opuawhanga	NRC	2633500	6631300	123	134	170	173	153	234	220	201	168	147	133	111	1967	107	1968-	39
545311	Maureen's	NIWA	2635400	6625400	108	117	173	161	128	274	199	207	139	168	103	77	1851	121	1970-1981	21
545312	Dandelion	NRC	2628600	6632400	145	131	162	178	219	222	271	186	173	145	144	166	2142	190	1995-	12
545411	Thomas	NIWA	2641700	6622800	119	97	163	174	160	240	196	206	161	163	108	71	1859	186	1968-1978	10
545412	Taihoa	NIWA	2641900	6623900	139	145	213	136	139	214	165	183	168	157	142	94	1867	146	1979-1991	12
545413	Baileys	NIWA	2639200	6624200	110	191	219	147	123	280	177	172	149	183	149	102	1888	183	1979-1985	6
545501	Matapouri	Met	2646712	6625017	84	81	117	123	119	158	146	144	115	93	90	78	1348	3	1967-	40
546001	Puketurua	Met	2608758	6614513	59	107	95	134	114	166	126	155	118	96	102	106	1392	101	1965-1975	11
546030	Pukewaenga	NIWA	2584000	6613800	79	101	101	117	103	166	144	149	115	97	91	109	1371	71	1964-1985	20
546031	Pukeiti	NIWA	2583000	6613400	81	103	100	135	118	181	149	160	123	101	102	111	1441	111	1965-1980	15
546032	Woolshed	NIWA	2589000	6614000	81	100	89	154	124	177	134	162	142	108	108	113	1502	122	1965-1976	11
546103	Ruatangata	Met	2617840	6616273	112	117	122	138	179	164	184	167	130	123	98	104	1643	183	1905-1962	58
546111	Rarewa	NIWA	2616300	6617100	85	92	102	137	115	206	144	156	121	136	92	96	1441	91	1968-1981	13
546202	Hikurangi	Met	2626953	6619798	92	121	152	146	142	184	191	166	147	123	101	109	1682	80	1956-1999	44
546203	Ruatangata No 2	Met	2620891	6614341	96	111	115	127	129	161	175	164	136	111	98	104	1527	152	1963-	44
546210	Matarau 2	NIWA	2621400	6617600	87	107	118	155	129	205	156	174	137	129	99	95	1588	155	1966-1981	15
546211	Tanekaha	NIWA	2619800	6621900	46	143	123	188	129	193	155	166	121	104	99	113	1339	91	1966-1974	8
546212	Jordan Valley	NRC	2621700	6621400	98	98	114	128	121	171	177	166	137	116	99	101	1526	107	1967-	40
546216	Okarika Auto	NRC	2616505	6620237	86	86	87	100	117	154	165	138	135	83	91	82	1324	106	1977-	30
546218	Cathcart, Wairua	NRC	2617729	6616274	99	107	123	105	145	138	196	144	121	108	101	102	1489		1990-	17
546301	Glenbervie Auto	NRC	2632545	6615246	109	136	167	151	164	198	190	189	154	137	116	115	1826	100	1947-	60
546310	Totara Rock	NIWA	2643400	6616800	78	145	185	128	128	233	194	172	150	125	116	116	1843	100	1976-1986	10
546311	Whangarei Falls	NIWA	2630900	6611800	96	149	161	124	137	228	157	171	144	133	84	122	1803	100	1978-1986	8
546315	Hansen	NRC	2631800	6612700	115	89	135	122	137	155	206	166	153	107	118	110	1613	80	1987-	20
546316	Batt	NRC	2637100	6615800	129	99	155	129	154	171	220	170	151	124	131	123	1756	85	1987-	20

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546411	Sands	NIWA	2642600	6621100	98	124	167	177	152	259	189	188	151	150	119	84	1843	151	1966-1984	18
546412	Ferguson	NRC	2641900	6619800	116	128	162	155	165	219	203	191	158	139	122	103	1861	137	1968-	39
546413	Noble Todd	NIWA	2640100	6622800	105	144	191	166	149	250	173	196	157	152	119	88	1876	155	1968-1988	20
546414	Dugmores	NIWA	2640000	6621700	118	105	160	177	154	241	191	192	153	165	99	68	1828	158	1968-1978	10
546415	Lookout	NIWA	2637900	6622100	134	110	167	188	167	260	197	210	157	182	108	80	1960	290	1968-1978	10
546416	Polerain, Ngunguru	NRC	2640430	6621278	131	117	136	149	168	192	242	197	157	123	137	140	1889	150	1987-	20
546510	Broughtons, Riponui	NRC	2611800	6620200	98	92	115	118	111	173	155	160	146	110	91	107	1482	10	1969-1998	29
546511	Whangaumu Bay	NRC	2649500	6617300	141	87	143	103	127	120	128	173	154	95	98	79	1404	8	1985-1990	6
546512	Lambly	NRC	2649200	6617300	90	92	110	105	126	141	172	139	98	97	83	109	1362	5	1993-	14
547001	Wairua Falls	Met	2607161	6603437	92	94	94	112	136	149	152	138	112	101	90	91	1356	15	1916-1995	80
547002	Titoki	Met	2607235	6608985	88	90	93	104	112	137	145	138	114	93	81	93	1288	28	1967-	40
547112	Totara Grove	NIWA	2616700	6603800	96	103	120	115	99	192	157	149	136	128	91	98	1503	143	1973-1985	12
547113	Rosehill	NIWA	2618100	6607600	86	156	136	98	102	186	142	138	125	120	99	123	1509	120	1979-1986	7
547201	Maungatapere	Met	2619216	6605154	99	131	134	132	151	170	167	176	138	118	111	106	1632	122	1948-1989	41
547212	Kokopu Block Rd	NIWA	2618400	6607700	84	134	113	107	108	184	145	141	124	110	85	105	1503	115	1977-1986	7
547214	Totara Place	NIWA	2628000	6605600	103	97	124	108	127	152	173	148	132	108	88	95	1455	61	1978-	29
547215	Maungatapere	NIWA	2619200	6602900	86	137	133	116	116	199	189	153	139	118	89	113	1632	170	1976-1986	10
547219	Cemetery Rd	NRC	2623500	6604600	121	110	131	125	135	154	175	160	139	117	104	111	1582	120	1979-	28
547220	Te Hihi	NRC	2625200	6606500	142	91	128	148	134	179	210	169	150	115	118	110	1694	168	1988	19
547222	Lynwood Farm	NRC	2623700	6605700	111	124	147	135	137	177	172	186	155	131	110	107	1701		1967-1993	26
547223	Redwood	NRC	2619200	6602900	115	99	117	118	146	162	183	159	142	105	99	106	1551	160	1983-	24
547224	McIntosh, Otaika Valley	NRC	2626529	6600580	94	91	111	111	139	154	166	141	120	94	88	110	1419		1995-	12
547225	Whatitiri at Coopers	NRC	2616521	6603080	140	91	108	132	172	159	202	159	120	109	119	119	1630		1998-	9
547302	Whangarei	Met	2632814	6606831	103	117	123	136	181	170	195	175	130	119	94	92	1639	37	1909-1967	58
547303	Whangarei Aero	Met	2634290	6603033	81	119	128	131	139	167	162	154	125	113	90	94	1501	37	1943-1988	45
547304	Whangarei Hospital	Met	2628291	6606903	97	106	135	132	121	186	162	162	133	132	88	89	1533	29	1970-1988	19
547305	Whau Valley	Met	2628349	6610564	112	104	146	134	126	175	177	178	156	137	101	97	1650	152	1970-1993	24
547307	Whangarei Aero AWS	Met	2634290	6603033	83	73	103	92	106	137	159	115	111	90	93	93	1255	37	1992-	15
547312	Waitangi Rd	NIWA	2632700	6616300	148	161	174	124	146	212	214	212	168	129	128	127	2030	180	1977-1990	13
547315	Kaka St	NRC	2630200	6606700	99	91	134	77	110	121	161	187	152	105	73	104	1472	180	1983-1993	10
547316	Steele	NRC	2632200	6606700	130	96	138	100	124	112	177	190	168	103	93	99	1498		1984-1995	11
547338	Robert St, Whangarei	NRC	2630500	6607500	83	61	115	113	96	141	193	136	121	93	95	81	1321	5	1989-	
547402	Waiparera	Met	2643430	6608427	73	116	127	156	128	189	163	189	133	87	97	89	1571	91	1965-1976	9
547411	Parua Bay	NRC	2642100	6602500	98	83	136	113	128	151	180	160	134	103	101	105	1492	20	1986-	21
547412	Massey	NRC	2643600	6606100	83	94	126	103	130	156	184	134	136	90	96	96	1428	20	1992-	15
547510	Greenstone Downs	NIWA	2649300	6603600	107	65	87	121	109	234	140	111	111	107	99	51	1475	40	1973-1981	8
547511	Bishells	NIWA	2651000	6607600	76	141	114	107	91	177	100	103	119	96	71	88	1257	2	1979-1986	7
547512	Taiharuru	NRC	2651000	6606600	90	69	85	89	89	131	146	187	111	81	84	80	1242	5	1988	19
548101	Tangihua	Met	2611581	6596052	98	110	105	118	127	159	159	153	127	111	105	97	1462	84	1958-1992	35
548201	Mangapai	Met	2626580	6595831	94	82	113	101	114	149	156	138	121	98	96	94	1356	27	1970-	37
548210	Palmer	NRC	2625400	6596000	96	54	91	100	96	138	173	134	120	89	101	87	1287	85	1988-	12
548211	Jones	NRC	2626300	6595200	105	84	119	123	115	169	177	151	137	113	110	104	1513	100	1972-	28
548212	NZRC at Marsden Pt	NRC	2645324	6594563	94	74	104	81	102	126	145	126	112	74	84	82	1204		1986-	21
548213	Ruakaka at Fosters	NRC	2642872	6589987	96	96	93	100	167	140	157	137	97	107	78	105	1373		2000-	7
548310	Whittle	NRC	2629500	6591400	93	91	111	115	125	163	158	153	123	110	105	106	1453	137	1964	43
548311	Sloanes	NRC	2633700	6590100	85	87	114	115	128	196	149	150	107	133	101	90	1455	3	1969-1984	15
548313	Cotton	NRC	2628800	6590900	102	107	148	122	112	182	180	161	123	119	111	128	1594		1976-1988	12
548402	Marsden Power Stn	Met	2643109	6590009	104	80	117	122	106	176	140	138	119	102	87	90	1393	3	1970-1990	21
548410	Prescott	NRC	2638600	6587200	100	68	124	97	117	143	170	150	142	124	103	100	1452	27	1980-	20
548411	Prescotts weir	NIWA	2638500	6588300	66	47	109	85	90	160	181	127	129	87	70	85	1230	35	1992-	8
548510	Taurikura	NIWA	2648300	6596100	61	98	120	165	133	174	156	172	109	77	89	83	1476	30	1965-1975	10
548511	Darch Point	NIWA	2645600	6596800	87	155	123	123	105	162	120	140	127	102	78	106	1505	8	198 <mark>0-1986</mark>	7

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549010	Monymusk	NRC	2604900	6578000	92	76	90	96	119	142	152	133	110	98	88	102	1298	20	1976	31
549011	Omana Bull	NRC	2596000	6586400	82	84	102	98	107	132	156	139	123	100	86	91	1292		1981-1998	17
549110	Manganui Bull	NRC	2613600	6581900	93	63	94	116	101	153	177	114	110	82	83	89	1327	80	1993-	7
549201	Waikiekie	Met	2623401	6582895	92	115	120	122	147	172	161	163	131	122	113	111	1568	107	1956-1977	22
549211	Keay	NRC	2626900	6579700	107	86	115	115	131	165	165	154	136	112	107	107	1500	40	1970-	37
549310	Taipuha Settlement	NRC	2627900	6577900	99	93	125	136	125	162	147	164	124	112	110	110	1515	6	1963-1993	30
549311	Carters	NIWA	2631400	6587800	68	87	166	190	158	213	128	163	114	117	116	121	1675	152	1967-1975	8
549402	Apple Cross, Waipu	Met	2636966	6584565	96	110	130	146	156	185	163	172	138	121	104	124	1664	27	1954-1977	24
630901	Arapohue	Met	2594733	6577735	78	79	81	98	116	137	132	119	102	95	81	84	1202	61	1955-	52
640010	Naumai	NIWA	2615000	6570800	80	66	94	121	109	161	138	126	115	105	88	74	1291	30	1970-1983	13
640201	Taipuha	Met	2626292	6577302	91	116	105	124	145	162	138	169	114	127	112	101	1543	18	1948-1977	30
640310	Finlayson Brook	NRC	2634200	6574700	108	90	137	111	136	149	173	171	147	124	104	120	1576	3	1981-1996	25
640411	Glenmohr Rd	NRC	2639700	6572400	90	90	115	120	126	171	161	157	127	111	103	98	1469	61	1969-	38
640436	Brynderwyn Auto	NRC	2638300	6571800	87	82	101	98	125	151	157	151	125	108	100	99	1384	92	1981-	26
640501	Waipu Cove	Met	2645792	6573314	81	83	103	103	117	152	144	136	107	97	93	93	1309	61	1948-	59
641001	Ruawai	Met	2602141	6564659	69	84	84	100	117	147	132	126	93	93	86	84	1210	5	1946-1985	40
641102	Claren Brae, Ruawai	Met	2611120	6562763	83	66	88	98	118	134	151	127	105	95	85	80	1230	70	1968-	39
641201	Paparoa 1	Met	2623148	6566251	91	100	96	112	135	157	149	153	107	105	115	96	1416	30	1938-1970	33
641203	Paparoa 2	Met	2621617	6566274	86	55	95	102	113	140	142	147	111	98	84	88	1238	28	1971-1994	24
641210	Higgins (Paparoa)	NRC	2621700	6566100	90	67	111	114	124	163	190	146	129	110	96	100	1440	10	1991-	16
641302	Melford, Maungaturoto	Met	2633562	6558651	85	93	111	109	132	156	147	158	123	106	98	100	1417	17	1952-1997	46
641310	Nthld Dairy Co	NRC	2634300	6565500	80	85	92	102	139	164	186	126	126	109	93	103	1405	20	1992-	15
641410	Topuni Saunders	NIWA	2641600	6555900	102	116	117	105	109	179	147	133	120	106	87	116	1421		1977-1987	10
641413	Hakaru	NRC	2644400	6561300	104	80	114	106	117	146	162	147	134	106	113	111	1440	100	1980-	27
641501	Mangawhai	Met	2651625	6562109	75	80	83	100	115	148	134	123	96	91	80	74	1203	4	1917-1990	74
641511	Tara	NRC	2647406	6564719	91	100	117	139	142	190	179	167	130	122	115	106	1598	90	1946-	61
642102	Pouto	Met	2609363	6546139	86	83	103	125	118	105	119	135	105	87	63	89	1217	97	1980-1987	8
642201	Pukehau	Met	2622979	6555155	76	72	91	88	109	134	128	125	103	90	83	88	1187	61	1955-	52
642401	Topuni	Met	2640966	6554863	90	87	105	115	130	151	138	153	114	103	94	99	1386	63	1948-1992	45
643112	Rotokawau	NRC	2614500	6539700	60	44	66	64	91	103	123	94	96	63	74	78	986	3	1976-1990	8

# **10.11** Appendix B: Flow statistics for Northland rivers

Table 16: Flow statistics from various flow stations in Northland

Site number	River	Area (km2)	Authority	Min flow (I/s)	Median flow (I/s)	Mean flow (l/s)	Max flow (m3/s)	Annual flood (m3/s)	Years of record	Data start
802	Selwyn Swamp	1.74	NRC	2	16	31	3	1.2	42	1965
1316	Awanui	222	NIWA	322	2801	6093	251	149	49	1958
1903	Oruru	79	NIWA	369	1342	2273	96	64	19	1988
3412	Rangitane	21.4	NRC	17	439	675	47	23	30	1977
3506	Maungaparerua	11.1	NIWA	11.3	200	452	89*	47	40	1967
3722	Waitangi	302	NIWA	204	4088	8035	605	227	28	1979
3819	Waiharakeke	229	NRC	12	2005	5054	188	84	40	1967
4901	Ngunguru	12.5	NRC	45	207	391	114	55	38	1969
5527	Waiarohia	18.6	NRC	20	152	334	98	30	28	1979
5528	Raumanga	16.3	NRC	48	192	330	69	24	28	1979
5901	Ruakaka (WDC Take)	45.3	NRC	0*	231	805	87	45	23	1984
6007	Waionehu	24.5	NRC	1	165	459	29	24	25	1982
6015	North	38.4	NRC	48	386	902	63	39	25	1982
6016	Waihoihoi	25.1	NRC	26	266	525	33	19	23	1984

Site number	River	Area (km2)	Authority	Min flow (I/s)	Median flow (I/s)	Mean flow (I/s)	Max flow (m3/s)	Annual flood (m3/s)	Years of record	Data start
6018	Ahuroa (Braigh Flats)	57	NRC	46	560	1241	170	72	24	1983
46611	Kaihu (Gorge)	116	NRC	526	2529	4102	395	150	37	1970
46618	Mangakahia (Twin Bridges)	246	NIWA	968	5005	9607	1080	484	47	1960
46625	Hikurangi	189	NRC	104	1759	5268	299	238	47	1960
46626	Mangakahia (Titoki)	798	NRC	1567	13446	26410	949	524	24	1983
46627	Waiotu	125	NRC	105	1533	4399	159	105	20	1987
46632	Whakapara	162	NRC	310	2354	5946	582	193	51	1956
46641	Waipao	36.7	NRC	59	477	672	21	13	28	1979
46644	Wairua (Purua Bridge)	544	NRC	750	7787	18320	313	205	47	1960
46646	Mangere	79	NRC	46	590	1543	91	55	24	1983
46647	Wairua (Wairua Bridge)	707	NRC	981	11304	20960	483	233	46	1961
46651	Manganui	411	NRC	77	2841	8836	320	168	47	1960
46674	Mangahahuru	20.5	NRC	49	320	487	19	13	39	1968
47595	Punakitere	284.4	NRC	369	3254	6613	158	153	13	1994
7804	Waipapa	122	NIWA	443	2189	4618	470	248	32	1975
1046651	Opouteke	105	NRC	332	2001	3755	507	222	23	1984

Table 16 cont.: Flow statistics from various flow stations in Northland

# **10.12** Appendix C: Low flows for Northland rivers

Table 17: Mean annual low flows (MALF) and design minimum low flows (DDF) in various Northland rivers

Site	River	Area (km2)	Authority	Data Start	MALF (1 day average I/s)	1 in 5 yr DDF, (7 day min flow I/s)
802	Selwyn Swamp	1.74	NRC	1965	4	2.2
1316	Awanui (Kaitaia)	222	NIWA	1958	557	460
1903	Oruru	79	NIWA	1988	505	434
3412	Rangitane	21.4	NRC	1977	84	49
3506	Maungaparerua	11.1	NIWA	1967	33	23
3722	Waitangi	302	NIWA	1979	966	552
3819	Waiharakeke	229	NRC	1967	137	46
4901	Ngunguru	12.5	NRC	1987	79	61
5527	Waiarohia	18.6	NRC	1984	60	38
5528	Raumanga	16.3	NRC	1983	77	64
6007	Waionehu	24.5	NRC	1969	25	13
6015	North	38.4	NRC	1983	100	70
6016	Waihoihoi	25.1	NRC	1979	85	57
6018	Ahuroa	57	NRC	1979	133	94
46611	Kaihu (Gorge)	116	NRC	1983	718	609
46618	Mangakahia (Twin Bridges)	246	NIWA	1960	1451	1171
46625	Hikurangi	189	NRC	1968	394	261
46626	Mangakahia (Titoki)	798	NRC	1979	3000	2455
*46627	Waiotu (SH1)	125	NRC	1997	233	197
*46632	Whakapara (Cableway)	162	NRC	1977	851	653
*46641	Waipao	36.7	NRC	1970	239	208
*46644	Wairua (Purua)	544	NRC	1994	1850	1450
*46646	Mangere (Knight Road)	79	NRC	1984	119	102
*46647	Wairua (Wairua Bridge)	707	NRC	1961	2250	1780
46651	Manganui	411	NRC	1978	276	154
*46674	Mangahahuru	20.5	NRC	1959	105	78
47595	Punakitere (Taheke)	284.4	NRC	1958	707	526
47804	Waipapa (Puketi Forest)	122	NIWA	1960	709	559
1046651	Opouteke	105	NRC	1967	571	484

\* indicates flows that have been naturalised for the Wairua Catchment Report (WCR) i.e. water use added to recorded flow values.

# **10.13** Appendix D: Regional Council hydrometric network sites

Site				NZMG	NZMG			Record	
number	Site name	River catchment	Map ref M	Easting	Northing	Altitude m	Telemetry	began	Record end
531313	Te Rore	Takahue	O 5:452692	2544722	6669178	250	Yes	11-Dec-2003	
531415	Mangakawaka Trig	Te Puhe	O 4:531730	2552539	6672633	475	Yes	31-Jan-1996	
351716	Kaeo	Kaeo	Q 4:829707	2586600	6673000	120	Yes	19-Sep-2003	
533301	Kohe Rd	Rotokakahi	O 5:395542	2539500	6654200	36	Yes	19-Nov-1998	
533817	Ohaeawai	Waitangi	P 5:901490	2590100	6649000	122	Yes	1-Jan-1967	
534403	Opononi	Hokianga Harbour	O 6:462323	2546112	6632305	10	Yes	25-Sep-2006	
534725	Kaikohe	Waima	P 5:831406	2583100	6640600	160	na	25-Jun-1998	6-May-1999
536613	Tutamoe	Waima	O 6:698156	2569648	6615272	500	Yes	25-Nov-2003	
536812	Brookvale	Opouteke	P 6:891113	2589100	6611300	120	Yes	2-Nov-1987	
536816	Twin Bridges	Mangakahia	P 6:879187	2587766	6618749	70	Yes	22-Apr-1999	
543010	McDonalds Rd	Waitangi	P 5:045517	2604509	6651733	91	No	30-Apr-1986	
545210	Puhi Puhi	Wairau	Q 6:261312	2626071	6631192	215	Yes	1-Nov-1905	
546216	Okarika	Wairua	Q 6:163203	2616254	6620306	106	No	22-Feb-1988	
546301	Glenbervie Forest	Hatea	Q 6:325152	2632500	6615200	100	No	31-Aug-1947	
546416	Polerain	Ngunguru	Q 6:404213	2640430	6621278	150	Yes	28-Oct-1987	
547336	Whau Valley	Waiarohia	Q 7:279099	2627855	6609920	60	na	2-Nov-1979	16-Nov-1987
547337	Base Hospital	Raumanga	Q 7:284062	2628392	6606247	29	na	20-Nov-1987	26-Jul-1988
547338	Robert Str	Hatea	Q 7:305076	2630500	6607600	10	na	16-Nov-1989	25-Jun-2004
547339	NRC Water Street	Waiarohia	Q 7:299076	2629899	6607524	15	Yes	25-Jun-2004	
547340	Kensington	Waiarohia	Q 7:297092	2629607	6609207	40	Yes	19-Nov-2006	
548215	Marsden Point	Whangarei Harbour	Q 7:453952	2645291	6695129	5	Yes	20-Sep-2006	
640436	Brynderwyn	Ahuroa	Q 8:382719	2638225	6571943	350	Yes	16-Feb-1981	
641213	Maungaturoto	Paparoa	Q 8:323671	2632238	6566979	120	Yes	21-Apr-2005	
641214	Taylors	Paparoa	Q 8:248650	2624714	6565041	80	Yes	20-Jul-2005	
641511	Tara	Mangawhai Harbour	Q 8:477646	2647700	6564600	90	Yes	12-Dec-1989	
643118	Pouto Point	Kaipara Harbour	Q 9:166370	2616556	6536998	20	Yes	23-Nov-2006	
644210	Kanono	Lake Kanono	Q 9:141366	2614090	6536582	61	na	21-Dec-1978	26-Jun-1979

Table 18: Regional Council automatic rainfall sites and the river catchment they are located in.

# Table 19: Regional Council automatic water level (WL) and flow sites

Site number	Station type	River/lake name	Site name	Map ref NZMS	NZMG Easting	NZMG Northing	Catchment area (km2)	Telemetery	Record began	Record end
802	Flow	Selwyn Swamp	Big Flat Rd	N 4:265981	2526512	6698076	1.74	Yes	26-Aug-1965	
1204	WL	Lake Ngatu	Western Acres	N 4:288854	2528719	6685395	na	na	6-Jun-1990	15-Apr-1992
1310	Flow	Whangatane	Spillway	Q 4:348780	2534817	6678057	na	Yes	30-Jul-2004	
1314	Flow	Awanui	Waikuruki	O 4:344776	2534352	6677557	229	na	2-May-1972	5-Feb-1992
1319	Flow	Victoria	Double Crossing	O 4:408760	2540800	6676000	na	na	3-Apr-1990	23-Apr-1992
1324	Flow	Victoria	Victoria Valley Rd Br	O 4:481727	2548025	6672695	53.6	na	30-Mar-1990	23-Apr-1992
1335	Flow	Tarawhataroa	Puriri Place	O 4:353755	2535270	6675489	na	Yes	30-Jul-2004	
1351	Flow	Victoria	Victoria Valley Rd	O 4:488722	2548703	6672110	na	Yes	16-Aug-2006	
1342	Flow	Te Puhi	Meffin Rd	O 4:446767	2544600	6676700	69.6	Yes	28-Mar-1990	28-Mar-1992
1343	Flow	Takahue	Diggers Valley Rd	O 4:423708	2542300	6670800	55.4	na	26-Jun-1990	23-Apr-1992
1347	WL	Awanui	Ben Gunn Wharf	O 4:435880	2534611	6688292	na	Yes	30-Jul-2004	-
1348	Flow	Takahue	Gray's	O 5:427690	2542706	6669073	na	Yes	18-Feb-2004	
3409	Flow	Waipapa	Pungaere Rd	P 5:915670	2591489	6667004	17.7	na	18-Sep-1975	4-Mar-1981
3412	Flow	Rangitane	Tubbs	P 5:995674	2599549	6667420	21.4	na	14-Jul-1977	30-Oct-2001
3413	Flow	Waipapa	Landing	P 5:991660	2599051	6665971	32.3	na	12-Jul-1977	4-Mar-1981
3432	Flow	Rangatane	Stirlings	P 5:989670	2598857	6667064	na	Yes	10-Oct-2001	
3503	Flow	Puketotara	Backblocks	P 5:916615	2591610	6661513	23.1	na	9-Sep-1975	31-Jan-1989
3515	Flow	Kerikeri	Peacock Gardens	P 5:972643	2597661	6664618	na	na	14-Jul-1977	15-Mar-1981
3707	Flow	Waiaruhe	Puketona	P 5:981549	2598104	6654930	175	na	1-Feb-1984	10-May-2000
3819	Flow	Waiharakeke	Willowbank	P 5:034446	2603396	6644629	229	Yes	2-Feb-1967	
3829	Flow	Tirohanga	D/S County Intake	P 5:103466	2610300	6646600	56.1	na	21-Mar-1989	23-Dec-1996
3835	WL	Veronica Channel	Opua	Q 5:127537	2612700	6653700	na	Yes	26-Apr-1990	
4901	Flow	Ngunguru	Dugmores Rock	Q 6:378164	2637800	6616400	12.5	Yes	22-Aug-1969	
5527	Flow	Waiarohia	Lovers Lane	Q 7:298076	2629802	6607579	18.6	No	17-Oct-1979	
5528	Flow	Raumanga	Bernard St	Q 7:295067	2629502	6606673	16.3	No	30-Oct-1979	
5538	Flow	Hatea	Whareora Rd	Q 6:311101	2631062	6610105	38.55	na	30-Jun-1986	24-Mar-1995
5539	WL	Hatea	Town Basin	Q 7:307076	2630700	6607600	na	na	7-Jan-1986	10-May-1994
5541	WL	Whangarei Harbour	Port Whangarei	Q 7:328040	2632800	6604000	na	na	29-Aug-1989	10-Feb-1992
5801	WL	Whangarei Harbour	Mardsden Pt	Q 7:453952	2645300	6595200	na	Yes	19-Jun-1989	
5901	Flow	Ruakaka	Flyger Rd	Q 7:374915	2637403	6591542	45.3	Yes	19-Mar-1984	
6007	Flow	Waionehu	McLean Rd	Q 8:421759	2642085	6575860	24.5	Yes	10-Nov-1982	
6014	Flow	Ahuroa	Durham Rd	Q 8:378730	2637796	6572961	18.6	na	29-Apr-1981	27-Jun-1997
6015	Flow	North	Applecross Rd	Q 7:379838	2637916	6583752	38.4	Yes	11-Nov-1982	
6016	Flow	Waihoihoi	St Marys Rd	Q 8:395763	2639536	6576298	25.1	No	27-Jan-1984	
6017	Flow	Millbrook	Millbridge Rd	Q 7:384802	2638364	6580172	16.6	na	17-Nov-1982	3-Dec-1984

Site	Station			Map ref	NZMG	NZMG	Catchment		Record	
number	type	River/lake name	Site name	NZMS	Easting	Northing	area (km2)	Telemetery	began	Record end
6018	Flow	Ahuroa	Braigh	Q 8:379768	2637904	6576801	57	Yes	29-Aug-1983	
46602	WL	Lake Kanono	Kanono Outlet	Q 9:139367	2613910	6536678	na	na	16-Feb-1977	24-May-1982
46611	Flow	Kaihu	Gorge	P 7:727042	2572725	6604237	116	Yes	2-Mar-1970	
46613	Flow	Kaihu	Rotu	P 7:804938	2580389	6593779	259	na	30-May-1977	16-Sep-1980
46625	Flow	Hikurangi	Moengawahine	P 6:050167	2604994	6616689	189	Yes	9-Apr-1960	
46626	Flow	Mangakahia	Titoki Br	P 7:059071	2605914	6607059	798	Yes	28-Feb-1983	
46627	Flow	Waiotu	SH1 Br	Q 6:222290	2622168	6629014	125	Yes	20-Oct-1987	
46632	Flow	Whakapara	Cableway	Q 6:262284	2626175	6628354	162	Yes	29-Sep-1956	
46633	Flow	Kaihu	Parore Cut	P 7:858873	2585801	6587234	na	Yes	16-Feb-2006	
46641	Flow	Waipao	Draffins Rd	Q 7:127077	2612700	6607691	36.7	Yes	22-Jun-1979	
46644	Flow	Wairua	Purua	Q 6:149159	2614941	6615862	544	Yes	21-Mar-1960	
46646	Flow	Mangere	Knights Rd	Q 6:143109	2614252	6610850	79	Yes	8-Feb-1983	
46647	Flow	Wairua	Wairua Br	P 7:097072	2609669	6607228	707	Yes	6-Sep-1961	
46651	Flow	Manganui	Permanent Station	Q 7:111816	2611054	6581578	411	Yes	20-May-1960	
46654	WL	Northern Wairoa	Kirikopuni	P 7:020959	2602035	6595916	na	na	29-Feb-1988	21-Feb-1996
46655	WL	Northern Wairoa	Dargaville	P 7:894841	2589356	6584107	na	Yes	16-Jan-1981	
46674	Flow	Mangahahuru	County Weir	Q 6:295170	2629517	6617008	20.5	Yes	15-Dec-1968	
46675	WL	Northern Wairoa	Tangiteroria	P 7:046973	2604635	6597308	na	na	3-Dec-1979	11-May-2000
46683	WL	Northern Wairoa	Tangowahine	P 7:943921	2594337	6592108	na	na	19-Oct-1979	7-Apr-1982
46684	WL	Northern Wairoa	Pukehuia	P 7:017888	2601652	6588793	na	na	21-Jan-1980	28-Mar-1996
46708	WL	Kaipara Harbour	Pouto Point	Q 9:166370	2616556	6536998	na	Yes	18/04/2001	
47539	Flow	Te Tunaotemaku	Rock Weir	P 5:832403	2583152	6640256	0.16	na	5-Jan-1989	25-Nov-1992
47540	Flow	Waikaka	Totara trees	P 5:825409	2582500	6640900	1.7	na	10-Nov-1989	30-Oct-1996
47595	Flow	Punakitere	Taheke	P 6:707373	2570700	6637300	284.4	Yes	16-Dec-1994	
48711	Flow	Rotokakahi	Kohe Rd	O 5:395542	2539500	6654200	136.6	na	25-Jun-1997	31-Jan-2004
1046651	Flow	Opouteke	Suspension Br	P 6:891114	2589114	6611370	105	Yes	13-Dec-1984	

Table 19 cont.: Regional Council automatic water level (WL) and flow sites

# **10.14** Appendix E: Awanui River Flood Management Scheme

Figure 20: Map showing Awanui River Flood Management Scheme, adapted from figure in Appendix A of the Awanui River Flood Management Plan (NRC 2005)

