Chapter 9: Freshwater

CONTENTS

Freshwater

Briefly ....

Since humans settled in Marlborough, there has been significant modification of freshwater systems, including wetlands. Various land use activities, different types of land cover, land drainage and the abstraction of water from rivers and aquifers have affected the quality and quantity of Marlborough's freshwater resources.

ISSUES

- Natural processes influencing quality and quantity of freshwater resources.
- Increased demand for water for irrigation with water being over allocated in some areas.
- Managing hydraulic links between groundwater and surfacewater resources.
- Potential for contamination of groundwater by seawater.
- Point source discharges and urban stormwater affecting water quality in rivers and streams.
- Stock walking through streams.
- Contamination of freshwater resources from failing on-site wastewater management systems, land disturbance, farming and viticulture activities.

PRESENT AND FUTURE MANAGEMENT

Water quality

Monitoring surfacewater quality

Currently there are 23 sites across Marlborough, where water quality is monitored on a monthly basis. Monitoring of water quality parameters at these sites is assessed against Australian and New Zealand guidelines for fresh and marine water quality. Monitoring shows:

- Nitrate concentrations generally have changed little over time. The lower Wairau River shows peak concentrations during winter and spring months, however maximum concentrations have changed little over the past decade. The Taylor River showed peak concentrations during the late 1990s with an apparent reduction since then, although concentrations still remain elevated over mid-1990s levels. Nitrate concentrations in the Rai River show peak winter levels steadily increasing since 1998.
- Dissolved reactive phosphorous levels are highest in urban and agriculture areas. Seasonal trends are not very apparent. The Lower Wairau shows a steady increase in concentrations in recent years although these are still within guideline values with only occasional exceedances.
- Ammonia concentrations are generally not a problem for Marlborough's surfacewaters.
- pH levels are generally within acceptable guideline levels. Higher pH levels recorded in the Awatere and the Waima Rivers are most likely because of underlying geology and soil types. High pH levels in the Upper Opawa and Waitohi Rivers is likely to be from degraded water quality.

Since sampling of macroinvertebrates began in 2000 no significant trends or changes to macroinvertebrate community structures have been detected. River sites on the Wairau Plain, including the Opawa, Tuamarina, Wairau Diversion, the urban spring sites in Blenheim and the urban sites in Picton, show fair to poor scores indicating that either or both water quality and habitat quality are degraded at these locations. The Graham River, located east of Waikawa, despite having more than 90% indigenous land cover in the catchment, only rates 'Good' and not 'Excellent' as might be expected for such a catchment.

Freshwater bathing quality

Monitoring of freshwater bathing quality began in 1996. 13 sites are sampled on a weekly basis over summer and assessed against national guidelines. Comparing results since sampling first began shows different trends in different parts of Marlborough.

- Two sites on the Pelorus River show a slight deterioration in bathing water quality since 1996. However, the median E. coli numbers for the Pelorus Bridge site are still very low in relation to Rai River sites and percentage compliance with the standards are highest for this site in the Rai/Pelorus catchment.
- Summer sampling shows water quality to be poor in the Rai River. However, when these results are combined with sampling carried out at other times of the year for the Clean Streams Accord and for state of the environment monitoring, there is a trend showing a decrease in median E. coli numbers.
- Monitoring in the Wairau catchment shows considerable improvement since 1996. The median E. coli number has dramatically reduced since monitoring began and compliance with the bathing water standards has increased, especially in the Wairau Diversion. Bathing water quality in the Opawa and Taylor Rivers has improved since monitoring began, particularly in the Taylor River where compliance with the bathing water standard has increased from 10% compliance to 80% compliance.

Impacts of dairying on water quality

In response to concerns about the impacts on water quality from dairying, programmes like the Dairying and Clean Streams Accord have been set up. The accord is supported locally through a regional action plan, which includes targets about cattle access to waterways, dairy herd stream crossings, dairy shed effluent discharges etc.

Monitoring has established strong links between dairy farming and degraded water quality in the Rai River catchment. Contaminant levels in water samples were higher during the milking season, but still occurred during dry periods (when there was little runoff) and peaked twice daily. With many permanently flowing rivers and streams in the catchment, there is a high number of regular stream crossings made by cows. A survey of all dairy farming properties in the Rai catchment in 2003 identified 112 dairy herd stream crossings. By 2007, this had been halved (to 56) and the number of priority crossings (those having the greatest impact on water quality) had reduced from 43 to 15. In 2006 intensive monitoring was begun to see how water quality had improved through removal of crossings. Habitat in the immediate vicinity of the crossings has definitely improved with return of a rock substrate and increased aquatic insect populations.

Natural toxic substances in groundwater

There are naturally occurring contaminants in Marlborough's groundwaters and these may exceed drinking water standards from time to time. The Council monitors groundwater from wells representing all aquifer types beneath the Wairau Plain, to provide a clearer picture of areas where drinking water might be at risk.

Man-made compounds in groundwater

Monitoring has shown nitrate contamination is not a major problem in Marlborough aquifers. Nitrate levels are above drinking water standards for short periods at some wells but this is likely to reflect historic nutrient use and does not appear to represent a widespread problem. Historically, there have been localised hotspots west of Renwick, in the Lower Brancott/Fairhall and along the fault line in the Lower Waihopai Valley areas. Nitrates often appear in groundwater as seasonal spikes, but monitoring shows there is no trend across all wells: wells in different locations have different seasonal spikes.

The Council has investigated the impacts of vineyard support posts containing chromium, copper and arsenic on groundwater. In western parts of the Wairau Plain there is little chance of these chemicals reaching groundwater because of the thick soil layer separating them from groundwater. Conversely at Rarangi some posts in low lying areas have their "feet" in groundwater for at least part of the year. There is uncertainty about the impact on Southern Valley aquifers although to date there have been no apparent changes. Modelling undertaken predicts that concentrations will remain low in most aquifers and be of no risk to human health.

Since 1993 the Council has taken part in a 4 yearly national groundwater pesticide survey. The latest survey conducted in November 2006, included 20 Marlborough sites representing various aquifer types. During this latest survey, herbicides simazine and terbthylazine, and a fungicide procymidone, were found in two Marlborough wells at very low concentrations of less than 5% of the drinking water standards. Of the two wells with positive values, one is linked to a nearby point source discharge with a history of contamination. The Council also carries out its own series of quarterly surveys at four sites to see if seasonal factors influence the presence of pesticides in local groundwater. Apart from isolated incidents related to well head security or spills, pesticide contamination is not a major issue for Marlborough aquifers.

Seawater intrusion

A network of seven wells was established along the Rarangi coast in 2000/2001 to provide early warning of contamination of groundwater by seawater. The greatest risk exists under late summer conditions when demand is greatest and the rate of freshwater flow offshore is at its lowest. Although no seawater intrusion has been evident so far, demand for water could increase in the future with further rural residential subdivision and viticulture development increasing the risk of seawater intrusion.

Rarangi groundwater quality

Because Rarangi has experienced and continues to experience land use change, the Rarangi Shallow Aquifer has become the most intensively studied and monitored aquifer in Marlborough. The aquifer is vulnerable to surface pollution and this is potentially a problem as the local community relies on this aquifer for all of its drinking water.

Elevated levels of arsenic were found in groundwater through routine monitoring of the North Rarangi community water supply in 2001. The drinking water standard was not exceeded in this well but two comprehensive surveys of all drinking water sourced from the aquifer were carried out in 2003 and 2005 to evaluate the wider risk to human health. Around 220 individual well water supplies were tested and 18% of these had high levels of arsenic, occurring in clusters near existing or buried wetlands. Two isolated occurrences of high arsenic levels appear to be related to historic sheep-dips.

Monthly surveys of 4 domestic water supplies between 2004 and 2008 showed a larger than expected fluctuation in levels with some samples being above drinking water standards. Factors causing this are not well understood but may involve changes in biochemical conditions connected with local wetlands or buried swamp deposits. Changes may also occur through rainfall or seasonal changes in aquifer level.

Other monitoring shows changes in nitrate-nitrogen and sulphate concentrations for the area north of the Wairau Diversion for a period when land was converted from pastoral farming to irrigated vineyard. It remains uncertain whether concentrations will increase, level out or decline.

Water quantity

Monitoring rainfall and river flows

Monitoring of river flows in Marlborough dates back to the late 1950s, while rainfall records at a few sites date back to the early 1900s. These ongoing records are valuable when looking at trends over time, and determining if changes are significant in relation to historical patterns. For instance, rainfall records at Sevenoaks, just south of Renwick, go back to 1903 and show dry seasons experienced between 2000 and 2007, are not dissimilar to other prolonged dry periods during the 1930s, the 1940s, and 1958 to 1965.

Monitoring data also shows an interesting comparison in the contrast between patterns of annual maximum flows for the Wairau River and Taylor River. The Wairau has its headwaters in the alps and is exposed to rain events from many directions. Variations in annual maximum flows range from about 600 cubic metres per second to about 6,000 cubic metres per second, a factor of about 10. In contrast, the Taylor River is on the dry east coast of Marlborough, and often misses major rainfall events. The range of annual maximum flows therefore is much greater; from as little as 3 cubic metres per second, up to 200 cubic metres per second, a factor of about 65.

Also notable in the Taylor River record are long periods of inactivity. In the 11 years from 1997 to 2007 there were no floods in excess of the average annual flood size of about 60 cubic metres per second, and there was also a 7 year period from 1982 to 1988 when an average annual flood was not recorded. In the Wairau River, the periods of

inactivity are shorter; the longest period when the average annual flood of about 2,000 cubic metres per second has not been recorded were the 6 years from 1977 to 1982.

Monitoring aquifer levels

The Council has operated a network of permanent wells to monitor aquifer status since the 1970s. Monitoring shows the largest changes in aquifer levels are in the Southern Valleys aquifers and the Deep Wairau Aquifer. Larger falls have occurred in Southern Valleys aquifers because of the ephemeral nature of the Fairhall and Omaka rivers recharging them. In the Wairau Aquifer, larger variations occur in the unconfined or western area. This reflects the greater concentration of abstraction locally and sensitivity to changes in recharge.

Four wells on the Wairau Plain with the longest standing records and which represent a variety of aquifer types and issues, show aquifer levels have fallen slightly over the past three decades. While the fall in some wells is greater than others, to date the level of fall is considered acceptable in terms of sustainably managing the Wairau Aquifer at a regional scale.

The Southern Valleys aquifers have been the most heavily committed and lowest yielding of Marlborough's groundwater systems. Aquifer levels have fallen by up to 10 metres since 1997, through low rainfall and increasing irrigation water demand. Demand peaked during the 2000/2001 summer drought when an estimated 1,000,000 cubic metres of water was pumped from the aquifers over a 6 month period, mostly for vineyard irrigation. The use of Southern Valleys Irrigation Scheme water instead of local groundwater since 2004, has generally seen aquifer levels stabilised and even shown a degree of recovery in some areas.

Surface/groundwater links

Many of Marlborough's significant aquifers are hydraulically linked to rivers and streams that flow near or over them. Taking groundwater close to surfacewater bodies can affect flow in the river or stream or in the case of springs, cause them to retreat downstream. Monitoring has shown:

- The biggest influence on Wairau Aquifer levels is the Wairau River. Natural losses of water from the Wairau River channel between the Waihopai River confluence and Wratts Road, supply 80% of aquifer recharge, with rainfall accounting for the remainder. Loss of river water to the aquifer is a continuous process, although rates vary depending on river flows, well level and bed sediments.
- Interaction between an aquifer and spring flow is determined by the nature of streambed sediments. Investigations on the hydraulic connection of individual springs on the Wairau Plain to see how sensitive they were to pumping showed flow in most springs could potentially be depleted by taking groundwater. Murphy's Creek was considered especially sensitive.
- The size of the wetland complex at Rarangi changes throughout the year. The wetlands reach their full extent in winter or spring, and recede in size over summer as the rate of drainage exceeds rainfall recharge. While the wetlands are dynamic and change seasonally, they are unlikely to dry up naturally. This could happen however, if overpumping of the Rarangi Shallow Aquifer occurred.

Irrigation water efficiency

Since 1992 the Council has worked with various crown research organisations and grape growers to refine how much water is needed to irrigate grape plants. The aim of the work is to make irrigators more efficient in their water use. Trial work and use of water meter readings has established that irrigators are actually using much less water than what they are allowed to. Most importantly trial work has shown no loss in the quality or quantity of fruit produced.

Computer modelling has improved understanding of how irrigation demand is affected by factors such as specific microclimates, soils and rooting depths and soil moisture. This work will help irrigators make decisions about when to irrigate during the summer. A key tool will be a programme allowing irrigators to design and implement a seasonal irrigation budget and track how much water is left at any stage in the season.

Freshwater

In depth ....

Freshwater includes groundwater and surfacewater resources. Groundwater is water located under ground, generally in aquifers. Surfacewater includes water that flows above ground, and includes rivers, streams, spring fed flows, lakes, wetlands and even artificial resources such as drainage canals and diversions.

Water and water resources have played a critical role in the development of Marlborough. Water is used to irrigate a variety of crops in the rural environment, is used in an assortment of industrial processes, is accessed by farmers and families for stock and domestic water supplies and is reticulated by the Council (and others) to provide municipal water supplies to Marlborough's larger communities. Water is also used in the generation of electricity.

Allocating rights to use resources in public ownership has become a fundamental part of the overall fabric of Marlborough's social and economic wellbeing. Our vibrant viticulture industry for example, which contributes significantly to Marlborough's economy, relies on access to freshwater resources from rivers and aquifers. However, sometimes in granting rights that allow the private use of public resources, community access to, or use of, those resources can be affected. Taking water from rivers or aquifers can reduce intrinsic and instream values and prevent other potential resource users from also taking the same water.

While Marlborough's significant freshwater resources currently sustain and enrich our communities and ecosystems, we need to ensure that freshwater quality and quantity are maintained at levels that continue to meet ecological, cultural, recreational, social and economic needs.

NATIONAL OVERVIEW

Under the Resource Management Act, the Council is responsible for making decisions on the allocation and use of water within Marlborough. However, central government is aware the country's rivers and lakes are valued for many reasons and demands on these resources are increasing, as the number and extent of various land uses grows. For these reasons central government initiated a "Sustainable Water Programme of Action" in 2003. The programme is looking at the cultural, economic, environmental and social implications of water allocation and use, water quality and water bodies of national importance.

In April 2006, Cabinet agreed to work towards the following outcomes for freshwater in New Zealand:

- Improving the quality and efficient use of freshwater by working more closely with local government, industry, Māori, science agencies and providers, and rural and urban communities.
- Improving the management of undesirable effects of land-use on water quality through greater national direction as well as through working with communities and resource users.
- Providing for increasing demands on water resources and encouraging efficient water management through national direction, working with local government on options for supporting and enhancing local decision-making, and developing best practice.

Central government has been working towards achieving these outcomes with the introduction of high level tools such as national environmental standards and a proposed national policy statement for freshwater. A brief description of these follows.

- A National Environmental Standard for Sources of Human Drinking Water came into effect on 20 June 2008. This standard will ensure that activities do not pollute drinking water sources, so water remains safe for people to drink.
- The National Environmental Standard for Measurement of Water Takes was recently approved and is being prepared for drafting into regulation. This is to help provide more accurate information about how much water is used.
- A discussion document has been available for public comment on a National Environmental Standard on Ecological Flows and Water Levels. This standard is to promote consistency in the way decisions are made about whether there is sufficient variability and quantity of water flowing in rivers, groundwater systems, lakes and wetlands.
- A discussion document on a National Environmental Standard for On-Site Wastewater Systems has also been out for public comment. This is to improve management and environmental performance of septic tanks and other on-site systems used to treat domestic waste water.
- A proposed National Policy Statement for Freshwater Management has been released for public submission. This is intended to provide a national direction to achieve key outcomes of the Sustainable Water Programme of Action described above.

PRESSURES ON MARLBOROUGH'S FRESHWATER RESOURCES

Natural factors

There are a range of natural processes that may influence the quality and quantity of our surfacewater and groundwater resources. These include characteristics of surrounding land, adjacent soil type, geology of the catchment, steepness, vegetation coverage of the surrounding landscape and climate (particularly rainfall quantity and intensity).

Looking at how climate can influence things, Marlborough's three largest rivers, the Pelorus, Wairau and Awatere Rivers all have significant catchments that extend to the western boundary of the district. Because of this, a large proportion of their flow is sourced from north-west rainfall in the Richmond Ranges and alpine areas. This means these rivers tend to have reliable flows although they can still be subject to low flows in drought conditions. In contrast, southern Marlborough has a much drier climate with many of the smaller streams being ephemeral - meaning they only flow for their full length after long periods of rainfall. These streams or rivers occur on the south bank of the Wairau River, in the Southern Valleys (e.g. the Taylor and Omaka Rivers), in the Awatere River catchment and further south (e.g. the Flaxbourne River).

The Awatere River provides an example of how topography and geology can affect surfacewater resources. Over most of its length the river is steeply graded and confined in a rock channel. In its lower reaches, it becomes deeply entrenched and has developed small alluvial flood plains. The Awatere River has a naturally high level of discolouration because of fine suspended sediments dissolved from the mudstone through which the river and its tributaries flow. The turbid nature of the river means that it is of limited value as a trout fishery, but it is still an important habitat for some of our native fish species. The gradient of the river does mean that there are a large number of riffles, which are home for the torrentfish and bluegill bully.

In terms of groundwater, geology can also be a significant factor in the quality of water. Generally groundwater chemistry largely reflects the aquifer it originated from. An area of Marlborough where the Council is carrying out research because of the unique chemistry of local groundwaters is the Wairau Valley. What has been found is that groundwater in this area can be very salty, which can be a problem for human consumption or for crop irrigation. The saltwater tends to be associated with the Wairau Fault, which runs along the upper terrace near the Wairau Valley township towards Renwick. Recent investigations by the Council and the University of Canterbury showed that while shallow groundwater is linked to rainfall or stream flow, older water at depths of more than 15 metres is commonly high in sodium, chloride, boron or arsenic and may be coming from the fault. In fact the saltiness of deep groundwater from a test well bored by the Council in the Wairau Valley is greater than seawater.


Upper Wairau River

In other areas of Marlborough the story is quite different: for example because of a short residence time and high flow rates beneath the northern Wairau Plain, groundwater does not necessarily reflect the mineralogy of the local geology. In some areas water stays underground for as little as 6 years. This means groundwater hasn't had time to acquire the chemical signature of the rocks forming the aquifer.

Human use factors

Activities that depend upon water resources such as farming, viticulture, commercial forestry, residential activity, waste disposal, transport activity, recreation and tourism, can also affect both the quality and quantity of water resources. The changing nature of some land uses has also had a significant impact on Marlborough's freshwater resources over time.

Increasing demand for water for irrigation

Marlborough has been experiencing unprecedented demand for water for irrigation purposes. More than 900 water permits authorising the taking of either surfacewater or groundwater have been granted since 1995.

The growth in demand has been fuelled by the expansion of viticulture in Marlborough. The total land area planted in grapes has increased from 2,655 hectares in 1997 to over 22,000 hectares in 2008. The expansion has occurred on the Wairau Plain, in the Waihopai and Awatere Valleys and now further south. Given Marlborough's climate and soils, the majority of vineyards need to be irrigated to survive. The expansion of viticulture into areas not traditionally irrigated has resulted in the need to access water where there was previously little or no demand.

The unprecedented demand for water has been putting pressure on certain water resources. A good example is the water shortage situation in the Southern Valleys. There, the taking and use of water from underlying aquifers has exceeded recharge in some seasons, resulting in the drawdown of aquifer levels over time. This has then affected people in being able to get enough water from the aquifers and, on a number of occasions, resulted in voluntary rationing by water users.

Water has been over allocated in some cases

The water allocation frameworks in the Council's resource management plans specify the amount of water that is available for allocation. These limits are based on best available hydrological information and allow for the flow/level requirements of natural and human use values supported by the rivers or aquifers. In some cases the Council has continued to allocate water beyond the specified allocation limits.

For example, further groundwater was allocated once the Class A allocation limits specified in the Wairau/Awatere Resource Management Plan for the various aquifers were reached. The current level of allocation for these aquifers is provided in Table 9.1. Further allocations were made on the basis that the actual rate of use (as measured by water meters) was significantly less than the paper allocation, and that the cumulative rate of use amongst all groundwater users did not appear to be adversely affecting aquifer levels.

The droughts of 1997/1998 and 2000/2001 highlighted that for aquifers in the Southern Valleys, the volume of groundwater abstracted exceeded the recharge resulting in decreasing aquifer levels. The aquifers decreased to such an extent that the ability of stock and domestic users to take groundwater was threatened. (This did result in a community response to look at the need for an irrigation scheme - see the box 'Southern Valleys Irrigation Scheme'.) In comparison, despite the apparent over-allocation

WAIRAU VALLEY DEEP GROUNDWATER SAMPLE

The photo shows a bucket of the distinctive Wairau Valley deep ground water oxidising on exposure to the atmosphere to form orange iron oxides or rust, and black manganese oxides. This water has been underground for 25,000 years based on recent tests by the Institute of Geological and Nuclear Sciences Limited. The appearance of this water immediately changed in colour as it was pumped to the surface.

in the Wairau Aquifer on paper, aquifer levels have actually remained relatively stable. This probably can be attributed to the aquifer's reliable rate of recharge from the Wairau River.

These two contrasting examples highlight the problem of using the term "over-allocation" - the phrase can mean different things to different people. Regardless, it is clear in some circumstances the level of cumulative use is adversely affecting the resource and/or the natural and human use values it supports. Given the dramatic growth in demand, it is possible this situation might arise in other catchments, particularly given the uncertainty over sustainable levels of allocation for some catchments/aquifers and climate variability in the future.

Links between groundwater and surfacewater

Many of Marlborough's significant aquifers are hydraulically linked to rivers and streams that flow near or over them. The most obvious example is the Wairau Aquifer, which is recharged from water from the Wairau River. River water flows into and through the porous river gravels that exist beyond both banks of the River as it moves downstream. Water is conveyed away from the Wairau River, at a rate of about 7000 litres of water per second just below the Waihopai River confluence.

The abstraction of groundwater close to surfacewater bodies can reduce the flow in the river or stream. This is termed "stream depletion" - see Figure 9.1. The degree of stream depletion is a function of the rate at which water is pumped from the aquifer, the distance between the well and the water body, and the nature of the aquifer under and surrounding the water body. Where a large amount of water is taken near to a river or stream and water is able to move easily through the bed of the river or stream, then there is greater potential for pumping to draw water directly from the river. If the volume of water collectively drawn from any surfacewater body by a group of groundwater users is large, then there is the potential for this groundwater abstraction to adversely affect the natural and human use values supported by the river.

Another aspect of the link between groundwater and surfacewater is where springs rely on groundwater for their supply. The water that bubbles out of the ground from aquifers to form spring fed creeks (e.g. Spring Creek, Murphys Creek, Fultons Creek, Yelverton Stream and Doctors Creek) is of a very high quality, as it has been filtered by the gravels and sands of the Wairau Plain.

The pumping of groundwater from aquifers in areas where spring fed streams emerge can result in a fall in the water table, which in turn reduces the flow of the springs, or causes them to retreat downstream. Since European settlement of the Wairau Plain, a combination of extensive drainage and groundwater abstraction for irrigation has reduced the size of many springs, especially in the Fairhall area.

Water shortages

Water users in certain parts of Marlborough experience water shortages on a seasonal basis. This is because of low rainfall over the summer months and/or water resources that are not sufficient to meet demand. Examples include the Southern Valleys, where groundwater use has proven to be unsustainable, and the eastern catchments such as the Blind and Flaxbourne catchments. The lack of water at critical times of year has had the effect of constraining use and development of rural land resources in those areas.

In this context, there have been various community initiatives to bring water to water short areas. At least four irrigation schemes have been either investigated (Ward Water Study), or have been consented (Wairau Valley Irrigation Scheme) or have been constructed and are now operational (Southern Valleys Irrigation Scheme, Blind River Irrigation Scheme). There may be further

TABLE 9.1: ALLOCATION LIMITS AND THE CURRENT LEVEL OF ALLOCATION FOR SOUTH MARLBOROUGH AQUIFERS (2008)

Aquifer	Class A Allocation (m^3/day)	Actual Allocation (m^3/day)
Wairau Aquifer	346,000	450,800
Omaka River Valley	14,860	14,860
Brancott Aquifer	3000	5302
Omaka Aquifer	1900	3745
Benmorven	1700	1915
Fairhall River Gravels	800	957

opportunities to boost water supplies by transporting water from areas where there is surplus water to water short areas. At the same time, taking water out of a catchment may affect existing or potential users of water in the source catchment.

Further residential subdivision in water short areas can make existing water shortages even worse as land owners can take up to 10m^3 per day for domestic needs and for stock water without the need for a resource consent. The combined effect of all of these water takes in a water short area can put further strain on an already stressed water resource and reduce the reliability of supply for existing water users.

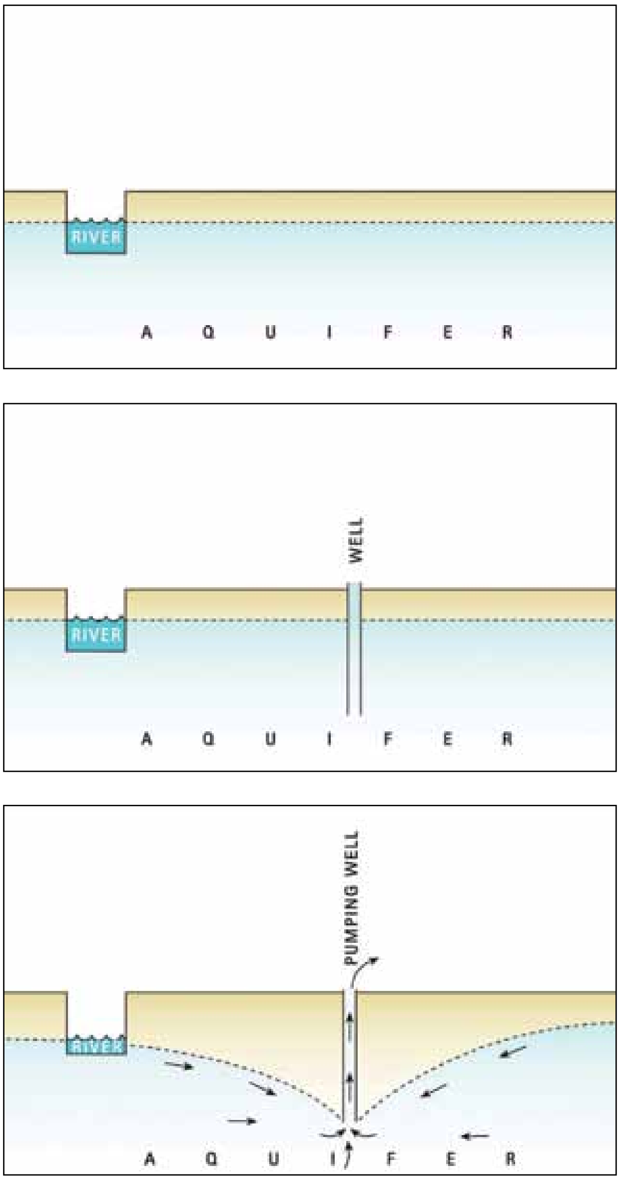
Extreme water shortages can also be experienced during drought conditions. During times of drought, even water users in areas that have reliable water supplies can be affected by low flows in the rivers or the lack of aquifer recharge. In these circumstances, it might be more critical that some water uses can continue than others. For example, water for domestic needs and stock watering is essential during times of drought for human and animal health.

Potential for sea water intrusion

Groundwater naturally flows towards the coast where it discharges to the sea. The two water bodies, freshwater and seawater, meet each other at a position called the saltwater or saline interface. The relative densities of freshwater and seawater, and the difference between groundwater and sea level, determine the position of the interface. In general, seawater is found in the aquifer slightly inland from the coastline. If groundwater abstractions in the aquifer are excessive, particularly near the coastline, the saline interface can move inland. If this occurs, the aquifer can become contaminated with salty water.

In Marlborough the coastal margin of the Wairau Plain along Cloudy Bay contains two important groundwater resources: the Rarangi Shallow Aquifer; and the coastal margin of the Wairau Aquifer. The Rarangi Shallow Aquifer is used mostly for domestic water supplies, either through a community water scheme, or through bores on individual properties. The aquifer water level is within 5 metres of the ground surface. Partially underlying the Rarangi Shallow Aquifer is the Wairau Aquifer, separated by a confining layer of fine silts. Water taken from the Wairau Aquifer along the coastal margin is mainly used for pasture and vineyard irrigation because the yields are higher than the Rarangi Shallow Aquifer.

FIGURE 9.1: STREAM DEPLETION CONCEPT



Water from both of the aquifers flows east toward the coast and the pressure created maintains the interface between freshwater and seawater offshore. Taking water from the Rarangi Shallow Aquifer or the Wairau Aquifer can decrease water pressure at the interface between freshwater and seawater creating the potential for seawater intrusion into these significant aquifers. An increase in groundwater salinity would have a significant impact because it would seriously affect the ability to use the water as a domestic supply and may make the water unsuitable for irrigating crops.

The Rarangi Shallow Aquifer is at greatest risk of seawater intrusion as, unlike the Wairau Aquifer, no protection is provided

Residential development at Rarangi

by overlying sediments. Given that the Rarangi community currently relies on water from the Rarangi Shallow Aquifer, any seawater intrusion has dramatic implications for the wellbeing of this coastal community.

Point source discharges

A point source discharge is one that discharges contaminants into the environment at a discrete point, such as a pipe or an outfall. Discharges directly into water, as opposed to land, have greater potential to affect the quality of water in our rivers, streams and wetland areas. While this potential does exist in Marlborough, the number of point source discharges into freshwater, with the exception of stormwater discharges, has been reducing here since 1995. This probably reflects the direction of existing policy to reduce the amount and concentration of contaminants and improve freshwater quality. Importantly Marlborough's climate also makes land disposal a viable option, especially the low rainfall and high evapo-transpiration over the summer months. In fact, all dairy effluent and vegetable processing wastewater, and most winery wastewater, is discharged to land as opposed to water. In comparison, the 1994 State of the Environment Report for Marlborough highlighted that there were 45 discharge consents to freshwater.

Today there are only four authorised discharges to freshwater - see Table 9.2. However, as Marlborough continues to grow there could be the desire or need for new point source discharges to service future residential, commercial or industrial development. In some cases existing infrastructure may need to be upgraded and reticulation. For example, the reliance of several Marlborough Sounds communities on the on-site management of domestic wastewater may not be sustainable and may need to be replaced with community sewerage schemes. Discharge of the treated effluent into water may be one of the options that need to be considered.

Urban stormwater discharges into waterways

Marlborough's urban areas generate stormwater from rainfall running off buildings, industrial and commercial yards, car parks, roads etc. This stormwater can flood properties and infrastructure, so stormwater in urban areas is collected and carried to the nearest appropriate disposal point. In Blenheim, this has traditionally been by way of a discharge to the Taylor and Opawa Rivers or their spring fed tributaries. In Picton and Waikawa, stormwater is discharged to the Waitohi Stream, Waikawa Stream or into coastal waters.

Urban stormwater picks up contaminants as its runs over impervious surfaces, including sediment, solids, organic matter, nutrients, heavy metals, petroleum product residues and bacteria. Given the volume of water created by rainfall events, the stormwater receives little or no treatment prior to discharge into the receiving waters.

Monitoring of freshwater quality has shown there are times when stormwater discharges are degrading water quality within the receiving waters. Periods of contamination tend to be episodic and are associated with rainfall events. The exception is when contaminants are deliberately washed or poured into the road kerb or stormwater drains.

TABLE 9.2: DISCHARGES INTO MARLBOROUGH'S FRESHWATER RESOURCES 2008

Discharges into freshwater	Receiving Environment
Blenheim, Woodbourne and Renwick municipal sewage	Opawa River
Spring Creek municipal sewage	Lower Wairau River
Seddon municipal sewage	Starborough Creek
Fonterra processing facility, Tuamarina (this is an emergency discharge and can only occur in when certain environmental conditions exist)	Lower Wairau River

Stormwater discharge to the Taylor River

Stormwater can also pick up sewage through cross connections between sewerage pipes and stormwater pipes. This has been a problem particularly in Picton and has caused periodic contamination of coastal water during rainfall events. The Council has been working to identify and eliminate cross connections.

Most stormwater and sewerage services are installed below ground. Unfortunately, many areas of Blenheim have a high groundwater table, meaning the construction of infrastructure can encounter water and create the need to dewater the excavation. This water can be high in suspended sediments. The discharge of sediment laden groundwater into the existing stormwater services, or into surfacewater bodies, can dramatically increase the turbidity and clarity of the receiving waters and affect instream flora and fauna.

One other issue is that, as more area becomes developed on the western side of Blenheim, there is decreasing groundwater recharge because stormwater systems intercept runoff. With this stormwater being diverted to the Taylor River instead of filtering through the ground, there is the potential for the headwaters of the town springs to recede.

Stock crossings through streams in rural areas

Dairy farming is an important agricultural land use in some parts of Marlborough. Areas with higher rainfall, such as the Rai and Pelorus River valleys, Linkwater, Koromiko and Tuamarina have traditionally supported significant dairy farming activity and still do.

Monitoring of water quality in these catchments has regularly shown high sediment, bacteria and nitrate levels. At times, bacteria numbers were so high that the rivers could not safely be used for activities like swimming and kayaking. More intensive monitoring in the Rai River catchment has also shown that contaminant levels are higher during the 8 to 9 months of the milking season and peak twice daily after milking times.

It has become clear that a large proportion of the contamination is as a result of stock crossing through the wet bed of creeks, particularly when going to and from the dairy shed. As the herd walks through the wet bed, it disturbs the waterbody resulting in the release of sediment into the water. Individual animals are also more likely to defecate/urinate in the stream than on land, resulting in the release of bacteria and nutrients into water. Results from a stream crossing survey in the Rai River catchment showed that there are approximately 3 million cow crossings per dairy season within the Rai catchment. These crossings collectively release up to 290 tonnes of waste into the river system per season, at a rate of about 1,000 litres per day. The Council has set a goal of eliminating stock crossings having the biggest impact on freshwater quality (i.e. stock crossings that are used on a regular basis or used by large herds).

While dairy farm numbers haven't grown in Marlborough in recent years, the Council is well aware in other regions of New Zealand have had significant increases in dairy herd numbers. The Ministry for the Environment's 'Environment New Zealand 2007' stated that the area of land in dairy pasture has increased and that between 1996 and 2006 the national dairy herd had grown by 24%. A change to this more intensive type of farming in Marlborough could have significant implications for freshwater resources, especially those groundwater resources on the Wairau Plain.

Cows crossing stream

Water in a stream upstream of a stock crossing in the Rai River catchment.

Water in a stream downstream of a stock crossing in the Rai River catchment.

Non-point source discharges from land use activities

Non-point source discharges are diffuse in nature in that they do not enter the environment at a discrete point. Instead this type of discharge generally occurs as rain water run-off, which picks up contaminants from land. Non-point source discharges are a lot harder to deal with because there is no particular point, such as an outfall, that treatment or management can be applied to.

There are various sources of non-point source contamination in Marlborough, including:

- Failing on-site wastewater management systems: On-site wastewater management systems use soil to provide treatment of domestic wastewater. However, if the rate of discharge exceeds the ability of the soil to absorb the wastewater, the domestic wastewater will break out onto the ground surface. If this occurs on a slope, then the wastewater will make its way downslope and could enter a stream or coastal water. In the Marlborough Sounds, failing on-site wastewater management systems are suspected of contributing to periodic water quality issues at some locations, usually where there is a dense concentration of residential properties.
- Land disturbance activities: Land disturbance activities, including excavation, cropping and forest harvesting, can expose soils to the elements and result in the run-off of sediment laden water during and after rainfall events. Sediment laden water can affect the clarity and turbidity of water and smother aquatic flora and fauna.
- Pastoral activities: Grazing stock results in the inevitable - faeces and urine being discharged onto the ground surface. Other inputs are also applied to pasture as part of normal farming operations, including fertiliser and lime. As in the case of land disturbance, run-off during and after rainfall events can pick up this material resulting in the input of nutrients and bacteria into nearby water bodies.

While all of these activities have the potential to have a significant impact on our water bodies, there have been limited investigations to establish the scale and severity of their impact in Marlborough.

Contaminants getting into groundwater

Most land uses on the Wairau Plain are sustained by the Wairau Aquifer or other localised aquifers. Groundwater is used for domestic use, municipal water supply, rural industry and irrigation. With the exception of possibly irrigation, these land uses rely on good quality groundwater. Fortunately, the quality of groundwater in the Wairau Aquifer is very high for human consumption by world standards, although the groundwater in some of the other aquifers can contain naturally occurring metals or salts due to their age. In most cases, groundwater is used with no or little treatment.

Permeable gravels underlie much of the Wairau Plain and in some locations the groundwater table is also close to the ground surface. These factors mean the use of chemicals and discharges into or onto land creates a risk of groundwater contamination by infiltration of contaminants through the gravels. Given the

extent of viticulture and residential land uses in this area, the use of agrichemicals and fertilisers and the discharge of domestic and winery wastewater are of greatest threat.

The monitoring of groundwater has not indicated any reduction in groundwater quality to date, although elevated nutrient (nitrate) levels have been detected in some locations in the past. It is possible that even if contaminants reach the aquifers, the volume of groundwater may be such that the contaminants are sufficiently diluted to not cause groundwater contamination. Given the uncertainties involved and the importance of maintaining groundwater quality, it is obviously desirable to avoid the contaminants reaching groundwater in the first place.

In early 2008 the Council had to deal with a significant contamination issue with Blenheim's drinking water supply. Wells in the Middle Renwick Road well field had shown positive results for contamination during routine monitoring. A boil water notice was issued for the Blenheim water supply as a precaution to avoid ill health in the community in case the contamination got worse. The Middle Renwick Road wells were then isolated from the supply network and water restrictions were also put in place to enable the remaining wells around Blenheim to meet demand.

As there was potential for a plume of contamination to reach other wells in Blenheim, sampling at these sites was upgraded. Contaminated water also reached the Council's two reservoirs (Wither Hills and Redwood Street) and these were chlorinated. The boil water notice was lifted some three weeks after the first positive results were noted.

The Council looked at changes in the surrounding area to see what the source of contamination might be. These included looking at nearby construction sites with deep excavations, property inspections focussing on identifying old wells that might be allowing surface water to drain into the aquifer, inspections of the Middle Renwick Road well heads and reviewing the sewer main construction occurring in nearby Rose Street. Despite these investigations, the source of contamination has yet to be found.

RESPONDING TO PRESSURES ON FRESHWATER RESOURCES

This section describes what is known about the current state of freshwater resources in Marlborough. It includes a look at both the quality and quantity aspects of surfacewater and groundwater. Where the Council has data going back over a number of years, trends are also described. The biodiversity aspects associated with freshwater resources can be found in the Biodiversity chapter.

SURFACEWATER QUALITY

Surfacewater quality monitoring network

Currently there are 23 sites across Marlborough, where water quality is monitored on a monthly basis. These sites have been monitored in the past at varying frequencies (monthly, quarterly and annually). Macroinvertebrate sampling is also carried out at the water quality sites and at a number of additional sites on an annual basis.

Current water quality monitoring is focused on assessing water quality within a river catchment by locating, where possible, the site at the bottom of the catchment. Land use within a river catchment has a huge influence on water quality within the catchment. Rivers and streams can suffer from reduced water quality after heavy rainfall when contaminants are washed off the surrounding land into the waterways. Therefore it is important to consider that what gets applied to land can potentially end up in our waterways.

The current water quality monitoring sites are located in what are deemed high risk areas in terms of land use. It is envisaged that the monitoring network will be built up over time so that each catchment is represented by a monitoring site. Periodic sampling at these locations will allow trends in water quality over time to be detected. These trends can then be related back to any change in land use or land use management in the catchment. Figure 9.2 shows the locations of the current water quality monitoring sites together with the catchment boundaries and principal land use types for Marlborough.

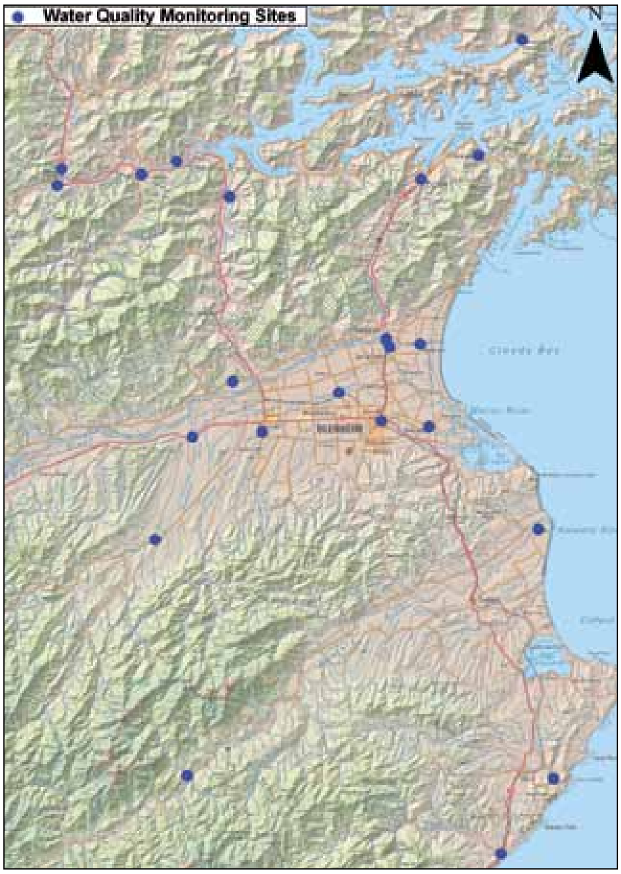
What is measured

Although numerous parameters can be used to define surfacewater quality only the main parameters that define water quality are discussed here. These parameters are compared with the current water quality standards as defined in the Australian and New Zealand Environment and Conservation Council Guidelines for Fresh and Marine Water Quality - 2000. The guidelines use trigger values for upland streams and lowland streams. Upland streams are those regarded as being unimpacted or only slightly impacted and have higher trigger values, whereas lowland streams are regarded as being more affected by human activity and have lower trigger values.

Nutrients

The two main nutrients that drive ecosystem function are nitrogen and phosphorus. Plant and algal growth is limited where there is a limited amount of these nutrients and conversely excessive plant and algal growth can result when these nutrients are in

FIGURE 9.2: MARLBOROUGH'S WATER QUALITY SAMPLING NETWORK



overabundant supply. An increase in plant growth can result in nuisance algal blooms and weed growth in the river.

Nitrogen and phosphorus are available to aquatic organisms in a number of forms e.g. nitrate, nitrite, total phosphorus, dissolved reactive phosphorus etc. The two forms that the Council samples are nitrate and dissolved reactive phosphorus.

Excessive plant and algal growth from an overabundance of nutrients can lead to reduced clarity and eutrophication, which depletes the water of available oxygen and affects the rivers ability to support aquatic life. Fertilisers, run-off from agricultural land and wastewater treatment systems all contribute to the amount of nitrogen and phosphorus that ends up in waterways.

Ammonia

Ammonia is naturally present in water systems through the breakdown of nitrogenous organic matter. High ammonia concentrations may also be an indicator of wastewater discharges and run-off from agricultural land. High ammonia concentrations can be toxic to aquatic life.

pH

The pH of water (i.e. how acid or alkaline the water is) largely occurs because of the surrounding geology and soil types. Some river systems have naturally high or low pH values e.g. streams in peat land areas can have a pH as low as 4 whilst streams in limestone areas can have values as high as 8.5.

The guidelines specify a pH range of 6.5 to 8 for healthy ecosystems. pH has a diurnal cycle, whereby the value will fluctuate during different times of the day and from season to season. However, for healthy ecosystems the range in which it fluctuates will remain stable over time. The guidelines specify that changes of more than 0.5 units from the natural seasonal maximum and minimum values are considered abnormal.

Conductivity

Conductivity is a measure of the total ions in the water and is related to the total dissolved solids in the water. Conductivity is also mostly a function of the surrounding geology and soil type. Values are expected to remain stable over time; an increase in conductivity can indicate increased pollution in the catchment. Conductivity is often used as a surrogate measurement of enrichment in waters.

Macroinvertebrates

Macroinvertebrates are stream dwelling organisms that vary in size from several millimetres up to several centimetres in length and include insect larvae, snails, worms, and crustaceans.

The kind of macroinvertebrates found in a stream is a reflection of the health of the stream. The types of species present and the abundance of various species tell us a great deal about the water quality at a particular site. Unlike water chemistry parameters, where multiple samples over an annual cycle are required to give an indication of water quality at a site, a single macroinvertebrate sample can give an indication of overall stream health.

Macroinvertebrate communities are not just influenced by water quality but also by habitat quality. This means for healthy streams, both habitat (instream and riparian) and water quality must be of a high standard.

The abundance and the types of species present in a macroinvertebrate sample are summarised by a method called the Macroinvertebrate Community Index (MCI). This takes into account the types of species present in a sample and their tolerance to pollution. This is then taken further with the abundance of individual species counted. (This is called the Semi-Quantitative Macroinvertebrate Community Index SQMCI). A moderately polluted site may have the same type of species present as a pristine site but pollution tolerant species will be present in much higher numbers. Conversely pollution sensitive species will be fewer in numbers, as the degree of pollution

TABLE 9.3: SUMMARY OF HISTORIC SURFACEWATER QUALITY MONITORING

River System	Year Monitored	Number of Sites
Awatere	1997	5
Omaka/Opawa/Taylor	1998	12
Pelorus/Rai	1999	6
Spring Creek	2000	10
Tuamarina	2002	11
Awatere	2003	5
Omaka/Opawa/Taylor	2004	12
Pelorus/Rai	2005	6

intensifies pollution sensitive species will die out and pollution tolerant species will thrive. Some examples of pollution sensitive and pollution tolerant species are shown in Figure 9.3.

Current state and trends in surface water quality

Freshwater monitoring had focused on intensively monitoring a river system through monthly sampling of a number of sites along the river reach for a year. Each year a different river system was monitored. Table 9.3 shows the river systems that have been monitored, the year in which they were monitored and the number of sites along the river that have been monitored. In addition a number of sites throughout Marlborough have been monitored on a quarterly and annual basis. The Lower Wairau has also been monitored on a monthly basis from 1989 to 2000 and from 2007 to present.

In 2005 a review of the Council's water quality monitoring programme was undertaken. The review saw the annual monitoring programme dropped and monthly monitoring of a limited number of parameters on all key sites adopted so trends in water quality could be picked up earlier. The recommendations from the review have been implemented and are the basis for the current monitoring programme.

The quality of Marlborough's waterways is discussed in more detail in terms of nitrates, dissolved reactive phosphorus, ammonia, pH, conductivity and macroinvertebrates in the following section.

Nitrate

Nitrate concentrations are highest at sites on the Wairau Plain and in the Rai and Kaituna Valleys (Figure 9.4). The number of samples at each site will vary depending on historic sampling frequency but each site has a minimum of 10 samples.

Nitrate concentrations are typically elevated during winter and early spring. High rainfall during these times results in higher water tables and correspondingly more runoff from land, with nitrates entering waterways through overland and subsoil processes.

FIGURE 9.3:

*(a) The mayfly **Ameletopsis sp**, found in pristine stony rivers and streams, is one of the most pollution sensitive species found.*

*(b) The non-biting midge larvae **Chironomus sp**, also called a blood worm because of the bright red colour, is one of the most pollution tolerant species.*

FIGURE 9.4: MEAN NITRATE CONCENTRATIONS FOR MARLBOROUGH PRE 1995 TO 2008

Nitrate concentrations for 5 river sites are shown in Figure 9.5. Concentrations are compared with the guidelines for nitrates in lowland rivers (shown by the red line).

In general there has been little discernible change in nitrate concentrations over time. The lower Wairau River shows peak concentrations during the winter and spring months, however maximum concentrations have changed little over the past decade.

The Taylor River showed peak concentrations during the late nineties with an apparent reduction since then. However, concentrations still remain elevated over mid-1990s concentrations.

Nitrate concentrations in the Rai show that peak winter concentrations appear to have steadily increased since 1998. Nitrate concentrations remain similar for Spring Creek whilst nitrate concentrations have slightly decreased for the Awatere over the past decade.

FIGURE 9.5: CHANGES IN NITRATE CONCENTRATIONS OVER TIME FOR SIX RIVER SITES.

The red line depicts the guidelines for nitrates in lowland rivers.

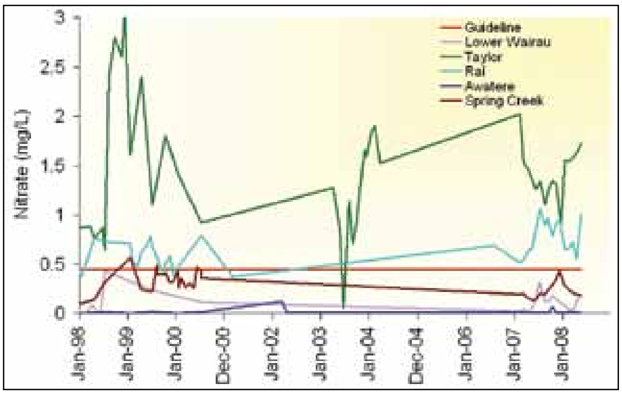
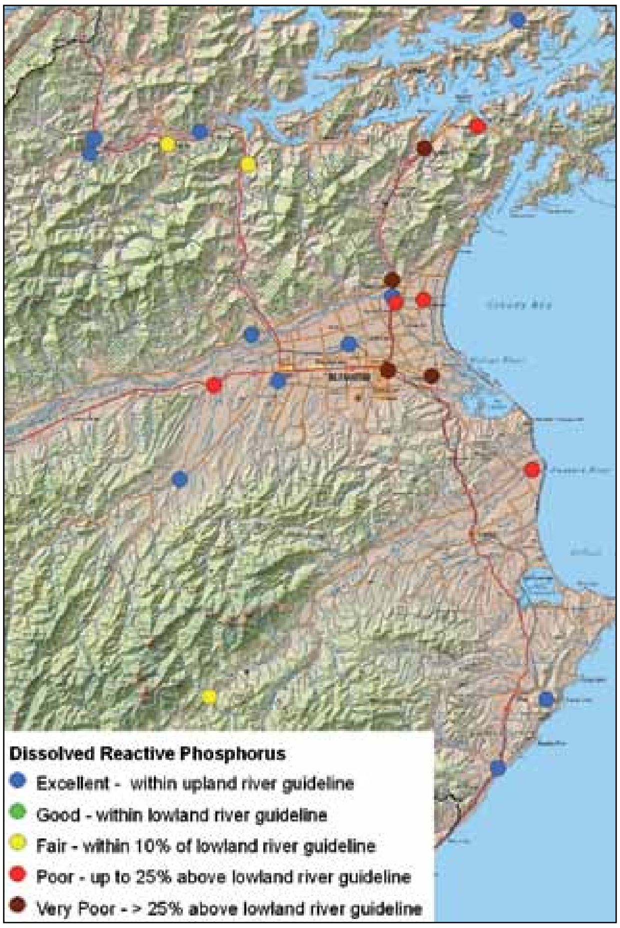


FIGURE 9.6: MEAN DISSOLVED REACTIVE PHOSPHOROUS CONCENTRATIONS FOR MARLBOROUGH PRE 2000 TO 2008



Dissolved reactive phosphorus

Sampling shows that dissolved reactive phosphorous levels are highest in urban and agricultural areas (Figure 9.6). The number of samples at each site will vary depending on historic sampling frequency but each site has a minimum of 10 samples. Seasonal trends dissolved reactive phosphorous concentrations, are not as apparent as for nitrate concentrations.

Dissolved reactive phosphorous concentrations for 4 river sites are shown in Figure 9.7. Concentrations are compared with the guidelines for dissolved reactive phosphorous in lowland rivers (as shown by the red line).

The Lower Wairau shows a steady increase in dissolved reactive phosphorous concentrations in recent years. However, the concentrations are still within the guidelines with only occasional exceedances of the guideline.

Ammonia

Ammonia concentrations are generally not a problem for Marlborough's surfacewaters. The Lower Waihopai River has had historic high values with a few recent high values. However, in general there has been a considerable improvement in ammonia concentrations and recent values are mostly below the detection level. Similarly ammonia concentrations in the Wairau Diversion and in the Tuamarina River have improved over the last few years to the point where they are mostly within the guidelines.

pH

pH does not fluctuate greatly over time in Marlborough's rivers and streams. Recent water quality data shows that pH levels are within the acceptable levels as defined in the guidelines (Figure 9.8). Exceptions are the lower Awatere, the Upper Opawa, the Waima and the Waitohi. The pH levels for the Awatere and the Waima are most likely to be because of the underlying geology and soil types but high pH levels for the Upper Opawa and the Waitohi Rivers are likely to be as a result of degraded water quality.

Conductivity

Conductivity values are shown for each of the monitoring sites in Figure 9.9 with the sites having been ranked from high to low conductivity values. The degree of fluctuation in conductivity readings is shown by the error bar on the graphs. The Waima and the Flaxbourne have very high conductivity values because of the limestone geology of these areas [Figure 9.9 (a)]. Removing these two sites [Figure 9.9 (b)] allows the degree of fluctuation in the readings to be more easily seen.

FIGURE 9.7: DISSOLVED REACTIVE PHOSPHOROUS CONCENTRATIONS OVER TIME FOR FOUR RIVER SITES.

The red line depicts the guidelines for dissolved reactive phosphorus in lowland rivers

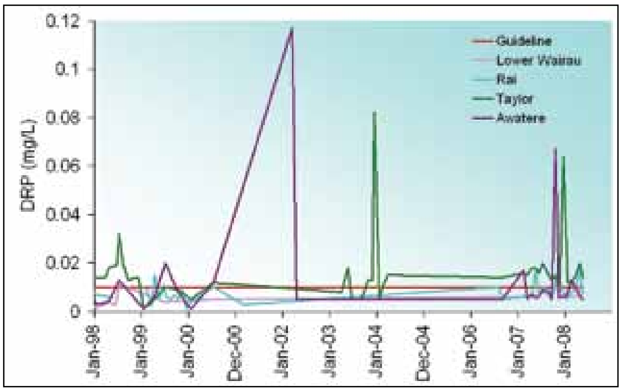


FIGURE 9.8: MEAN PH FOR THE CURRENT SURFACEWATER QUALITY SITES FOR 2007.

The guidelines for pH of 6.5 to 8 are shown as red lines on the graph.

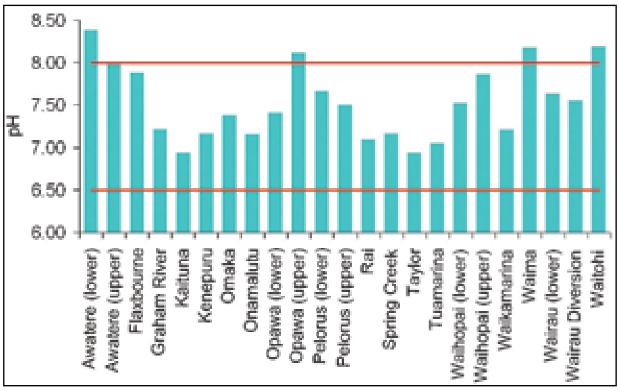
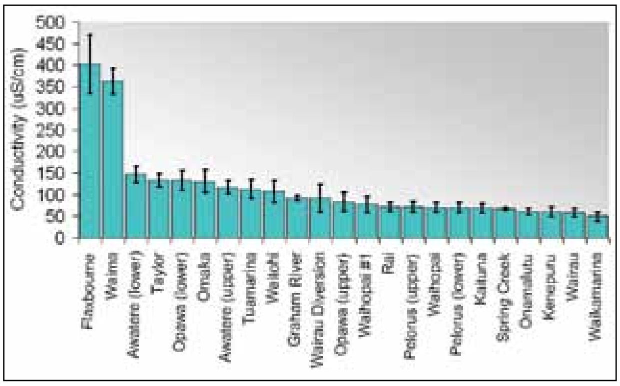


FIGURE 9.9 (a): AVERAGE CONDUCTIVITY FOR THE RIVERS IN MARLBOROUGH:

All 23 monitoring sites



Spring Creek has the least amount of fluctuation, indicating that conductivity readings have remained very stable since 1995. This is to be expected as Spring Creek is a spring fed stream and in this type of stream, the water chemistry usually remains very stable over time.

In general there has been no appreciable increasing or decreasing trends in conductivity over time. However, there are a few rivers that potentially do show increasing conductivity with time (Figure 9.10). The most apparent of these are the Rai and the Omaka.

Macroinvertebrates

Figure 9.11 summarises the average macroinvertebrate scores for sites in Marlborough that have been sampled more than twice. An interpretation of each of the scores is given by the coloured bands as defined by Stark (1985). (The Macroinvertebrate Community Index takes into account the types of species present in a sample and their tolerance to pollution. The Semi-Quantitative Macroinvertebrate Community Index takes into account these parameters but also includes the abundance of individual species.) The mean score for each site has been used to determine the overall water quality at the site.

Since sampling of macroinvertebrates began in 2000 no significant trends or changes to the structure of macroinvertebrate communities have been detected at any of the sites sampled. Both scores show that river sites on the Wairau Plain, including the Pukaka and the urban spring sites in Blenheim, show fair to poor scores. This indicates that water quality and/or habitat quality are degraded at these locations.

The Rai Falls and Lower Pelorus have lower Macroinvertebrate Community Index scores than the Upper Pelorus and the nearby Wakamarina, again an indication that pastoral activity in the catchment may be having a detrimental impact on water quality in the Rai and Lower Pelorus.

The Waima, and in particular the Flaxbourne, also rate as fair to poor in terms of macroinvertebrate scores. Water quality sampling at these sites does not indicate degraded water quality, however naturally high conductivity and pH (mean pH value of 8 for both sites) as a result of the limestone geology of the catchment, and high water temperatures may be influencing the macroinvertebrate community at these sites. Species recorded at the Flaxbourne are predominately pollution tolerant species indicating that there is possible mild pollution at this site.

In summary between 25% and 30% of river sites are classed as having excellent water quality in terms of the Semi-Quantitative Macroinvertebrate Community Index (see Figure 9.12). These sites are mostly located in catchments with a high percentage of indigenous and/or exotic forest. The entire length of the Wairau River ranks as having excellent water quality, however from the two samples taken at the State Highway 1 road bridge indicate that the lower Wairau is at risk of suffering from degraded water quality. Sites classed as poor and fair are mainly located in urban and intensive pastoral areas and account for approximately half of sites, with the remaining sites being classed as good. With such a large percentage of sites being classed as fair or

FIGURE 9.9 (b): AVERAGE CONDUCTIVITY FOR THE RIVERS IN MARLBOROUGH:
Waima and Flaxbourne sites excluded

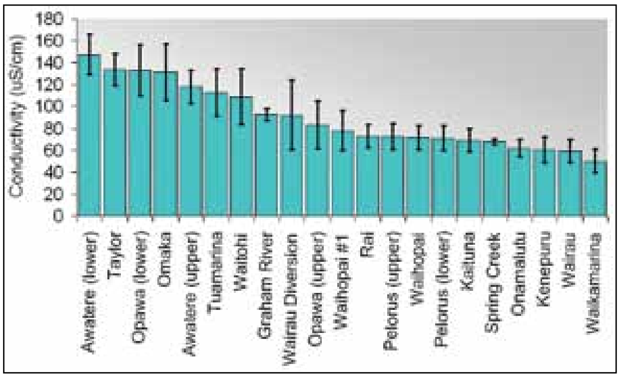


FIGURE 9.10: TRENDS IN CONDUCTIVITY VALUES FOR 4 RIVER SITES IN MARLBOROUGH

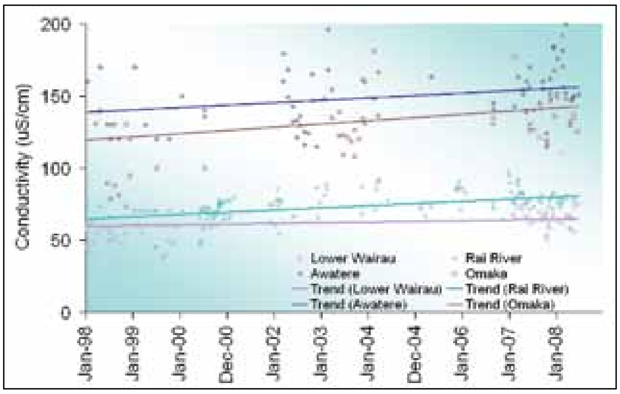


FIGURE 9.11: AVERAGE MACROINVERTEBRATE COMMUNITY INDEX SCORES FOR MARLBOROUGH'S RIVERS

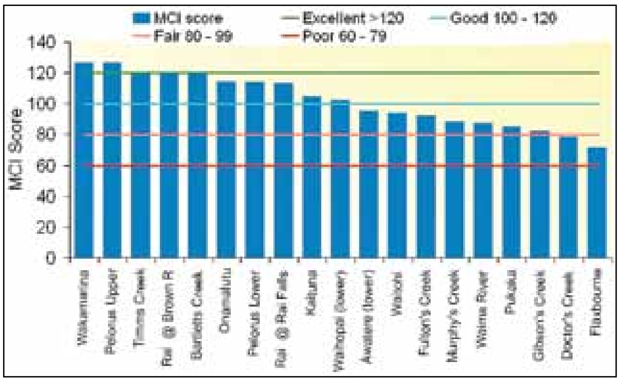
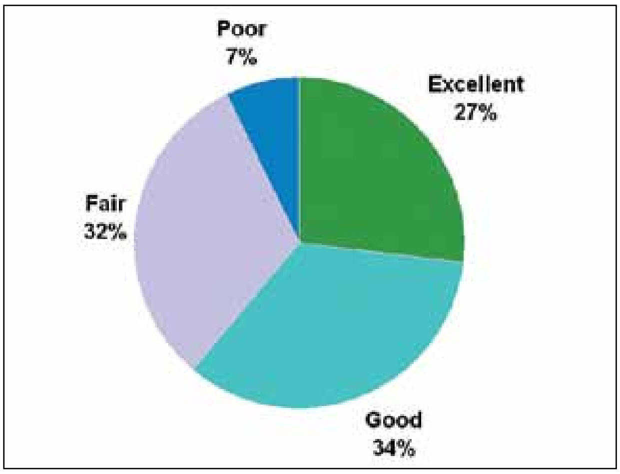


FIGURE 9.12: SUMMARY OF SEMI-QUANTITATIVE MACROINVERTEBRATE COMMUNITY INDEX SCORES



poor improved land management practices and/or riparian management may be required in areas where sites are shown to have degraded water quality.

Freshwater bathing quality

Freshwater bathing quality monitoring of Marlborough's freshwaters began in 1996. Sites were chosen based on local knowledge of perceived use and risk. There are now 13 sites that are monitored on a weekly basis over the summer months.

Freshwater bathing quality is described in terms of E. coli numbers. E. coli are known as indicator organisms, i.e. the E. coli themselves may not cause illness or infection, but their presence in a water sample gives an indication of the likelihood that other, more serious, pathogens are present. Sources of bacteria can be human (septic tanks, municipal sewage), animal (cattle, dogs, possums), birds (ducks, seagulls, swans etc.), in fact any warm blooded animal. Heavy rainfall is associated with poor bathing water quality as run-off from land can contain high bacteria numbers, which are transported via streams and overland to bathing areas.

Freshwater bathing monitoring network

Bathing water sites are sampled on a weekly basis from November to March inclusive. Each week monitoring results are assessed against the Ministry for the Environments national guideline standards - Microbiological Water Quality Guideline. The guidelines help determine whether or not water is suitable for recreational bathing. The current guideline standards were published in 2003 and are shown below.

Further details on the standards are available at http://www.mfe.govt.nz/publications/water/microbiological-quality-jun03/.

Each week, during the bathing water season, the results are posted on the Council's website.

At the end of the summer a report is published, which summarises bathing water quality for the whole district. These annual reports are also available on the Council's website. Results from the last available report (2006/007 season) are shown in Table 9.4. This depicts the percentage of time the sites were deemed safe or otherwise for swimming and are ranked accordingly. The Rai and the Taylor Rivers had the poorest water quality during the summer 2006/2007 season and the Wairau and Opawa Rivers had the best.

Freshwater bathing results 1996 – 2008

A summary of the freshwater bathing results since sampling began in 1996 shows some very different trends in different parts of Marlborough.

The median numbers are examined as any changes over time in these numbers can relate to improvements or deterioration in water quality. The median number is a type of average score which represents the E. coli number that is present for 50% of the time. A guideline of 126 E. coli/100mL as the median number is recommended for safe bathing waters.

A decrease in the median shows that the highest numbers of E. coli and the average number is decreasing, although there still may be exceedances of the bathing water standards. Thus an

COASTAL BATHING WATER STANDARD				
Acceptable 'Green Mode'	A single sample < 260 E.coli/100mL	Highly likely to be uncontaminated	Routine monitoring	Safe
Alert 'Amber Mode'	A single sample > 260 E.coli/100mL	Potentially contaminated	Investigate likely causes	OK
Action 'Red Mode'	A single sample > 550 E.coli/100mL	Highly likely to be contaminated	Further investigation, inform relevant interested parties	Unsafe

TABLE 9.4: FRESHWATER BATHING SITES RANKED ACCORDING TO THE PERCENTAGE OF TIME THEY WERE SUITABLE FOR CONTACT RECREATION (2006/2007)

SITE NAME	SITE ID	% of time E.coli numbers < 260 MPN/100mL Suitable for recreational use	% of time E.coli numbers >260 <550 MPN/100mL OK for recreational use	% of time E.coli numbers > 550 MPN/100mL Unsuitable for recreational use
Wairau @ Blenheim Rowing Club	WRR-1	100	0	0
Wairau @ Wairau Rowing Club	WRR-9	100	0	0
Opawa @ Elizabeth Street Footbridge	OPL-1	95	0	5
Wairau @ Ferry Bridge	WRR-8	94	6	0
Waihopai @ Craiglochart Bridge #2	WHR-3	94	0	6
Wairau Diversion @ Neals Road	WDV-1	89	11	0
Opawa @ Malthouse Reserve	OPR-40	84	5	11
Pelorus @ Totara Flat	PLR-3	84	5	11
Pelorus @ Pelorus Bridge	PLR-2	84	11	5
Taylor @ Hutcheson Street Bridge	TYR-5	74	26	0
Rai @ Brown River Reserve	RAR-2	74	16	11
Rai @ Rai Falls	RAR-1	74	5	21
Taylor @ Riverside	TYR-16	68	32	0

improvement in bathing water quality may not be reflected in the percentage of time in which the site complies with the bathing water standards. The percentage compliance figure is based on a one-off sample whereas the median figure is based on multiple samples. Similarly an increase in the median number (which would show a deterioration in water quality) may not result in non-compliance with the bathing water standards. Therefore, assessing the percentage of time in which a site complies with the bathing water standards over time, may not give an accurate indication of trends in bathing water quality over time.

The Rai/Pelorus catchment

The Council monitors four sites in this catchment. These sites are the Rai River at Brown River Reserve and at Rai Falls, and the Pelorus River at Pelorus Bridge and at Totara Flat. Figure 9.13 looks at the median and the percentage compliance with bathing water standards for each summer season from 1996 to 2008 for these sites.

The Pelorus sites show a slight deterioration in bathing water quality since 1996. It is more difficult to see any trends in the Rai sites.

The two sites on the Pelorus show an upward trend in the median number. There is also a corresponding decrease in percentage compliance with the bathing water standards. Dairy farming in the Rai catchment has long been a cause for concern for deterioration in water quality in the Rai and Lower Pelorus, however the Pelorus Bridge site is upstream of the Rai and so cannot be influenced by water quality in the Rai catchment. The median E. coli numbers for the Pelorus Bridge site are still very low in relation to the Rai sites and percentage compliance with the standards are highest for this site in the Rai/Pelorus catchment. However, the downward trend in water quality in the Pelorus may need further monitoring to determine the causes of the deterioration and to reverse this trend.

Culverted dairy crossing

RAI FALLS MEDIAN E. COLI 1999 TO 2007

The median E. coli number for the Rai Falls site was estimated for each calendar year from 1999 to 2007 - see below. This not only took account of summer bathing water sampling but also sampling that has been carried out outside the summer months for the Clean Streams Accord and state of the environment monitoring. A decreasing trend in E. coli numbers is much more apparent indicating that work carried out by farmers as part of the Clean Streams Accord is having a positive impact on water quality in the Rai catchment. It is hoped that this trend will continue and will be reflected in increased compliance with the Ministry for the Environment's bathing water guidelines.

MEDIAN E. COLI NUMBER FOR RAI FALLS

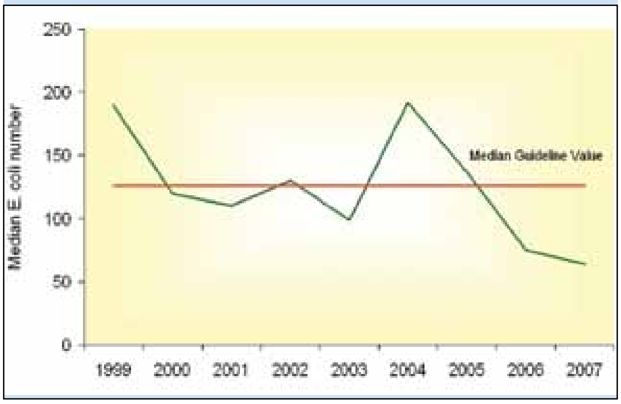


FIGURE 9.13: MEDIAN E.COLI NUMBERS FOR THE BATHING WATER SITES AT THE RAI AND THE PELORUS RIVERS

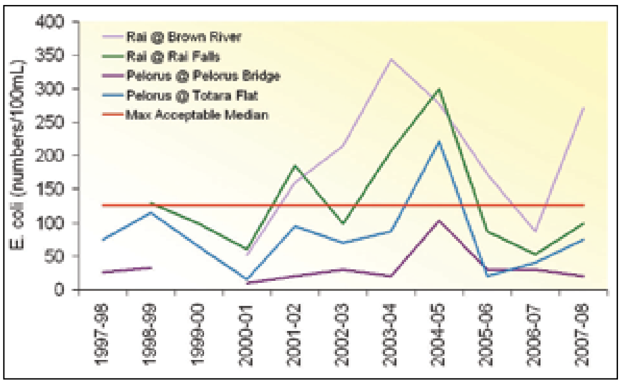


FIGURE 9.14: LOCATION OF MONITORING SITES IN RAI/ PELORUS CATCHMENT

Despite extensive work by dairy farmers in the Rai Valley to achieve compliance with the Clean Streams Accord since 2003, there is little evidence to show that bathing water quality has substantially improved in the catchment. However, when a more thorough examination of E. coli numbers is carried out for the Rai Falls site a different picture emerges - see box 'Rai Falls median E. coli counts 1999 to 2007'. With the exception of the 2007-2008 summer season, the median E. coli numbers were decreasing at both Rai sites and the Pelorus at Totara Flat.

Kayaking on the Pelorus River

The Wairau catchment

The Council monitors five sites in this catchment. These sites are at Craiglochart on the Waihopai River, the Wairau Rowing Club, the Blenheim Rowing Club and Ferry Bridge on the Wairau River and at Neals Road bridge on the Wairau Diversion - see Figure 9.15.

Bathing water quality in the Wairau catchment shows considerable improvement since monitoring began in 1996. The median number has dramatically reduced since monitoring began. Compliance with the bathing water standards has also increased, particularly in the Wairau Diversion. Figure 9.16 shows the trends in bathing water quality for this catchment.

The Taylor/Opawa catchment

The monitoring sites on the Taylor River are at Hutcheson Street and Riverside Park, and the Opawa River at Elizabeth Street and at Malthouse Road.

Bathing water quality in the Opawa and Taylor has shown to have improved since monitoring began. This is particularly so in the Taylor River where compliance with the bathing water standard has increased from 10% to 80% compliance and where the median number has dropped from 800 to less than 200. A similar trend in improved water quality is seen in the Opawa at Elizabeth Street. A summary of the bathing water quality for these sites is shown in Figure 9.17.

Impacts of dairying on water quality

Dairying is a significant land use in New Zealand. However, there has been increasing concern about the effects of this intensive land use on the quality of water within streams, rivers, lakes and wetlands.

Dairying and Clean Streams Accord

The Dairying and Clean Streams Accord is an agreement between the Fonterra Co-operative Group, regional councils, unitary authorities (such as the Marlborough District Council), the Ministry of Agriculture and Forestry and the Ministry for the Environment, to improve the environmental performance of dairying. It establishes a goal of achieving "clean healthy water in dairying areas".

Five priorities for action are identified in the Accord to reduce the impact of dairying on streams, rivers, lakes and wetlands: cattle access to water bodies, dairy herd stream crossings, dairy shed effluent discharges, nutrient management and wetlands. Each of these priorities has a national performance target, as follows:

- Dairy cattle are excluded from 50% of streams, rivers and lakes by 2007, 90% by 2012.

FIGURE 9.15: LOCATION OF MONITORING SITES IN THE WAIRAU CATCHMENT

FIGURE 9.16: MEDIAN E.COLI NUMBERS FOR THE BATHING WATER SITES ON THE WAIRAU RIVER CATCHMENT

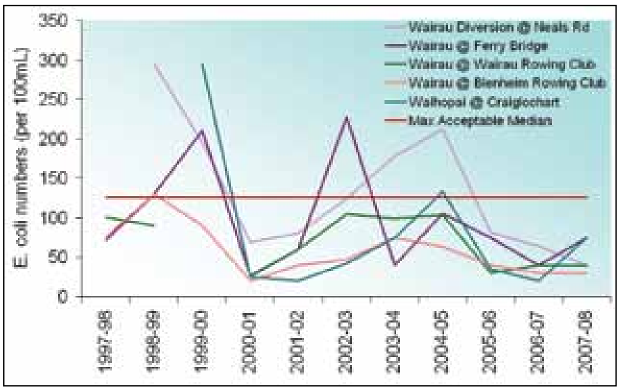
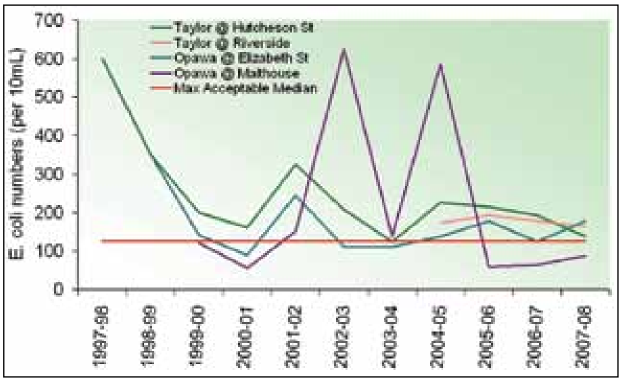


FIGURE 9.17: MEDIAN E.COLI NUMBERS FOR THE BATHING WATER SITES ON THE TAYLOR AND OPAWA RIVERS



- 50% of regular crossing points have bridges or culverts by 2007, 90% by 2012.
- 100% of farm dairy effluent discharges comply with resource consents and regional plans immediately.
- 100% of dairy farms have in place systems to manage nutrient inputs and outputs by 2007.
- 50% of regionally significant wetlands to be fenced to prevent stock access by 2007, 90% by 2012.

A further priority for action is the preparation of "Regional Action Plans" to be developed by Fonterra and each of the regional councils and unitary authorities to help in implementing the Accord. The Marlborough Regional Action Plan, prepared in consultation with Federated Farmer and Fonterra shareholder representatives, became operative in June 2004. It sets out local commitments toward achieving the Accord's goal, whilst taking into account local circumstances. These commitments focus on the priorities for action already established by the Accord, but with a local target set for each priority, as set out in Table 9.5 below.

The local targets match those set out in the Accord, except for stream crossings in the Rai River catchment and the management of dairy shed effluent. The reason for the difference in these latter targets is the fact that the Council has developed specific strategies to deal with statutory responsibilities under the Resource Management Act. (The next item describes progress on eliminating stream crossings, while the Land chapter includes information on managing dairy shed effluent.)

Fonterra monitors progress toward achieving the other three targets through annual on-farm assessments. Dairy farmers have been informed of the Regional Action Plan and the local targets through a brochure and further information will be provided on a one-on-one basis during the annual dairy shed effluent discharge inspections.

Progress on meeting the targets is reported annually by the Accord partners. The most recent report (dated 2006/2007) includes a table setting out progress on achieving the targets. This is shown in Table 9.6.

TABLE 9.5: MARLBOROUGH REGIONAL ACTION PLAN TARGETS

MARLBOROUGH REGIONAL ACTION PLAN TARGETS
Stock access to waterbodies
■ Dairy cattle are excluded from 50% of streams, rivers and lakes by 2007, 90% by 2012.
Dairy herd stream crossings
■ 90% of category 1 and 2 dairy herd stream crossings in the Rai River catchment are eliminated by the commencement of milking season (August) in 2006.
■ 90% of category 1 and 2 dairy herd stream crossings in the Pelorus River and Tuamarina River catchments are eliminated by the commencement of milking season (August) in 2007.
■ Except for those stream crossings in the Rai River catchment, 50% of all other crossing points have bridges or culverts by 2007, 90% by 2012.
Management of dairy shed effluent
■ There is no "major" non-compliance with relevant resource consents or permitted activity rules.
■ The rate of "minor" non-compliance with relevant resource consents or permitted activity rules shall not exceed 15% in any one milking season and any instance of "minor" non-compliance shall be rectified to the satisfaction of the Council within 2 weeks.
■ All dairy farmers that require a discharge permit to discharge dairy shed effluent onto land are operating with the necessary consents.
Nutrient Management
■ 100% of dairy farms to have in place systems to manage nutrient inputs and outputs by 2007.
■ Wetlands
■ 50% of regionally significant wetlands to be fenced to prevent stock access by 2007, 90% by 2012.

TABLE 9.6: PROGRESS TOWARDS THE DAIRYING AND CLEAN STREAMS ACCORD TARGETS 2003 - 2007

Accord target	2003/2004	2004/2005	2005/2006	2006/2007
Dairy cattle are excluded from streams, rivers and lakes (2007 target: cattle excluded from 50% of Accord rivers)	67% (a)	72%	75%	83%
Regular race crossing points have bridges or culverts (2007 target: 50% of regular crossing points bridged or culverted)	92% (b)	93% (b)	93% (b)	97% (b)
Farm dairy effluent is appropriately treated and discharged	n/a	Average compliance level of 67% nationally	Average compliance level of 67% nationally (c)	Average compliance of 93% nationally including minor non-compliance (d)
Nutrients are managed to minimise losses to ground and surface water (2007 target: all farms have a system in place to manage nutrient inputs and outputs)	17% (e)	19% (e)	33% (e)	97% (e, f)

(a) This includes farmers that had no Accord-type waterways.

(b) Percentage of Accord-type crossings (i.e. deeper than a red band gumboot (ankle depth), wider than a stride (approximately 1 metre) and permanently flowing).

(c) The 2005/2006 average compliance excludes minor non-compliance statistics. If minor non-compliance statistics were included, the average compliance figure would be 90%.

(d) Monitoring and reporting standards vary between regions. Some regional councils did not report separate statistics for major and minor non-compliance in their regions in 2006/2007. Therefore it is not possible to accurately compare annual non-compliance figures between regions. Also, the average national compliance figure for 2006/2007 includes minor non-compliance statistics for some regions.

(e) These figures represent the percentage of farmers with a nutrient budget, which is an important step in the development of a nutrient management system. Data on farmers using nutrient management system is not yet available.

(f) At the time of reporting, Fonterra's On-Farm Assessment, not yet completed for the season, showed 64 per cent of farms have nutrient budgets. The 97 per cent reported is more comprehensive data from Fert Research's analysis of the fertiliser industry's customer databases.

Progress on meeting the target for wetlands has been difficult to report as only four of the 13 regional councils have defined and identified regionally significant wetlands. However, in the regions where councils have defined and identified regionally significant wetlands, the 2007 Accord target has been met.

Eliminating dairy herd stream crossings in the Rai River catchment

Community concerns were raised about water quality in the Rai River and tributaries (the Opouri, Tunakino and Ronga Rivers) in the late 1990s. Monitoring of water quality that commenced in 1999 regularly showed high sediment, bacteria and nitrate levels within the Rai River and tributaries. At times, bacteria levels were so high that the Rai River could not safely be used for contact recreation, such as swimming and kayaking.

The main rural land use in the catchment is dairy farming. The monitoring established strong links between dairy farming and degraded water quality. Contaminant levels were higher during the 8 to 9 months of the milking season, still occurred during dry periods (when there was little run-off) and peaked twice daily. As shown in Figure 9.18, the twice daily peaks coincided with milking times, leading the Council to look at dairy herd stream crossings.

The Rai catchment is a high rainfall area with many permanently flowing rivers and streams. With the need to move stock around the farm, particularly dairy herds to and from the dairy shed, the result is a high number of regular stream crossings. As the herds walk through the waterways, they disturb the substrate resulting in the release of sediment into the water. Individual animals are also more likely to defecate/urinate in the stream than on the race, resulting in the release of bacteria and nutrients into water. The effect of each individual stream crossing builds up, resulting in seriously degraded water quality within the Rai catchment.

A Council survey of all dairy farming properties in the Rai River catchment in 2003 identified 112 dairy herd stream crossings. Taking into account herd size and frequency of use, this corresponded to 4,068,885 cow movements across water bodies per milking season.

The Council decided to take action and instigated a programme of eliminating all crossings in an effort to enhance water quality. The crossings were all prioritised in terms of their impact on water quality and Council staff negotiated an agreement with affected farmers to eliminate the most significant crossings. The initial target was to eliminate these priority crossings by August 2006. Compliance with the agreements has been monitored on an annual basis since 2003.

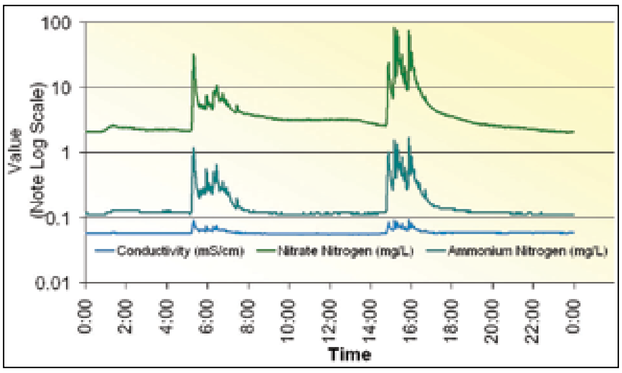
By 2007, the total number of crossings had been halved (to 56) and the number of priority crossings had reduced from 43 to 15. This significant achievement would not have been possible without the co-operation of the farming community and individual farmers. The fact that the initial target was not met (in terms of eliminating all priority crossings) reflects the significant practical and financial barriers to eliminating some crossings.

In 2006, the Council commenced an intensive monitoring exercise to establish whether water quality had improved with the elimination of crossings. This involves sampling water quality throughout the catchment on a regular basis. It is expected it will be several years before sufficient data can been collected to draw robust conclusions. However, habitat in the immediate vicinity of the crossings has definitely improved with the return of a rock substrate and increased aquatic insect populations.

The success of the programme, due in no small part to the co-operation of the farming community, has prompted the Council to extend the programme to other dairy farming catchments, including the Pelorus River, Kaituna River and Tuamarina River catchments and the area around Linkwater.

The programme to eliminate dairy herd stream crossings was the first of its kind to be implemented in New Zealand and progress was closely monitored by other regional councils, the Ministry for the Environment and Fonterra.

FIGURE 9.18: CONTAMINANT LEVELS DOWNSTREAM OF A DAIRY HERD STREAM CROSSING



Cows walking through a stream

Recently installed bridge

GROUNDWATER QUALITY

Groundwater quality monitoring network

The Council's current groundwater monitoring network has evolved over time in response to local issues, and will continue to change as new pressures arise such as climate variability, population growth or changes in irrigated crop type. Geographically the main focus has always been and will continue to be the Wairau Plain, although in recent years wells at Wairau Valley, Ward and the Tuamarina River Valley, have been included to reflect land use change including the expansion of viticulture into non-traditional areas and more intensive residential settlement.

Every season, staff manually sample 30 wells to determine groundwater quality in relation to human health standards, to identify any land-use impacts, and refine community understand of aquifer behaviour generally. In addition to the standard series of groundwater chemistry parameters collected each season targeted surveys are made of pesticides, microbes and nutrient concentrations in local groundwater.

New Zealand's groundwater quality and how Marlborough compares

The Ministry for the Environment recently reported on the status of groundwater quality in New Zealand. By comparison with international studies the report found that generally speaking groundwater quality in New Zealand is similar to that in many other countries. It described the current status and trends in groundwater quality based on data collected by regional councils for their state of the environment reports, or as part of the national groundwater monitoring programme.

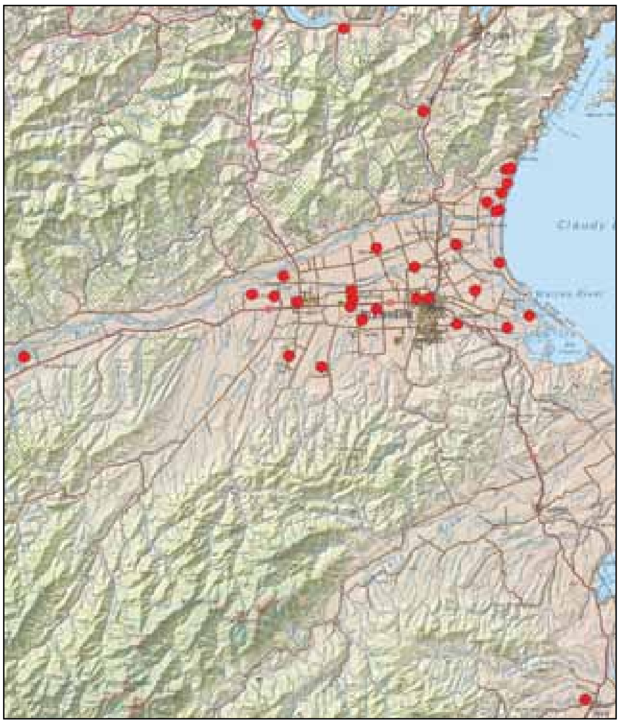
The national report found that despite Marlborough's groundwater's having the same number of monitoring sites representing potentially at risk aquifers as the national average, only 4% actually showed human or agricultural impact, compared with 57% of sites nationally. To a large extent this reflects the naturally high rate of dilution and flushing through the aquifers underlying the northern Wairau Plain, rather than good practices or management. The residence time of groundwater in this area is generally less than 6 years old.

Natural toxic substances in groundwater

There can be some localised groundwater problems caused by natural processes. These include:

- Acidity of groundwater - the groundwater of the eastern half of Wairau Aquifer is acidic. The acidity, measured by the pH of the water, in some of the monitoring wells is less than 6.5 (a pH of 7.0 is considered neutral). Acidic water can cause corrosion of metal and cement pipes.
- Increased iron concentrations - there are areas where concentrations of iron exceed the Ministry of Health's Drinking-water Standards for New Zealand 2005 for taste purposes. This does not mean that this water is unsafe to drink, it just means that the water may taste slightly "metallic". High iron concentrations are found in some of Marlborough's aquifers.
- Increased manganese concentrations - manganese is a chemical element that is found in the different types of rocks and can be dissolved in groundwater. Manganese concentrations are generally high in areas where iron concentrations are also high. Filtering water supplies with higher manganese concentrations is usually needed to make the water taste better.

FIGURE 9.19: MARLBOROUGH'S GROUNDWATER QUALITY MONITORING SITES 2008



One of the other most harmful constituents to human health in groundwater is arsenic. Since 2001 the Council has been looking at when and where arsenic may cause a health risk to drinking waters. This involves an ongoing programme of surveying groundwater from wells representing all aquifer types beneath the Wairau Plain, to provide a clearer picture of areas where drinking water might be at risk.

The aquifers at risk from having higher level of arsenic are older groundwaters, chemically reducing environments such as wetlands or confined aquifers, and water sourced from near fault-lines e.g. Wairau Valley. An added complication is that arsenic shows a seasonal variability depending on what the background or ambient chemical conditions are.

The presence of dissolved iron or manganese are good indicators of the likely presence of arsenic because they dissolve under similar chemical conditions as arsenic. This is useful because although the Council has few arsenic values to define the area of risk, there are several hundred measurements of iron concentrations available. The Council is aware there are naturally occurring contaminants in Marlborough's groundwater and these may exceed drinking water standards from time to time. More survey work is needed to understand their distribution and seasonal variability. (See later in this section for information about naturally occurring arsenic at Rarangi.)

Man-made compounds in groundwater

Monitoring of groundwater has shown that while groundwater quality in Marlborough is generally very high, there are instances where man-made contaminants exceed drinking water standards. Some of these instances, which include elevated levels of nitrates and pesticides, are reported here. Some information on monitoring the effects of timber preservatives in posts reaching groundwater is also provided.

Nitrates in groundwater

Nutrients commonly originate as either human or animal effluent, decaying plant waste or fertilisers; with the latter being the most common source of non-point source contamination issues for Marlborough groundwaters. The Wairau Plain has been used for agricultural purposes since European settlement and artificial nutrients have been used over time to maintain natural soil fertility. The thin alluvial soils overlying the Wairau Aquifer in the Rapaura/Renwick area and sandy soils forming the Rarangi Shallow Aquifer, are the most vulnerable to leaching.

Nitrate is one of the common nutrients found in the more vulnerable aquifers. Nitrate-nitrogen in groundwater has two main sources: from nitrogen fertilisers applied to land above aquifers; and liquid wastes (sewage effluent or industrial effluent) applied to land above aquifers. Levels of nitrate are of particular interest because concentrations above 11.3 parts per million can be harmful to human health in drinking waters. Nutrients do exist naturally in groundwater, but only at low levels and for New Zealand conditions, a nitrate-nitrogen concentration of more than 3 parts per million is generally indicative of a human influence.

Monitoring has shown that nitrate contamination is not a major problem in Marlborough aquifers. Historically there have been localised hotspots west of Renwick, in the Lower Brancott/Fairhall and along the fault line in the Lower Waihopai Valley areas as shown in Figure 9.20. These have been attributed to historical arable and dairy farming, but it remains uncertain how long these plumes will persist. Because they exist in aquifer areas with less natural groundwater flushing (referred to as marginal aquifer areas) they may be around for decades to come. This is part of the reason the Renwick municipal well field is likely to be moved further north in the future to improve the quality of drinking water.

Nitrates often appear in groundwater as seasonal spikes, most commonly in spring when higher rainfall causes leaching. This seasonal pattern is illustrated by the Council's monitoring of a well in the Springlands area on the western side of Blenheim over

DRINKING WATER STANDARDS

Safe drinking-water, available to everyone, is a fundamental requirement for public health. The Ministry of Health administers the Drinking-water Standards for New Zealand 2005, which apply to drinking-water, that is, water intended to be used for human consumption, food preparation, utensil washing, oral hygiene or personal hygiene. The standards are applicable to all drinking-water irrespective of its source, treatment or distribution system, whether it is from a public or private supply, or where it is used. (The only exception is bottled water, which is subject to standards in the Food Act 1981.)

The standards specify maximum acceptable values for the microbial, chemical and radiological 'determinands' of public health significance in drinking-water and also provide compliance criteria and procedures for making sure the water supply is not exceeding these values. (A determinand is a property of the water that is determined, or estimated, in a sample. An example of a microbial determinand in water would be total coliform.) The standards also set out what has to be done when the maximum allowable values are exceeded.

The standards are set to protect public health. However, as the public generally assesses the quality of its water supply on aesthetic perceptions, guideline values for aesthetic factors such as taste and smell are also provided.

a number of years - see Figure 9.21. Each of the dots represents a sample with the colour showing the season when it was collected. Blue dots represent winter, green for spring, red for summer and brown for autumn.

This well records its highest values in summer, autumn and to a lesser extent spring. This suggests higher aquifer levels dilute nutrients, or alternatively summer irrigation may be leaching fertilisers to groundwater.

In other aquifers the seasonal trend in nitrate levels appears to be reversed. For example, the Rarangi Shallow Aquifer well shows no apparent long-term trend in nutrient levels, but there are sudden fluctuations that show the sensitivity of this aquifer to leaching of surface contaminants by rainfall. Irrigation may also be contributing to leaching. This highlights the need to avoid over-watering crops and re-circulating groundwater that can flush contaminants through from the soil. This is especially true for thin soils with low water holding capacity where regular small doses of irrigation water are needed.

In a well representing the Wairau Aquifer north-west of Renwick a different trend occurs. This site is interesting because the source of aquifer recharge is almost exclusively leakage from the nearby Wairau River channel, rather than from rainfall. Peak nitrate levels are normally associated with winter when river flood events carry nutrients that have accumulated through summer or autumn, deep into the aquifer. Nitrate levels in the well are still very low relative to the human health limits because of the diluting effect of the free-flowing aquifer and because nitrate levels in the river are low.

An area where nitrate levels have been recorded as exceeding drinking water standards on occasion is in a well representing the unconfined Wairau Aquifer to the west of Renwick. This area was converted from pastoral farms during the 1990s. While there are too few samples to identify longer term trends, values sometimes exceed the drinking water guideline and also fluctuate significantly – see Figure 9.22. This pattern is consistent with intensive agricultural land-use overlying an unconfined aquifer, and matches levels observed in other wells close to the Renwick Terrace. The impact is probably short lived due to the flushing effect of Wairau Aquifer flows. It is also uncertain whether high levels reflect current or historical agricultural activities either locally, or further south in the Waihopai Valley.

This emphasises the importance of monitoring groundwater, particularly as this is the upstream part of the aquifer, where activities can potentially affect downstream aquifer water users, including the Renwick or Blenheim municipal water supplies.

FIGURE 9.20: WAIRAU PLAIN NITRATE-NITROGEN DISTRIBUTION

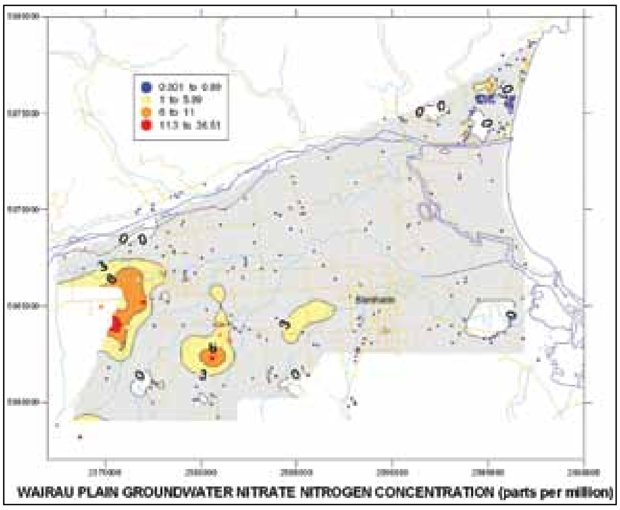


FIGURE 9.21: SPRINGLANDS GROUNDWATER NITRATE-NITROGEN CONCENTRATION

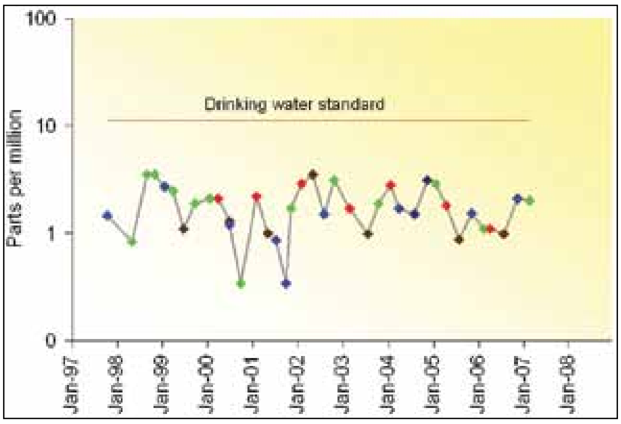
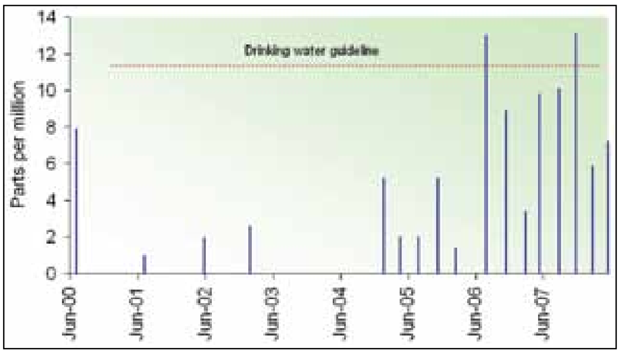


FIGURE 9.22: WAIRAU AQUIFER NITRATE-NITROGEN CONCENTRATION WEST OF RENWICK



TIMBER PRESERVATIVES AND GROUNDWATER

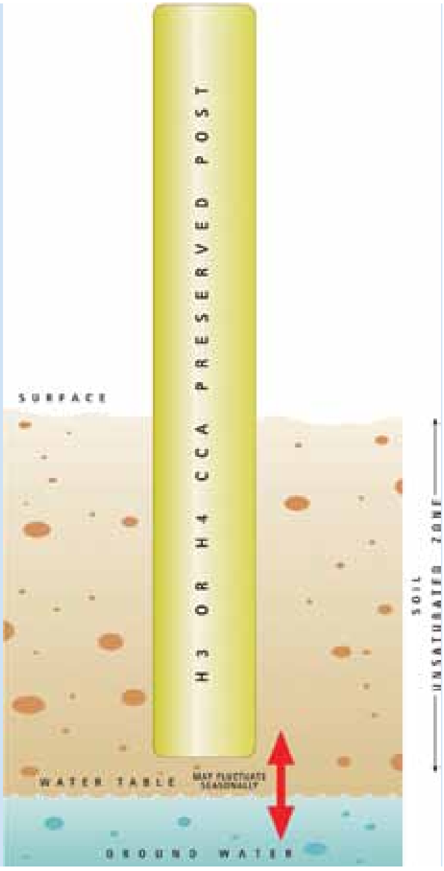
Marlborough is home to the largest concentration of vineyards in New Zealand, supported by millions of chemically preserved posts. The community to question whether there were any environmental side effects from the timber treatment chemicals.

In 2003, the Council commissioned research into the environmental impacts from chemicals used to preserve vineyard support posts. The most common active ingredients in these treatments are chromium, copper and arsenic. Local experiments showed all posts lose a certain amount of these chemicals where they come into contact with the soil through natural processes.

HortResearch scientists used mathematical models to extrapolate the experimental results, and predict what would happen if the current practice of replacing posts across the existing vineyard area continued for the next 500 years. A small accumulation of these chemicals in the soil was predicted, with some reaching groundwater although this depended on local factors such as the depth to the water table. The diagram shows a typical post in contact with the soil with the water table sitting below in blue.

In the western parts of the Wairau Plain there is little chance of preservative chemicals from posts ever reaching groundwater because of the thick soil layer separating them from groundwater. Conversely at Rarangi some posts in low lying areas have their "feet" in groundwater for at least part of the year. Notwithstanding this, modelling predicts that concentrations will remain low in most aquifers and be of no risk to human health.

An area of uncertainty noted by the researchers was the Southern Valleys Aquifers, which have long established vineyards overlying aquifers with sluggish flow. Monitoring levels of arsenic will verify the model predictions, although so far there have been no apparent changes.



Typical post sitting in soil

In summary, while nitrate levels are above the drinking water standards for short periods at some wells, this is likely to reflect historic nutrient use and does not appear to represent a widespread problem. Tracking trends in nutrient levels in relation to land-use conversion and working with the industry to minimise effects on groundwater quality will be a focus over the next 5 years.

Pesticides in groundwater

Pesticides are widely used in agricultural and horticultural situations to control a range of animal and plant pests so that high quality crops can be produced. Pesticides are a general term that includes the use of herbicides to control unwanted plants or weeds, insecticides to control unwanted insects and fungicides to control various types of fungi (i.e. moulds and mildews).

Some pesticides have the ability to build-up in the soil or leach downwards to groundwater. The risk of this occurring in any given situation depends on the pesticide used, the soil type, crop type and climate. Because groundwater is a key source of drinking water for Marlborough residents, pesticide use needs to be carefully managed to maintain the current high quality of groundwater for this purpose.

Since 1993 the Council has taken part, along with most other regional councils, in a central government funded 4 yearly national groundwater pesticide survey. Since the national programme started in 1990, similar percentages of wells have had pesticides detected in each survey, suggesting levels are static. While significant numbers of detections are made throughout New Zealand, they are mostly at low levels relative to drinking water guidelines. Generally they occur in shallow, unconfined aquifers susceptible to pollution such as the soils of the Rarangi Shallow Aquifer.

The pesticides most commonly detected are members of the triazine family of herbicides (used for grass control in orchards or vineyards) because they are immobile and stay in soil or water for long periods of time. The replacement of traditional crops in Marlborough with grapes over the last three decades is likely to mean increased fungicide use relative to insecticides, although herbicides probably remain the dominant pesticide type used today.

The latest survey was conducted in November 2006 and included 20 Marlborough sites representing various aquifer types. During this survey, the herbicides simazine and terbthylazine, and the fungicide procymidone, were found in two Marlborough wells at very low concentrations of less than 5% of the respective human drinking water guidelines. Of the two wells with positive values, one is linked to a nearby point source discharge with a history of contamination. Both herbicides have the potential to leach to groundwater and persist in the environment, properties which mean they should not be used on land overlying unconfined aquifers.

To complement this work, the Council carried out its own series of quarterly surveys at four sites, to see if seasonal factors influence the presence of pesticides in local groundwater. Sites were selected to represent vulnerable aquifers including the Rarangi Shallow Aquifer and the unconfined Wairau Aquifer. Sampling took place in August 2007, November 2007, February and May 2008.

Certain pesticides were targeted based on their current use, while others were included because they had been measured previously, or were associated with a historical land-use. One fungicide, cyproconazole, was detected at the low concentration of 1.4 parts pesticide per billion parts of groundwater, but this originated from the source well described above, and is indicative of localised contamination.

Apart from isolated incidents related to well head security or spills, pesticide contamination is not a major issue for Marlborough aquifers. The four yearly national survey is probably adequate for monitoring the impacts of pesticide use under Marlborough conditions, however for vulnerable aquifers used as sources for community or drinking water supply, the Council will conduct annual samples as part of the regular monitoring programme at three sites each spring.

Seawater intrusion

The boundary where Wairau Plain aquifers meet the Cloudy Bay coast has been a focus for the Council since 2000 because of the potential for seawater intrusion. The shallow sandy Rarangi Shallow Aquifer exists at depths down to 10 metres below ground level as far south as the Wairau Bar. This aquifer is underlain by the confined Wairau Aquifer, which occurs at depths of more than 30 metres south of Rarangi Road. The Wairau Aquifer is potentially less at risk from seawater intrusion because its structure forms a barrier to the ocean.

A monitoring network of seven wells along the coast was established in 2000/2001 to provide early warning of problems. These sentinel wells measure the conductivity of the water every 15 minutes. Salty water is much more conductive (i.e. able to carry a current) than freshwater, so it is easy for us to be able to tell if the interface has migrated inland.

Seawater intrusion won't occur if offshore aquifer flow balances the pressure of seawater. Figure 9.23 shows a simplified concept of a seawater interface moving in response to the relative pressure from freshwater in green on the inland side, versus the heavier saltwater in blue sliding underneath from offshore. Ideally the interface should not migrate far enough inland to intercept and contaminate any freshwater wells as shown in scenario 3.

The Council is still learning about the sensitivity of coastal aquifers to abstraction. It may take another five summer seasons before there is a clearer picture, because the volume amount of water that has been authorised to be taken from the aquifers in this location, has yet to be fully used. From the modelling work, aquifer levels need to remain a minimum elevation of 1.25 metres above mean sea level. The greatest risk exists under late summer conditions when demand is greatest and the rate of freshwater flow offshore is at its lowest.

GROWSAFE CALCULATOR

Aside from the monitoring of groundwater to detect pesticides, the Council has been involved with a national project to minimise the risk to soil quality and especially to groundwater. This has involved the Agrichemical Education Trust, other regional councils, agrichemical producers, primary producer groups and HortResearch Ltd and has resulted in the development of a tool to assist farmers to make decisions about the best pesticide to use on their properties.

HortResearch Ltd used a computer model to simulate what would happen with typical spray regimes for a range of pesticides used in the major crop growing areas of New Zealand. About 16,000 scenarios involving combinations of soil, climate and typical spray programmes were simulated and stored on a CD called the GROWSAFE CALCULATOR. Farmers can use this tool to predict the relative risk of pesticide build-up in the soil or leaching to groundwater and choose the most environmentally suitable product for their property.

Although no seawater intrusion has been evident so far, demand for water could increase in the future with further rural residential subdivision and viticulture development resulting in a corresponding increase in the risk of seawater intrusion. The Council is therefore continuing to actively manage the risk because of the potential for significant impacts on community water supplies at Rarangi and for irrigation of crops. An automated alarm system is planned, with Council staff closely monitoring coastal aquifer status over the next two seasons until demand for water peaks.

Rarangi groundwater quality issues

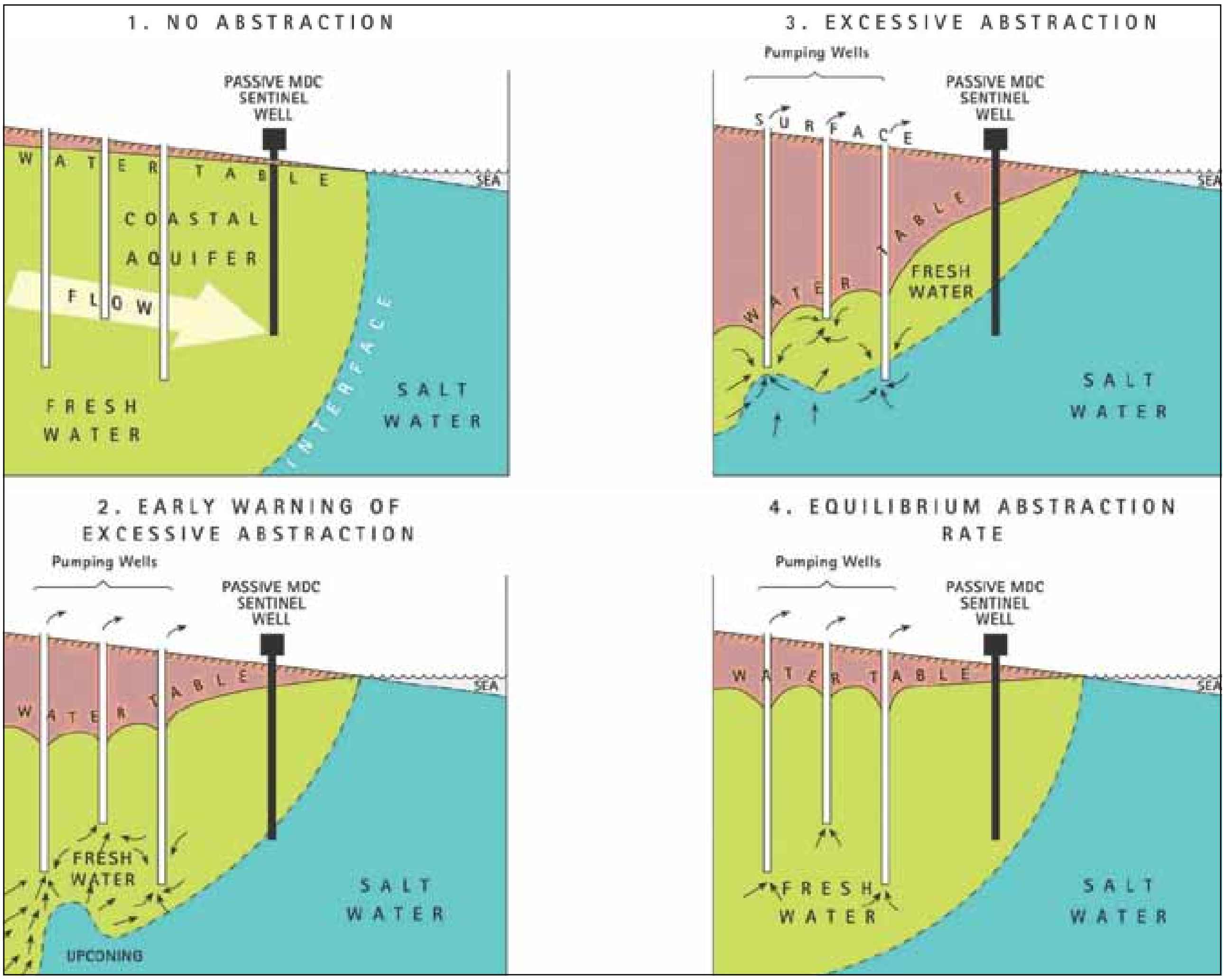
Rarangi is an area of Marlborough that has experienced and is continuing to experience land use change. Historic land uses such as semi extensive pastoralism have been replaced by vineyard and rural residential developments. Because of this the Rarangi Shallow Aquifer has become the most intensively studied and monitored aquifer in Marlborough.

Water quality issues in this area are potentially significant because the local community relies on the Rarangi Shallow Aquifer for all of its drinking water. Free draining sandy soils and high aquifer levels are factors that make this aquifer vulnerable to surface pollution. Possible sources of contamination include agricultural activities and the growing number of rural residential settlements. There are also natural water quality issues with elevated levels of arsenic having been recorded.

Naturally occurring arsenic

Elevated levels of arsenic were first discovered in groundwater through routine monitoring of the north Rarangi community water supply in 2001. Figure 9.24 shows the variation in arsenic

FIGURE 9.23: CLOUDY BAY EARLY WARNING SYSTEM FOR SEAWATER INTRUSION



concentration at that well from 2001 through to 2007. Monitoring was required by the Ministry of Health because of the presence of elevated levels of arsenic in a registered community water supply, although the Drinking-water Standards for New Zealand 2005, shown by the dashed red line, has not been exceeded.

To evaluate the wider risk to human health, the Council along with the Marlborough Public Health Unit, initiated two comprehensive surveys of all drinking water sourced from the Rarangi Shallow Aquifer. These were carried out in the winter of 2003 and summer of 2005, and involved testing around 220 individual well water supplies.

A significant number (18%) of supplies had high levels of arsenic, which occurred in clusters near existing or buried wetlands. Two isolated occurrences of high arsenic levels appear to be related to historic sheep-dips. Other than this, and based on a review of possible sources from existing land uses and known past activities in the area, monitoring points to a natural source for the arsenic.

While the distribution of environmental arsenic at Rarangi is well defined, whether these values represented the maximum or minimum that could be expected long-term in nature, remained uncertain. Monthly surveys of four domestic water supplies by the Council between 2004 and 2008, showed a larger than expected fluctuation in levels. Figure 9.25 shows the results of the survey with each of the four sites represented by a different coloured line, in relation to the Drinking-water Standards for New Zealand 2005. Factors causing the variation are not well understood but probably involve changes in biochemical conditions associated with local wetlands or buried swamp deposits. Changes may be caused by rainfall or seasonal changes in aquifer level.

Manmade impacts on Rarangi Shallow Aquifer quality

Monitoring by the Council shows that humans are having a detectable but limited effect on water quality in the Rarangi Shallow Aquifer. For example Figure 9.27 shows quite a number of wells with elevated sulphate levels emerging opposite the Rarangi Golf Club. This possibly reflects use of sulphate as a fertiliser on the golf course. This plot is based on results from the 2005 arsenic survey and is consistent with the known direction of groundwater flow from the ranges towards the sea. Similar concentrations occur in domestic wells near the corner of Neal and Rarangi Roads because of residential activities. Although levels are elevated, they are still within the Drinking-water Standards for New Zealand 2005, and groundwater is safe to drink.

FIGURE 9.24: ARSENIC CONCENTRATIONS AT NORTH RARANGI COMMUNITY WATER SUPPLY WELL

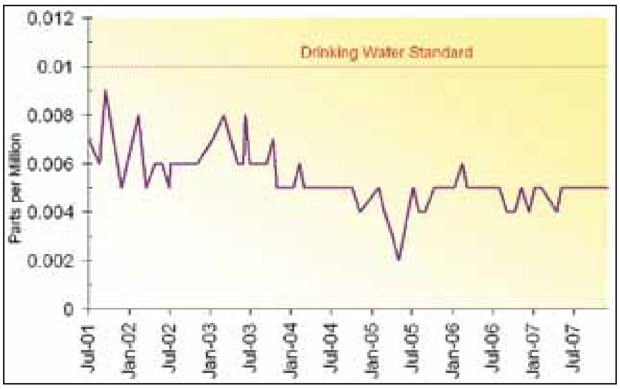


FIGURE 9.25: ARSENIC VARIABILITY SURVEY RESULTS

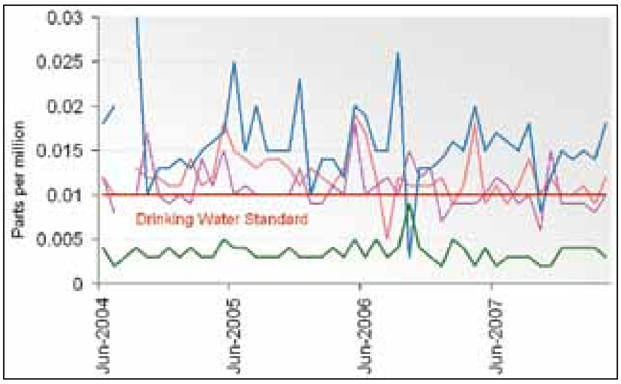


FIGURE 9.26: RARANGI SHALLOW AQUIFER SULPHATE AND NITRATE-NITROGEN TRENDS

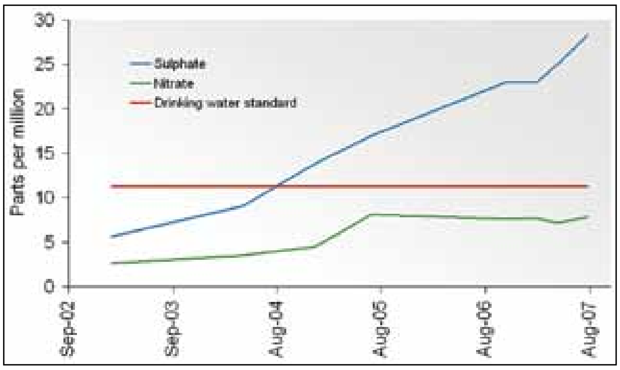
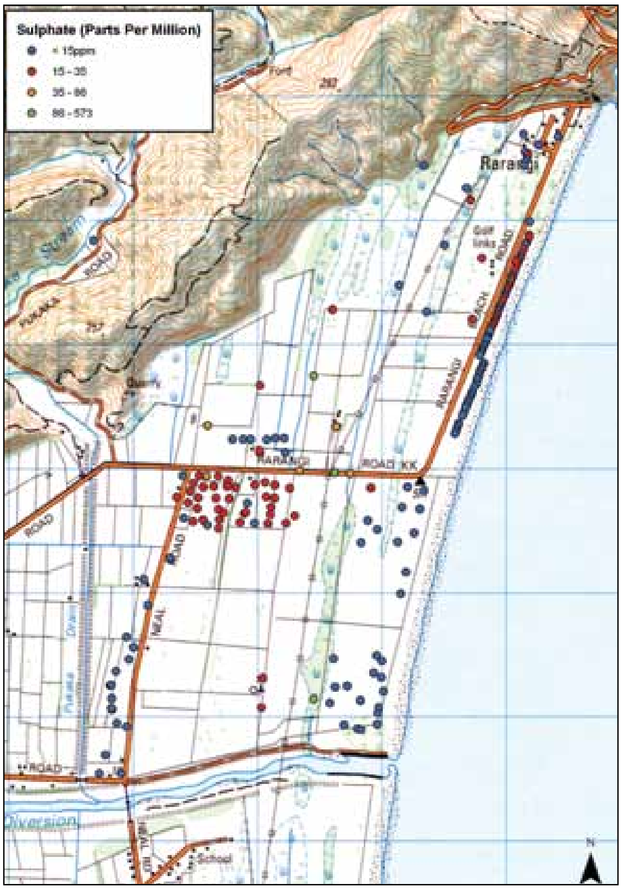


Figure 9.26 shows the change in Rarangi Shallow Aquifer nitrate-nitrogen (green) and sulphate (blue) concentrations for the area north of the Wairau Diversion during a period when land was converted from pastoral farming to irrigated vineyard. The upward trend in nitrate and especially in sulphate, clearly shows that land uses are having an effect on the water resource, but it remains uncertain whether concentrations will increase, level out or decline.

FIGURE 9.27: RARANGI SHALLOW AQUIFER NUTRIENT PATTERNS



The Rarangi Shallow Aquifer is particularly sensitive to pesticides because of naturally low organic carbon content in local soils. In spite of this, a recent survey at five wells did not detect the presence of any pesticides. The Council will sample for pesticides on an annual basis each spring because of the importance of the Rarangi Shallow Aquifer for drinking water.

The health risk posed by microbes in groundwater is of special interest at Rarangi because of the growth in rural residential settlement over the past decade, and the potential for cross-contamination of drinking water supplies by human effluent. Historically very few faecal bacteria have been detected, which is to some extent surprising, but shows that existing separation distances and soil conditions are adequate to allow natural die-off of bacteria.

Monitoring groundwater at Rarangi

WATER QUANTITY

Monitoring rainfall and river flows

Rainfall and river monitoring network

The Council has a network of rainfall and river monitoring sites throughout Marlborough. These sites provide representative monitoring in most areas where water resources are important. The network is constantly expanding as demand dictates. Information is collected by electronic technology (referred to as 'telemetry') from most sites, which means less missed records as site faults are able to be quickly identified, and rectified. In the last 3 years the monitoring system has been significantly upgraded to a new generation of hardware and software. Figure 9.28 shows the rainfall monitoring sites and Figure 9.29 shows the water level and flow monitoring sites. (The sites in Figure 9.29 include sites operated by both the Council and the National Institute of Water and Atmospheric Research.)

Many one off measurements of stream flows are also carried out in streams where a permanent monitoring site is not possible, or justified. These measurements can then be correlated back to nearby permanent sites, and so long as a reasonable relationship is able to be derived between the two, the measurements can then be used to give a reasonable indication of the flow characteristics of the waterway.

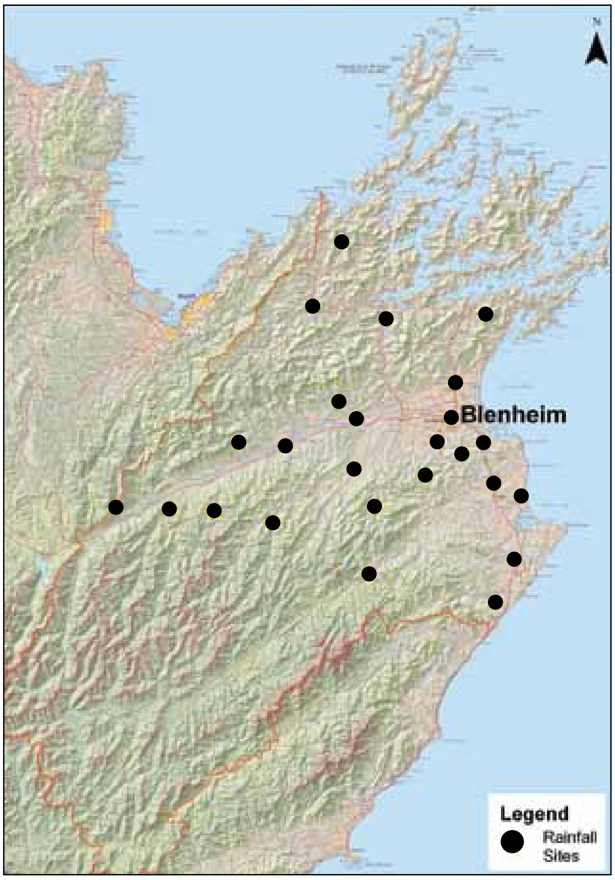
New technology for measuring river flow

The Council has recently purchased two Acoustic Doppler Current Profilers for measuring river flow. This new technology is the first real change in the technique for measuring river flow in the last 100 years. Previously current meter gaugings were carried out by measuring the velocity of the water at about 20 points across a river. This is done using a current meter, a device with buckets or propellers that rotate at a speed in proportion to the water velocity. At each point, known as a 'vertical', the depth of the water, and distance to the bank were also measured, allowing the area between each vertical to be calculated. The discharge in each vertical can then be calculated. The total of the discharges gives the total flow for the river.

Rather than using a spinning current meter, the Acoustic Doppler Current Profiler uses sound waves to measure the river flow. The profiler floats on the surface of the water and is moved across the river to make the measurement. Sound waves are transmitted downward, and are bounced back off water particles and the river bed, allowing water velocities and depths to be calculated. Each crossing typically takes three minutes. This short time permits four measurements to be completed in less time it takes to complete a conventional current meter gauging. Having multiple measurements means there is greater confidence in the reliability and repeatability of the flow measurement. In contrast to the measuring velocity at just one or two depths the Acoustic Doppler Current Profiler continuously measures velocities through the entire section of the river. Figure 9.30 shows a typical velocity profile measured with this new technology. The different colours represent different water velocities.

The Streampro Acoustic Doppler Current Profiler completing a measurement utilising a motorised traveller

FIGURE 9.28: MARLBOROUGH DISTRICT COUNCIL RAINFALL MONITORING SITES 2008



The Acoustic Doppler Current Profiler units have been in use by the Council for the last year, with some 400 measurements having being made. They were successfully deployed during the October 2007 Wairau River flood and the 2008 Taylor and Omaka floods.

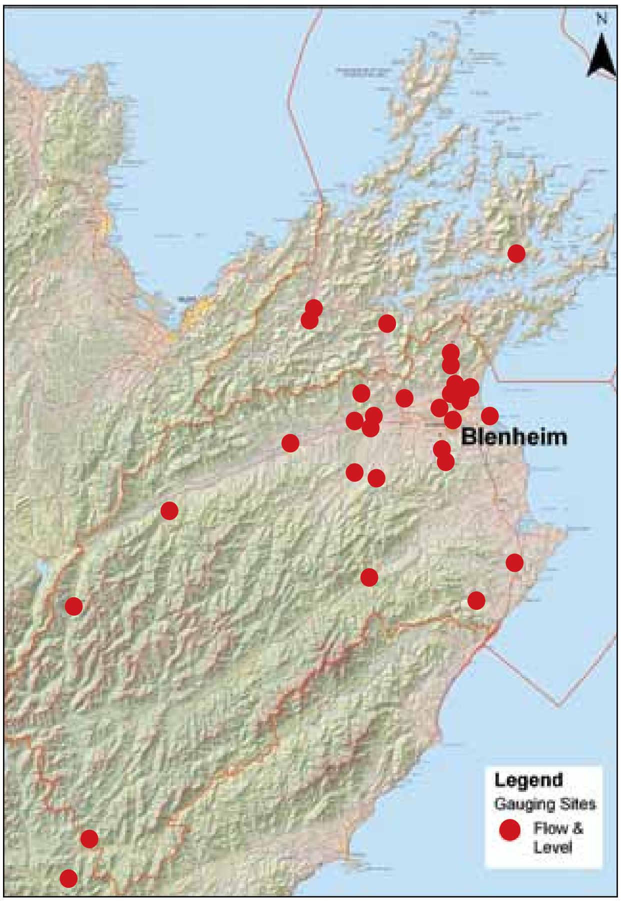
Flood prediction and monitoring systems

The hydrological monitoring network serves another important purpose - it provides information to predict and monitor flood events. In fact it was for this reason that the Council's first remote data retrieval (telemetry) was established back in the early 1960s. Early telemetry was basic, with an accuracy of about 300 millimetres, and was transmitted by telephone or radio telephone as a series of beeps, which the observer had to count, and translate into levels. The introduction of the computer controlled Aquitel system in 1983 was a vast leap forward and served well until 2005, when the current HydroTel system was installed.

The HydroTel system is much more versatile, being able to be configured for a range of loggers and sensors in the field. It also has a much more graphical interface for users. The number of telemetered sites has been increased significantly, as part of a desire to have real

The Rio Grande Acoustic Doppler Current Profiler deployed for flood gauging, using a tagline from the Wairau Diversion bridge

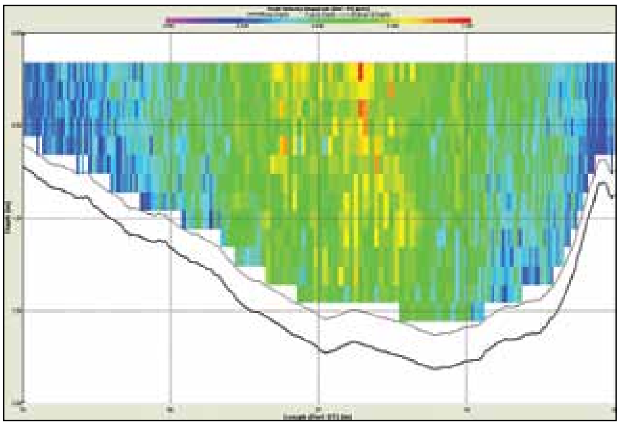
FIGURE 9.29: MARLBOROUGH DISTRICT COUNCIL AND NATIONAL INSTITUTE OF WATER AND ATMOSPHERIC RESEARCH THE WATER LEVEL AND FLOW MONITORING SITES 2008



time access to as many sites as possible, as well as allowing more targeted maintenance, which gives better reliability.

Together with formal and informal flood prediction techniques, hydrologists and rivers staff are able to predict and monitor floods much more accurately than in the past. The availability of weather radar information has also improved flood monitoring, as the path of a storm event can be tracked and related to observations from the rain gauge network for verification -see box 'Flood event 30-31 July 2008'.

FIGURE 9.30: VELOCITY PROFILE MEASURED BY AN ACOUSTIC DOPPLER CURRENT PROFILER



Telemetred rainfall site at Red Hills looking down the Wairau Valley

Rainfall and river flow trends

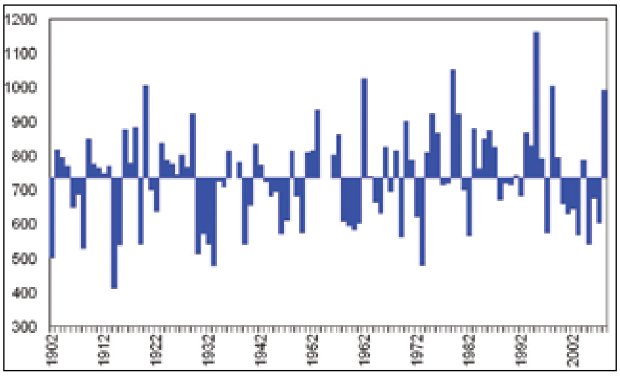
In order to identify trends in rainfall and river flows it is necessary to have good long term records for comparison. Climate can vary seasonally, annually, and on longer time frames. For instance the Interdecadal Pacific Oscillation affects wind patterns and rainfall trends, and changes every 20 to 30 years. There are also shorter term trends such as the El Niño - Southern Oscillation pattern, which affects climate.

In the positive phase of the Interdecadal Pacific Oscillation, over the south west Pacific region southerly winds are more prevalent. This results in south westerlies being more frequent in New Zealand. The negative phase of this Oscillation brings a tendency for more frequent northerly winds for the south west Pacific and north easterly winds in New Zealand.

Three phases of the Interdecadal Pacific Oscillation have been identified during the twentieth century - a positive phase through 1922 to 1944, a negative phase from 1946 to 1977, and another positive phase from 1978 through until 1998. Recent findings show that there has been another shift towards a negative Interdecadal Pacific Oscillation since 1999. These changes cause climate shifts in the South Pacific.

Monitoring of river flows in Marlborough date back to the late 1950s while rainfall records at a few sites, date back to the early 1900s. These ongoing records are valuable when looking at trends over time, and determining if changes are significant in relation to historical patterns. For instance rainfall records at Sevenoaks, just south of Renwick, go back to 1903. Plotting the annual rainfalls as variations either side of the average shows that the dry seasons experienced between 2000 and 2007, are not dissimilar to other prolonged dry periods during the 1930s, the 1940s, and 1958 to 65 - see Figure 9.31. The positive Interdecadal Pacific Oscillation period from 1977 to 1998, was generally a wetter period. In contrast the negative Oscillation period from 1947 to 1977, was generally drier.

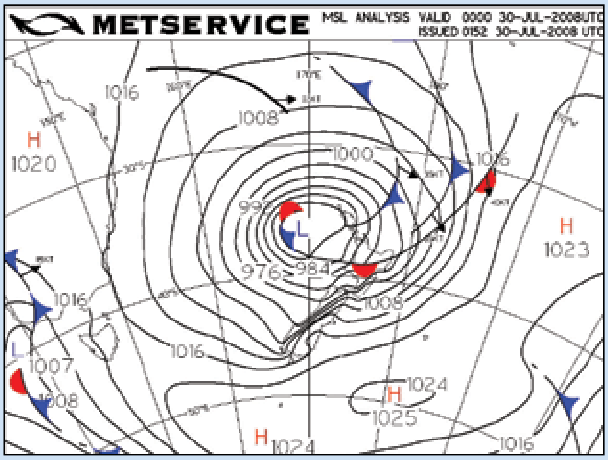
FIGURE 9.31: SEVENOAKS RAINFALL 1902 - 2008



FLOOD EVENT 30 - 31 JULY 2008

The Council first became aware of a significant weather event through a Special Weather Warning from Met Service at 9.45 am on Tuesday the 29th of July 2008. A deep depression moving south down the west coast of New Zealand was forecast to bring heavy rain, and strong winds to many parts of the country. For Marlborough the forecast was for 100-120 millimetres of rain on the Richmond Ranges, and easterly gales of 120-150 kilometres per hour.

SITUATION MAP FOR 30 JULY 2008



The situation map for mid-day 30 July 2008 shows the deep depression, and its associated fronts about the time of the heaviest rain period; the isobars indicate the direction and strength of the winds experienced. Verbal communication from the MetService forecasters indicated the likelihood of heavy rainfall in eastern areas, although it did not meet their criteria for an official warning due to the limited area.

The event was monitored by hydrology staff using the Council's telemetry systems. Another valuable tool was use of the live radar feed from MetService, which allows forecasters to see how widespread rainfall is, and focus on areas that may be significantly affected.

Rainfall events from the east mainly affect the Taylor River, and eastern coastline, including the eastern Marlborough Sounds. When strong winds are involved the rainfall can push well inland, hence the warning for the Richmond Ranges as well. It is also worth noting that in the four weeks of July leading up to this event, between 70 and 90 millimetres of rain had been

recorded on the Southern Valleys hills, and 140-160 millimetres in the Picton area. This meant that soil moisture was already quite high, with higher run-off likely.

Rain started falling just before midnight on Tuesday the 29th of July 2008, and continued throughout Wednesday, making this a prolonged event. While rain was widespread through much of the district, two areas, the hills to the south of Blenheim, and parts of Picton, both received much higher intensities than other areas. This can be seen in the rainfall distribution map showing the amounts of rain recorded for this weather event.

RAINFALL DISTRIBUTION FOR JULY 2008 STORM EVENT

The map shows that rainfall across the Southern Valleys from the Taylor River to the Omaka River was very high, with totals for the event in excess of 200 millimetres at two gauges: Taylor at Tinpot, and Omaka at Ramshead Saddle. East and west of these sites rainfall dropped off markedly. (The Onamalutu Saddle site did not record rain because of a blockage from debris from a fallen tree.)

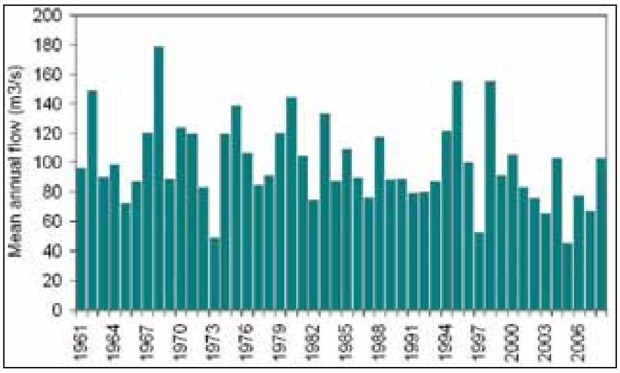
Very high rainfall was experienced in Picton, although this appears to have been confined to relatively small areas. Rainfall totals have been obtained for secondary gauges in the area, with the highest total of 281 millimetres being recorded at the Elevation reservoir site. Intensities at this site exceeded 14mm/hour for 11 continuous hours, peaking at 20 millimetres per hour.

The rain pattern appears to have been orographic, with the highest rainfall recorded low down in the valleys, accentuated by very strong winds and the funnelling effect of the hills around Picton. As a consequence flooding was more related to the local run-off and small streams, with only moderate events being recorded in the larger Waitohi and Waikawa streams. The Council's main rain gauge in the centre of the Boons Valley (Waikawa stream) catchment recorded only 113 millimetres.

Analysis of the frequency of this storm event has been carried out for a number of catchments. However, it has been difficult to quantify the return period in some areas because of lack of hydrological information. This was an event which had significant rainfall and flooding in some areas. Fortunately high intensity rainfall was not widespread, otherwise the localised problems experienced would have been much more widespread and serious.

Vineyard inundated by flood waters

FIGURE 9.32: WAIRAU RIVER MEAN FLOWS 1961 - 2007



It is apparent from this that 7 of the last 8 years have been drier than average. This dry period is reflected in river flow trends for the district, as illustrated by the Wairau River mean flows shown in Figure 9.32.

This shows that 6 of the last 7 years have been below the long term mean of 98 cubic metres per second, whereas prior to that, the number of years above and below the mean is approximately equal. Whether this trend continues remains to be seen. If it does then it will have implications for water resource management in Marlborough.

It is noted that 2008 has been a wetter year in coastal areas, with about 640 millimetres of rain in Blenheim to the end of October, which is almost the annual average with two months of the year remaining. However, this above normal rainfall is not reflected district wide, as most inland and northern rainfall sites are on track for about average rainfall for the year. This is reflected in the Wairau River mean flow for the year to date, which is only about 94 cubic metres per second, slightly below the long term mean. With November and December usually being lower flow months, this is unlikely to increase.

One interesting comparison that can be made is the contrast in the pattern of annual maximum flows for the Wairau and Taylor Rivers - two very different Marlborough rivers. The Wairau has its headwaters in the alps and is exposed to rain events from many directions. Therefore the variations in annual maximum flows range from about 600 cubic metres per second to about 6000 cubic metres per second, a factor of about 10 - see Figure 9.33. In contrast, the Taylor River is on the dry east coast margin of Marlborough, and often misses the major rainfall events. The range of annual maximum flows therefore is much greater; from as little as 3 cubic metres per second, up to 200 cubic metres per second, a factor of about 65 - see Figure 9.34.

Also notable in the Taylor River record are long periods of inactivity. In the 11 years between 1997 and 2007, there were no floods in excess of the average annual flood size of about 60 cubic metres per second. There was also a 7 year period from 1982 to 1988 when no floods in excess of the average annual size were recorded.

In the Wairau River, the periods of inactivity are shorter; the longest period when the average annual flood of about 2,000 cubic metres per second has not been recorded was the 6 years from 1977 to 1982.

FIGURE 9.33: WAIRAU RIVER MAXIMUM FLOW RECORDED IN EACH CALENDAR YEAR 1962 TO 2008

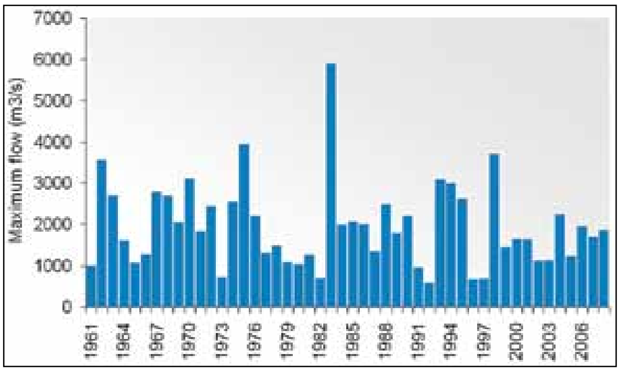
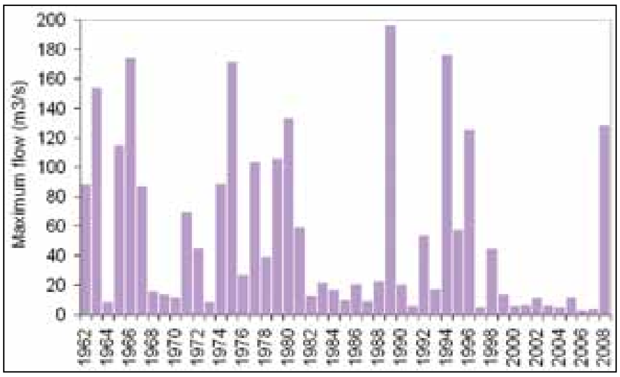


FIGURE 9.34: TAYLOR RIVER MAXIMUM FLOW RECORDED IN EACH CALENDAR YEAR 1962 TO 2008



Wairau River during flood event.

DEMAND FOR WATER IN WARD-FLAXBOURNE AREA

With the returns able to be achieved from land planted in grapes, it is not surprising that developers and growers are looking to areas where water resources have not been considered sufficient for irrigation uses in the past. The area around Ward is a classic example of such development. Potentially 1,500-2,000 hectares of land is available for the planting of grapes, particularly with the recent trend of carrying out major earthworks to re-contour rolling hills to allow planting.

The main water resource in the area is the Flaxbourne River, which has very low summer low flow, often less than 10 litres per second (0.010 m^3/s). Several smaller streams, such as Needles Creek and Tachalls Creek, also carry lesser flows.

Summer low flows of 10 to 15 litres per second are only sufficient to support about 70 hectares of grapes through the irrigation season. In addition, there is a need to maintain flows for habitat purposes and to protect the two community domestic/stockwater schemes that rely on the Flaxbourne River. This has led the Council to take a cautious approach to water allocation in the area. Most consents issued to date include a condition requiring users to stop taking water when flows fall to a certain (trigger) level.

The trigger levels for the Flaxbourne River have been conservatively set. This precautionary approach of the Council has meant that development opportunities have been limited to date. The demand for water has lead to community conflict, with most consent applications being opposed by other parties wishing to take water, or to protect existing consents.

Several options to bring water into the area from other sources are now being explored, both by a community group, and private individuals. Some of these proposals involve conveying water over 20 kilometres, which highlights the significant added value that water brings to land in Marlborough. Piping water over this long distance follows the trend set in other areas of Marlborough, such as the Southern Valleys Irrigation Scheme (approximately 4,500 hectares), Blind River Irrigation Ltd (approx 1,600 hectares), and numerous smaller community group initiatives. In the long term, particularly if climate change further reduces water availability, a combination of piping water from larger, more reliable sources, coupled with large scale storage, will be necessary to sustain existing plantings, and ensure ongoing development.

Monitoring aquifer levels

The Council has operated a network of permanent wells to monitor aquifer status since the 1970s. There are now several decades of continuous record available at some sites for identifying trends in aquifer behaviour from the effects of authorised water takes versus natural variation. The Council operates a network of 30 monitoring wells that provide real time information on water levels or conductivity in aquifers every 15 minutes. Measurements are transmitted electronically to the Council's office in Blenheim with daily summaries being posted on the Council's website. Figure 9.35 shows the location of these sites for the Wairau Plain along with the boundaries of the main aquifers.

In addition to the permanent network of well sites, at any time the Council has a series of temporary installations or surveys operating to provide short term information on topical issues. Current examples include the interaction of the Rarangi wetlands with groundwater and the hydraulic properties of Wairau Plain freshwater springs.

Another example is that of the Riverlands Aquifer where over the past 5 years a new monitoring well has been put in place. Well level surveys, water quality surveys, water use surveys and computer modelling of the likelihood of seawater intrusion have taken place to help improve the Council's understanding of how this aquifer operates and the effects of abstraction on it. One of the interesting conclusions of the work programme was the fact that a high proportion of groundwater naturally drains from the Riverlands Aquifer by seeping upwards through the bed of the Taylor River, increasing channel flow.

Monitoring has shown the largest changes in aquifer level have been being experienced in the Southern Valleys Aquifers area, and the Deep Wairau Aquifer. The larger falls in the Southern Valleys Aquifers is a consequence of the high level of demand for irrigation water resulting in over allocation in some cases, together with slow recharge and periods of drought. In the Wairau Aquifer larger variations occur in the unconfined or western area. This reflects the greater concentration of abstraction locally and sensitivity to changes in recharge. More detail on these trends in particular aquifers follows.

Wairau Aquifer trends and status

The four well sites with the longest standing records, and which represent a variety of aquifer types and issues are shown in Figures 9.36 to 9.39. The wells source water from the Wairau Aquifer, the main groundwater resource underlying a 20,000 hectare area of the Wairau Plain. Trend lines for each well are shown in red.

Figure 9.36 is a site representing the Wairau Aquifer near the Cloudy Bay coast that has been operating since 1988. There has been a small, 100 millimetre fall in level since 1988 but aquifer pressures remain healthy at more than 2 metres above mean sea level in this area.

Figure 9.37 features the Council monitoring well near Athletic Park in Blenheim, which has been operating since 1977. This represents the confined portion of the Wairau Aquifer beneath Blenheim, which is the source of drinking water for the town. Levels have fallen by around 400 millimetres over the past 31 years which is significant, but is not causing any apparent problems.

The third plot (Figure 9.38) shows a net fall in Wairau Aquifer levels of around 600 millimetres at the longstanding Council operated well near the old Conders Forest north-west of Renwick. This well has been monitored since 1982 and shows by far the largest change in levels of all the wells monitored by the Council.

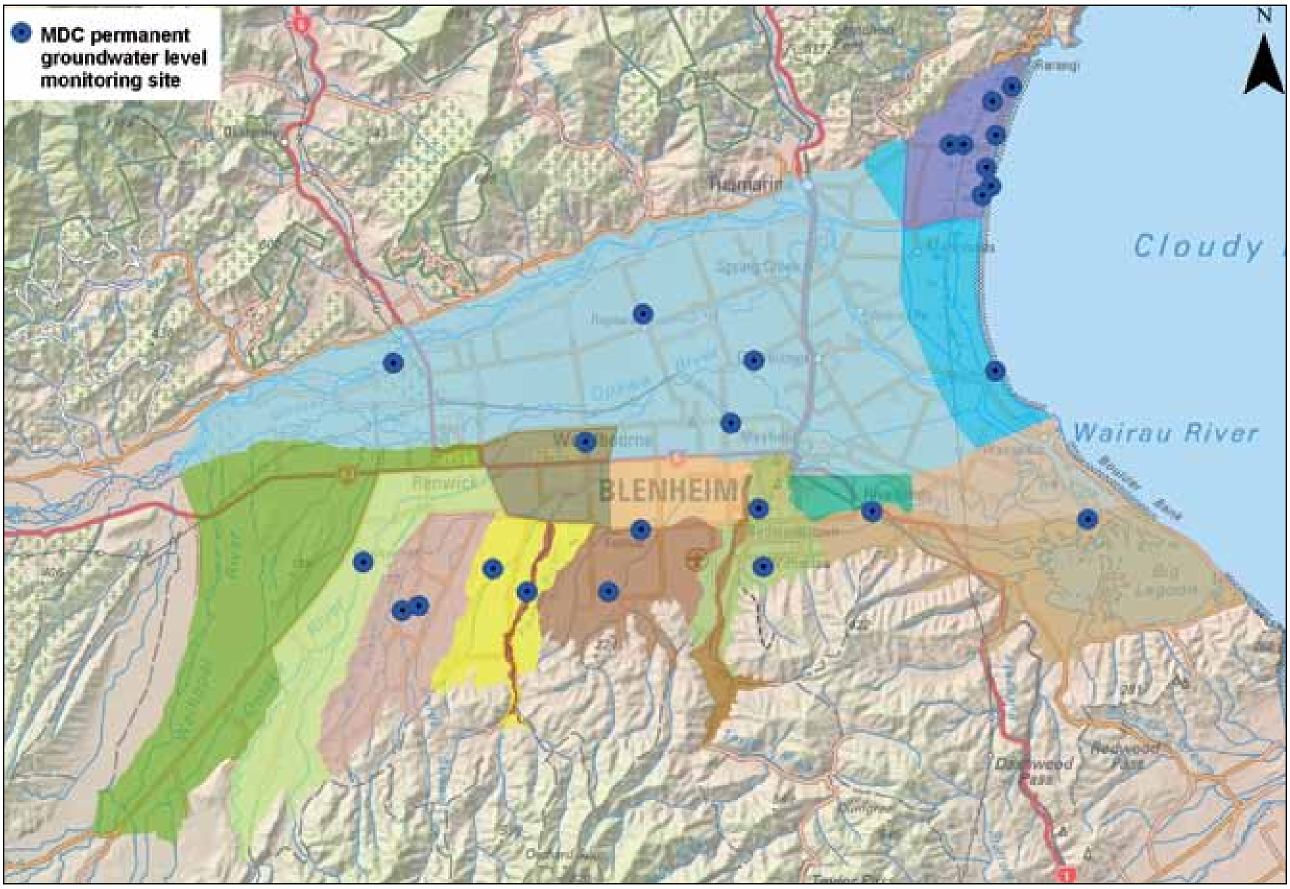
The last site (Figure 9.39) features the Rarangi Shallow Aquifer with record dating back to 1988. This shows that average levels have fallen by 100 millimetres over the last 20 years, which is more significant than for other systems. This is because this aquifer is thin, with a saturated thickness of less than 10 metres compared to 30 metres or more for the bulk of the Wairau Aquifer.

In summary, aquifer levels have fallen slightly over the past three decades, which is reflective of the increased demand for water. To date the magnitude of fall is considered acceptable in terms of sustainably managing the Wairau Aquifer at a regional scale, when the fall is compared against the total aquifer depth.

Southern Valleys Aquifer Trends

The Southern Valleys of the Wairau Plain, around the Brancott, Benmorven, Omaka, Taylor and Burleigh areas, contain remnants of glacial outwash materials that have not been reworked by the Wairau River to remove the finer sand and sediment. The lack of removal of the sediment from the gravels has meant that the aquifers in the Southern Valleys are not as porous as those of the Wairau Aquifer and therefore movement of water into and through these aquifers is much slower. The recharge of these aquifers relies on the winter flows of the small rivers and streams above them and on local rainfall. During the summer months low rainfall means that the river and stream channels draining the Southern Valleys often dry up.

FIGURE 9.35: PERMANENT MONITORING NETWORK AND AQUIFER BOUNDARIES



The Southern Valleys aquifers have been the most heavily committed and lowest yielding of the groundwater systems the Council has had to manage. A variety of land uses occur in the area although the main land use is viticulture.

The Southern Valleys have also become an increasingly desirable place to live and a number of rural residential subdivisions have been developed, such as at Fairbourne Drive and Morven Lane. The result is that a significant amount of water is also taken from the aquifers to supply domestic water. These takes are authorised by permitted activity rules within the Wairau/Awatere Resource Management Plan and are not required to be metered. Domestic water use has been estimated at approximately 160,000 cubic metres per year.

In the mid 1980's the Council introduced the requirement of fitting water meters to all takes in the Southern Valleys area in order to measure consumption. While the Council's staff have regularly read meters during each irrigation season since 2001, self monitoring is being phased in. The Council now has a good record of individual user water use and the cumulative take from the aquifers

Aquifer levels have fallen by up to 10 metres since 1997 as a result of low rainfall and increasing irrigation water demand. Demand peaked during the 2000/2001 summer drought when an estimated 1,000,000 cubic metres of groundwater was pumped out of local aquifers over a six month period, mostly for vineyard irrigation.

In response to concerns that the level of abstraction from Southern Valleys aquifers was not sustainable, coupled with two significant droughts, the Council initiated a voluntary approach with irrigators to restrict water use. This approach was first put in place in during the 2001/2002 summer season. The voluntary approach was based on a community agreement to stabilise aquifer levels no lower than the minimum experienced during the benchmark 2000/2001 drought so that domestic wells would be protected. Irrigators have found that with information obtained from meter readings they have been able to prepare irrigation schedules and budget water use during the irrigation season. By doing so irrigators have actually found they can get by with less water than previously used.

FIGURE 9.36: GROUNDWATER ELEVATION WAIRAU AQUIFER AT BAR 1988 - 2008

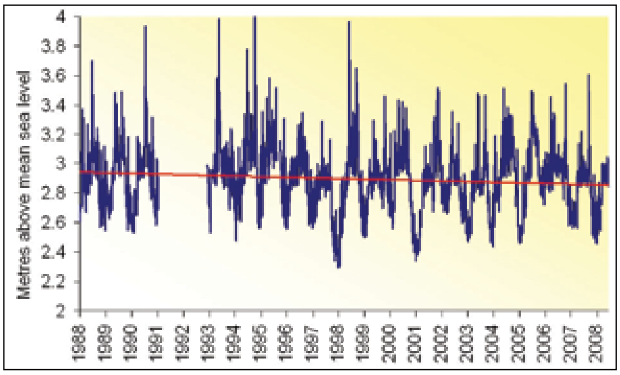


FIGURE 9.38: GROUNDWATER ELEVATION WAIRAU AQUIFER WEST OF RENWICK 1982 - 2008

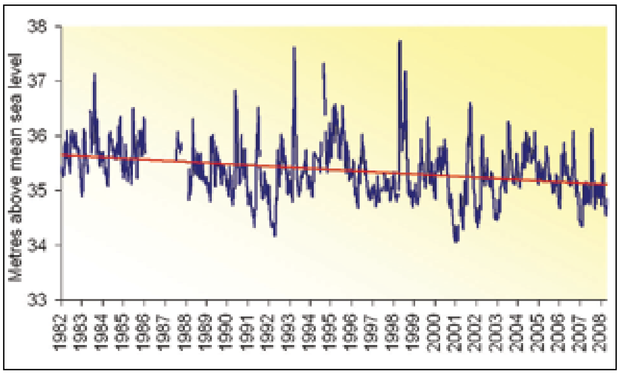


FIGURE 9.37: GROUNDWATER ELEVATION WAIRAU AQUIFER AT BLENHEIM 1977 - 2008

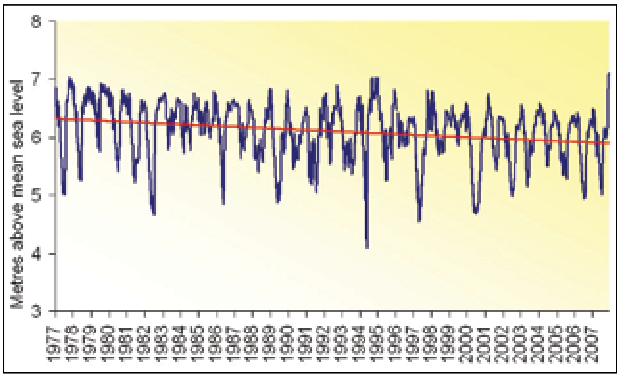
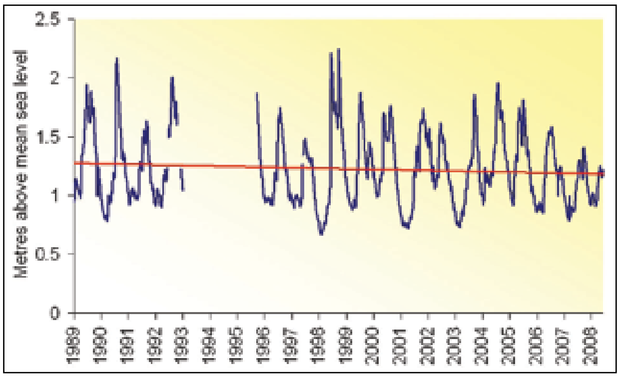


FIGURE 9.39: GROUNDWATER ELEVATION RARANGI SHALLOW AQUIFER 1988 - 2008



SOUTHERN VALLEYS IRRIGATION SCHEME

Irrigation water for land uses in the Southern Valleys has traditionally been taken from the Southern Valley Aquifers. There are a total of 56 water permits authorising the taking of water from these aquifers.

Aquifer levels have been declining over time and reached record lows during the 2000/2001 drought. The amount of water taken over summer and autumn months, in addition to the stock and domestic water taken year round, has exceeded the amount of recharge over the following winter and spring months. Droughts have made this worse as recharge during the drought is dramatically less than normal, while abstraction can be higher than in average rainfall years. As a result, aquifer levels have progressively reduced and affected the ability of some users to continue to access groundwater, particularly over the summer months.

Because of the effects of abstraction on aquifer levels, and the limitations that this placed on water supply, a group of landowners formed the Marlborough Water Augmentation Group in 1999 to investigate options to supplement groundwater supplies in the Southern Valleys. This group looked at bringing water into the Southern Valleys from alternative sources, including the Wairau River. In 2003, the group successfully applied for resource consent to take water from the Wairau River, pipe it to, and distribute it throughout, the Southern Valleys. The construction of this irrigation scheme, the Southern Valleys Irrigation Scheme became a Council funded project and was commissioned late in 2004. The $17 million capital cost of the scheme was funded through a compulsory rate on all potentially irrigable land, which will continue for a 20 year period. There is an annual water charge on top of the rates that is charged on a per unit basis.

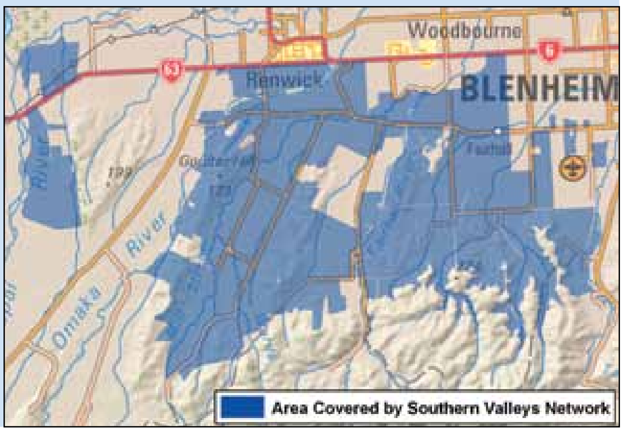
The scheme now provides an alternative supply of irrigation water to 4,500 hectares of land. The area supplied is shown in the map.

There are properties that currently source groundwater in the Southern Valleys, but which are not supplied by the scheme, particularly in the upper Omaka River catchment. There are also areas outside of the scheme area, but which are supplied scheme water on a contract basis (e.g. Fareham Lane, parts of Guernsey Road, east of Ben Morven Road).

Southern Valleys Irrigation Scheme intake

Until the commissioning of the scheme, the only sources of water in the Southern Valleys were groundwater or the storage of high flows from ephemeral water bodies. With the exception of users in the southern part of the Omaka River valley and the Brancott vineyard, all irrigation users in the Southern Valleys now have the potential to access an alternative supply of irrigation water. The irrigation scheme has therefore created the potential to achieve a reduction in the demand for groundwater and stabilise or improve aquifer levels.

The resource consent authorising the scheme to take water from the Wairau River requires the take to stop when flows at the Council's Tuamarina recorder fall to a specified level. For this reason, the Council is investigating options of storing water in order to improve the reliability of supply. The stored water would be used when the taking of water from the Wairau River was restricted.



Around the same time as the voluntary approach was first used, investigations also began on the development of a water augmentation scheme for the Southern Valley areas - more about this scheme, which commenced in the 2004/2005 irrigation season, is in the box 'Southern Valleys Irrigation Scheme'.

The variation in levels in two of the Southern Valley aquifers (the Benmorven and Brancott) are shown in Figures 9.40 and 9.41. Figure 9.40 shows that up until the 1997/1998 drought, Benmorven aquifer levels were above ground (or artesian) by up to 5 metres, but are now likely to remain permanently below the surface. The rebound in Brancott Aquifer levels since 2004 reflects the use of Southern Valleys Irrigation Scheme water instead of local groundwater. Generally speaking aquifer levels have stabilised and even shown a degree of recovery in some areas.

The Deep Wairau Aquifer is the most recently exploited groundwater resource in Marlborough, having been discovered during the 1997/1998 drought by exploratory drilling. As a consequence it is not completely understood, although it is known to contain some of the oldest groundwater in New Zealand with an average age of 24,000 years. Few water permits have been granted to use Deep Wairau Aquifer groundwater because of its link to the heavily committed Southern Valleys Aquifers, and uncertainty over its safe yield.

Following 10 years of use, investigations as to how the Deep Wairau Aquifer has responded to abstraction has been undertaken. Monitoring shows there has been no overall downward trend in aquifer levels, suggesting active recharge is occurring to some extent. It was also found that despite 500,000 cubic metres of groundwater having been abstracted, there was no appreciable change in the chemical or isotopic signature of the groundwater, implying it is a larger system than the currently defined boundary suggests.

FIGURE 9.40: GROUNDWATER ELEVATION IN BENMORVEN AQUIFER 1990 - 2008

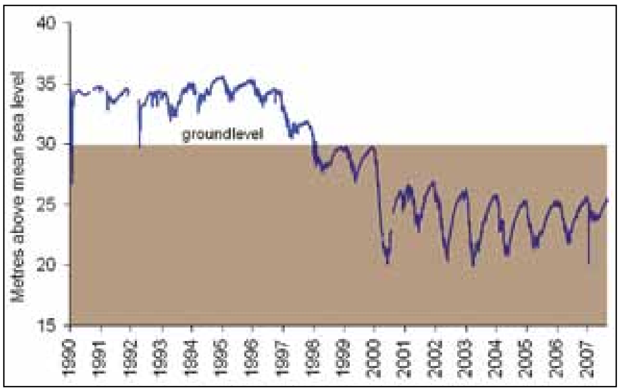
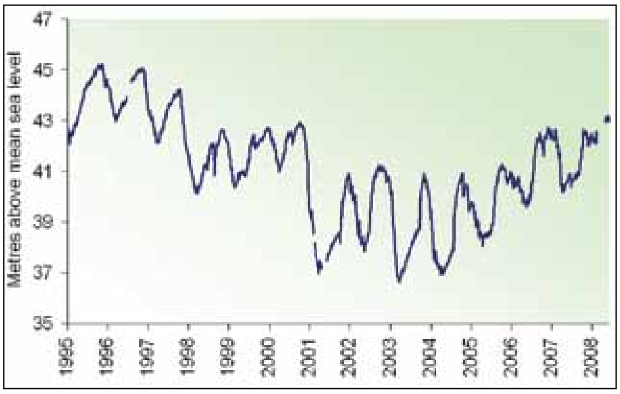


FIGURE 9.41: GROUNDWATER ELEVATION IN BRANCOTT AQUIFER 1995 - 2008



Surface/groundwater links

Monitoring trends in spring flow helps to determine whether abstraction is having an impact on groundwater levels. In turn this monitoring also helps to tell whether the Wairau Aquifer is being sustainably managed. Because springs are the only groundwater that is visible to the public, they act as a good barometer of aquifer health.

Status of freshwater springs

A series of freshwater springs emerge in a belt through the middle of the Wairau Plain. Most people are aware of high profile springs like Fultons Creek running through Pollard Park, or Spring Creek, but many more are on private property and are not visible to the public. They often provide a unique ecological habitat because of a continuous flow of cold water generated by up-welling groundwater.

These springs exist because of two natural mechanisms - topography and aquifer structure. In the western Wairau Plain springs are controlled by topography. As ground slope reduces and the water table rises to intercept the surface in low lying areas. Further east towards the coast, the emergence of a thick layer of marine sediments, or a confining layer, forces groundwater to the surface. These processes are illustrated in Figure 9.42.

FIGURE 9.42: SURFACE AND GROUNDWATER INTERACTION CAUSING SPRINGS

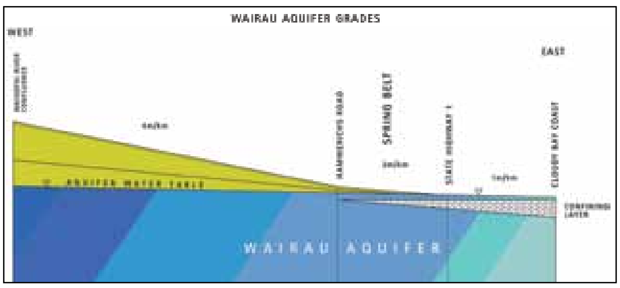
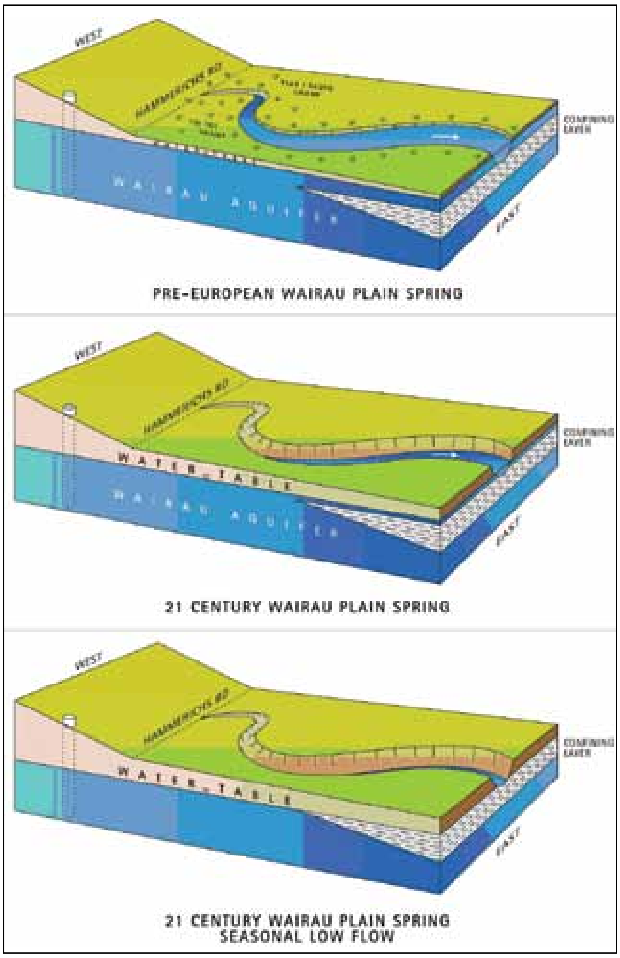


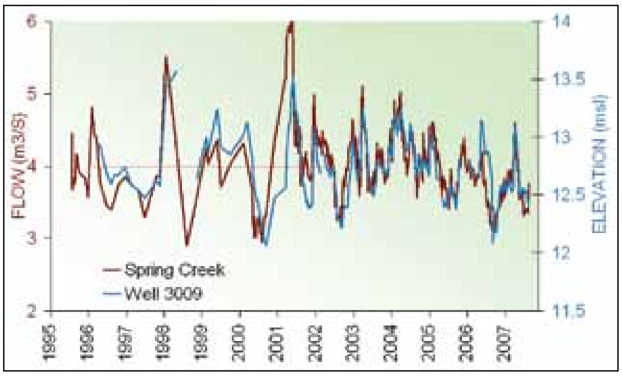
FIGURE 9.43: SPRING RECESSION



Spring fed streams generally have a very steady flow regime, even in times of summer drought. The flow of the spring is closely linked to groundwater levels in the surrounding aquifer. Over time the flow may vary with changes in groundwater levels from either natural climatic variability or through abstraction of groundwater. Along with a stable flow, springs also tend to have a stable temperature reflecting the relatively constant nature of groundwater inputs. The limited magnitude of high flow events means sediments in the bed of springs tend to be relatively fine and water clarity is often very high.

As explained earlier in this chapter, there is the potential for abstraction of groundwater to cause springs to recede or dry-up. The reason for this is that the springs rely on groundwater seepage and if a well is pumping nearby, groundwater that would otherwise emerge as spring flow, is pumped out of the well and used on paddocks or in vineyards. Often it is difficult to tell by the naked eye whether flow has been affected by pumping, but receding of a springs headwaters is much more apparent. The way in which a fall in groundwater causes springs headwaters to recede is shown in Figure 9.43.

FIGURE 9.44 : WEEKLY SPRING CREEK FLOW AND WAIRAU AQUIFER ELEVATION



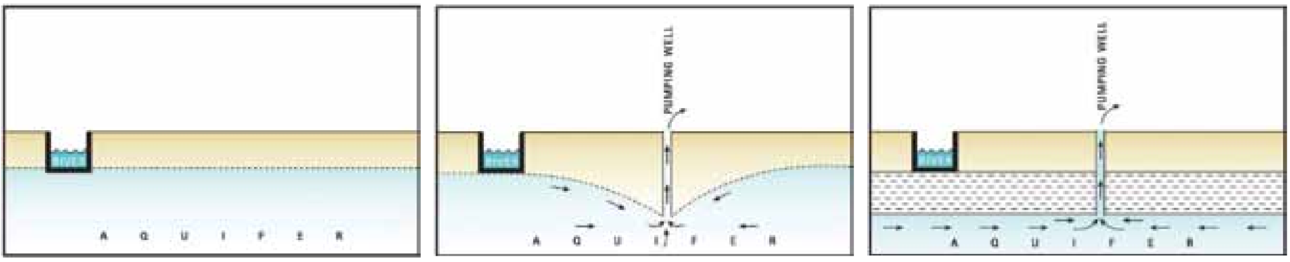
The Council has been measuring spring flows regularly since 1996 and now has sufficient record to identify trends in spring behaviour. Figure 9.44 shows the variation in weekly flow of Spring Creek and Wairau Aquifer levels at Wratts Road. Aquifer level is in blue, but the similarity between this and the flow in Spring Creek (in red), shows they are closely linked and in fact aquifer level can be used to determine what the average flow each week will be. Figure 9.44 also shows that while there are variations in flow, generally speaking the flow in Spring Creek reflects the longer term variation in Wairau River flow and summer irrigation water demand.

Investigating spring sensitivity to pumping

There has been a good understanding developed over time with monitoring of the link between the Wairau Aquifer and spring flow at a regional scale. However, the Council has been investigating the hydraulic connection at a local level to identify spring sensitivity to pumping.

What has been looked at more recently is the nature of streambed sediments, which determine the degree of interaction between the aquifer and spring flow. For example, a spring with a gravel bed will be more affected by pumping from a nearby well than a spring with a thick layer of fine silts, which will tend to isolate the two water bodies - see Figure 9.45. The technical term used to describe the isolating effect of these sediments is its streambed conductance. A spring with a higher conductance value is more likely to be susceptible to the effects of abstractions of groundwater. Conductance values are commonly used in equations to calculate the stream depletion effect of new water permit applications. However, up until

FIGURE 9.45: RIVER AND AQUIFER INTERACTION



recently its value was uncertain and had been estimated. An investigation was undertaken to directly measure the nature of streambed sediments in springs and calculate values of streambed conductance to improve the accuracy of predictions.

This work largely involved field measurements in the channels of spring fed waterways and was undertaken and reported in two parts. Stage 1 included investigations on the tributary springs of Spring Creek, Old Fairhall River and Fultons Creek. Stage 2 focussed on spring tributaries of the Taylor River, which maintain channel flow through the urban area of Blenheim in summer.

The key conclusions of the investigations were:

- Hydrological surveys show streambed conductance values of between 100 and 200 m/day are characteristic of most of the Wairau Plain freshwater springs.
- Values for Murphy's Creek are higher, indicating this spring is particularly sensitive to groundwater abstraction.
- Work from both stages of the project showed that flow in most Wairau Plain freshwater springs can potentially be depleted by groundwater abstraction.
- Standardised values of stream bed parameters used to calculate spring depletion should be used.
- Defining minimum acceptable spring flows and management criteria was seen as being a pre-requisite to developing future policy.

Headwaters of Spring Creek (near Rapaura Tennis Club)

There needs to be recognition of the cumulative stream depletion effects generated by smaller takes in addition to the larger direct effects.

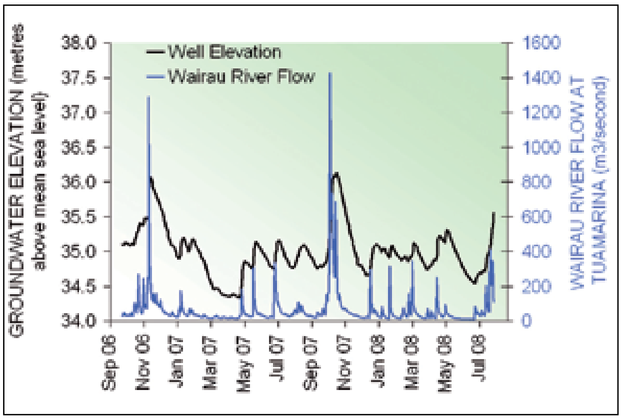
Because of increased community awareness of the value of springs and the potential for new abstraction to be developed in sensitive headwaters areas, the Council continues to gauge flow in the major springs each week. This information will be useful for deriving sustainable flow regimes in the future.

Wairau River interaction with groundwater

The biggest influence on Wairau Aquifer levels is the Wairau River. Natural losses of water from the Wairau River channel between the Waihopai River confluence and Wratts Road, supply 80% of aquifer recharge, with rainfall accounting for the remainder. Figure 9.46 shows the daily fluctuation in Wairau River flow in blue against well level in black, with an increase in river flow causing well levels to rise.

The loss of river water to the aquifer is a continuous process, although the rate varies depending on flow in the river, well level and state of the bed sediments. While the precise relationship remains uncertain, higher rates of recharge are associated with floods and lower rates with droughts. One aspect of the process that isn't fully understood is the sensitivity of river losses to

FIGURE 9.46: WAIRAU RIVER VERSUS WELL LEVEL



changes in channel bed sediments. It is likely the position of the active channel and the nature of the bed sediments affects the rate of aquifer recharge.

A build-up of river gravel will increase the gradient and hence the rate of recharge, although beyond a certain point this will tend to isolate the aquifer from the river, resulting in less recharge. A fall in gravel levels will reduce the rate of recharge, everything else being equal. Large floods benefit the aquifer by flushing out fine silts or clays, which clog the river gravels and reduce the rate of recharge. Channel cross sections show that gravel is relatively static in the critical recharge zone reach of the Wairau River channel.

The lowest groundwater levels in 26 years of record occurred during the first 4 months of 2007 at the Council monitoring well close to the Wairau River. This was explained by low river flows, with the fourth lowest summer quarter in terms of mean Wairau River flow since 1960.

Rarangi Wetlands

The Rarangi wetland complex is one of the last remnants of wetland in existence on the east coast of the South Island because of systematic changes in land use since European settlement. The wetland complex has unique geological characteristics as well as being home to five flora or fauna species on the New Zealand threatened classification system.

In the State of the Environment Report Update 2003/2004 we wrote about monitoring work the Council had been carrying out on water levels in and around the Pipitea wetland at Rarangi was reported. The purpose of the monitoring had been to get a better understanding of how groundwater interacts with the wetland in this area.

Rarangi wetland

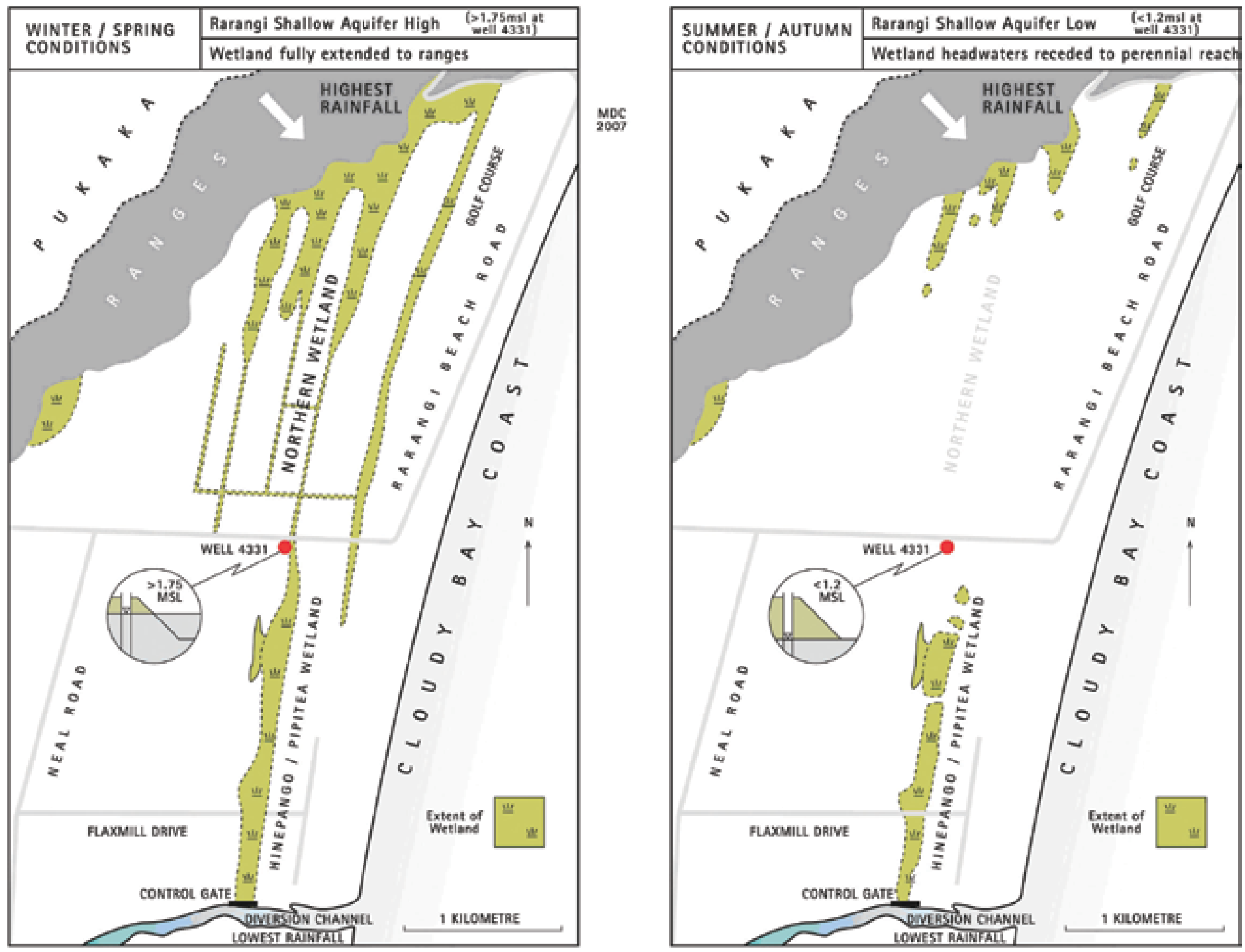
Measuring water, Rarangi wetlands

The 2003/2004 report stated that during the winter, because of high rainfall on the surrounding hills, excess groundwater in the northern part of the Rarangi Shallow Aquifer drains into the northern part of the wetland. The wetland then acts as a channel to recharge the aquifer along the southern margin of the Rarangi Shallow Aquifer, around Flaxmill Drive. During the summer, when there is little recharge, the northern part of the wetland acts as a storage reservoir, and slowly drains into the aquifer as water levels drop. The aquifer drains to the south and into the Wairau Diversion through the wetland.

The Council has continued monitoring aquifer levels at a well on Rarangi Road since 2004 and has also had undertaken an ecological investigation into this wetland system.

The monitoring of water levels in the Pipitea wetland has shown how important wetlands can be in storing and distributing water on a seasonal basis across an aquifer. From the results of monitoring and the ecological investigations it is known that the size of the wetland network changes throughout the year. The wetlands reach their full extent in winter or spring, and recede in size over summer as the rate of drainage exceeds rainfall recharge - see Figure 9.47. While the wetlands are dynamic and change seasonally they are unlikely to dry up naturally. This could happen however, if over pumping of the Rarangi Shallow Aquifer occurs.

FIGURE 9.47: RARANGI WETLAND SEASONAL VARIABILITY



RARANGI WETLANDS AREAL EXTENT VERSUS RARANGI SHALLOW AQUIFER STATUS

This means to maintain the wetlands, but also allow for water to be abstracted through existing resource consents, shallow aquifer levels have to be above a certain elevation. Monitoring of aquifer levels during and after the operation of a resource consent to irrigate a local vineyard, has shown that abstraction does influence the extent of the wetland. From this and general aquifer monitoring, an elevation of 1.2 metres mean sea-level appears to provide for a healthy wetland. Monitoring will continue permanently at Rarangi because of the ecological importance of the wetland and its sensitivity to small changes in aquifer level.

Monitoring water levels, Rarangi wetland

Raupo, Rarangi wetlands

Piezometer being used in Dowlings Creek to measure aquifer level relative to spring level

Making the most of the water we have - Irrigation water efficiency

Water demand patterns in Marlborough have changed dramatically since the early 1970s. Traditional dry-land pastoral farming has been replaced by viticulture, which is reliant on irrigation through the dry summer months. This pattern is set to continue with new developments likely to expand into drier areas where there will be summer competition between users for water. If less water is used in a particular catchment, the surplus can be redistributed to other users or left in the environment for other uses or values.

Since 1992 the Council has collaborated with various crown research organisations to refine the reasonable irrigation requirements of grape plants. This has included looking at irrigation efficiency, which is about optimising plant needs while maintaining consistent yields and fruit quality. This relies on knowledge of the local climate, soil properties and grape physiology.

The Wairau/Awatere Resource Management Plan currently includes water allocation guidelines for a number of activities including for different crop types. For grapes the guideline value of 155 cubic metres/per hectare/per week, equates to 2.2 millimetres per day or 12 litres per plant per day. Since around 1995 this guideline value has been used in allocating water for irrigating grapes. This figure represents the amount of water required to offset natural transpiration, or in other words what a grape plant will drink if allowed to. However, it isn't necessarily the optimum amount of water a grape plant needs in terms of producing fruit or wine quality.

Through trial work under Marlborough conditions and with the use of water meter readings, the Council has established that irrigators are using much less than what their individual resource consents allow. This is the case even in drought seasons when peak usage may occur for a day or two at most. Most importantly the trial work has shown that there is no loss in the quality of fruit produced with acceptable yield and juice quality attributes being maintained.

While there is scope for reducing the guideline for grapes from the 12 litres/plant/day irrigation currently used, to achieve more information is needed about specific microclimates, soils and rooting depths. New techniques for measuring soil moisture have improved understanding of grape transpiration rates. Computer models have significantly improved understanding of how irrigation demand is affected by these factors.

Application of this knowledge has shown that an increase in vineyard planting densities from 3 metres to 1.8 metres, only requires around a 12% increase in water. Increasing density of planting isn't something that was envisaged 20 years ago, but it is increasingly common as growers look to optimise the harvest from premium wine producing areas.

Currently the science component of the water use efficiency project is winding down and the focus will shift to applying the technology, developing decision support tools and reviewing the Council guideline for grape plant water needs. If irrigators are expected to become more efficient then they must have an understanding of the science gathered over the past 15 years and the tools to make the decisions about when to irrigate during the summer. This will be important as irrigators sometimes irrigate their crops even though there may not necessarily be a need to do so. One of the key tools therefore will be a budgeting programme that allows the irrigator to design and implement a seasonal irrigation strategy and track how much water is left at any stage in the season.

The last trial has been operating at a vineyard in the Lower Awatere Valley for the past two seasons and is aimed at determining whether there are regional differences in irrigation water needs. In simple terms, what is being looked at is whether a grape plant in the Awatere Valley needs more or less water than a plant growing on the Wairau Plain. This will help in managing (including allocating) water resources more efficiently in areas with different soil and weather characteristics.

Irrigation trial

Upper Wairau River