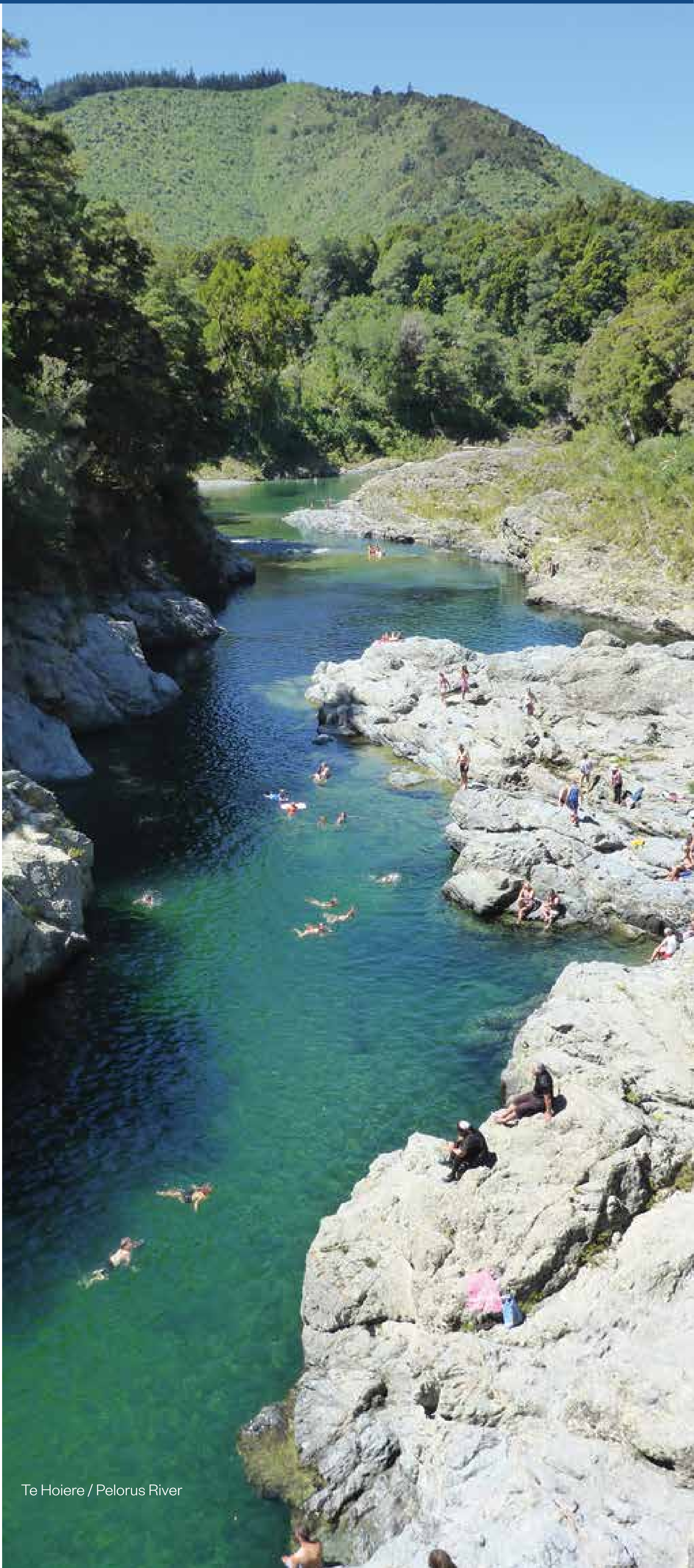
FRESHWATER

MARLBOROUGH DISTRICT COUNCIL

Marlborough has many fresh waterways, from high country streams to broad braided rivers, creeks and wetlands. We rely on good water, and plenty of it, for drinking, farming, growing grapes, industry, recreation and domestic use.

Under the Resource Management Act it is the Marlborough District Council's responsibility to look after the region's water to make sure we have enough and share it fairly.



Te Hoiere / Pelorus River

SURFACE WATER QUANTITY

Fresh water is divided into two categories – surface water (rivers, streams, lakes and wetlands) and groundwater (stored in natural aquifers under the ground). The quantity and quality of our surface water and groundwater is regularly monitored by the Council.

RIVER FLOWS

River flow and water levels are measured at more than 30 monitoring sites in Marlborough and the information is used for flood warnings, resource consents, water allocation and other research (Figure 1). Real-time data are sent by telemetry to the Council throughout the day. Short-term recorders are also used at different river sites, as well as one-off flow measurements for analysing low-flow areas and water allocation.

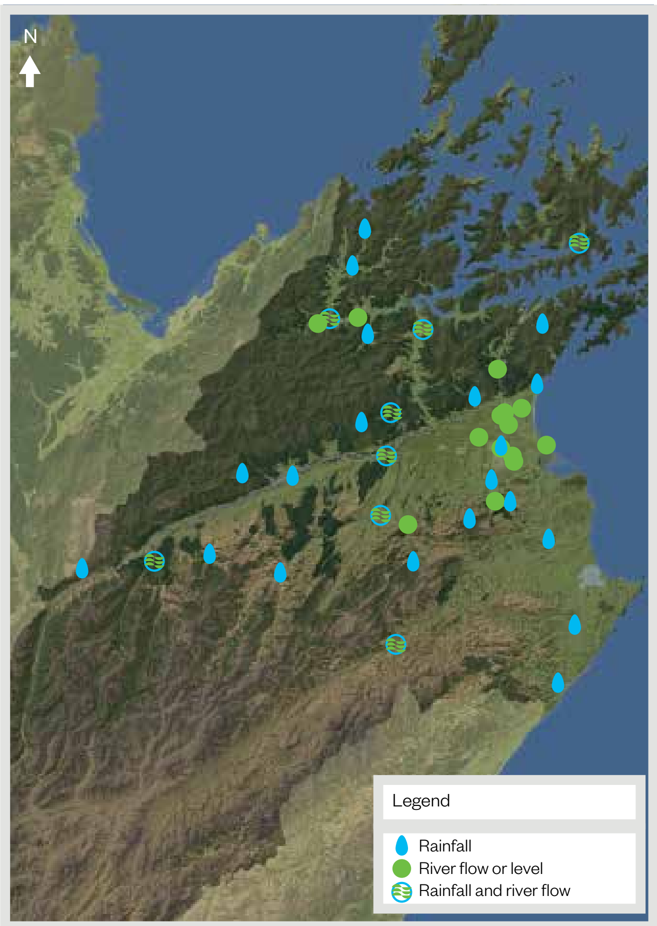


Figure 1: Rainfall and river flow and level monitoring locations

CHANGES SINCE THE 2008 SOE REPORT

- Continued increases in demand for surface water abstractions.
- Increased incidence of low flows in major river systems.
- Largest recorded flood in Te Hoiere / Pelorus River, December 2010.
- Major flood event in Southern Valleys rivers and streams, July 2008.

Measuring river flow

Monitoring has been carried out by the Council for more than 50 years at some sites and these long-term records are now used to investigate flow trends, climate change and the effects of water allocation regimes (Figure 2). Because of our variable climate it is good to have records going back at least 30 years when looking for trends. Even then, other factors such as changes in land use and water allocation can make it difficult to interpret the results.

PRESSURES ON OUR WATER RESOURCES

Several factors are putting pressure on our water resources. Some are within our control while others are not.

Table 1: River flows measured at sites throughout Marlborough.

SITE	RECORD LENGTH	MEAN TO 2005 m^3/s	MEAN TO 2006-2015 m^3/s	CHANGE
Wairau at Dip Flat (NIWA)[1]	1952-2015	26.9	26.5	-1.5%
Te Hoiere/Pelorus at Bryants (NIWA)	1978-2015	20.2	19.1	-5.5%
Rai at Rai Falls	1980-2015	11.6	11.0	-5.2%
Waihopai at Craiglochart	1961-2015	14.8	13.9	-6.0%
Taylor at Weir	1962-2015	0.67	0.64	-4.5%
Wairau at Tuamarina	1961-2015	101.0	91.5	-9.5%
Acheron at Clarence (NIWA)	1959-2015	23.4	20.9	-11.5%
Clarence at Jollies (NIWA)[2]	1960-2015	14.8	12.9	-12.8%

[1] National Institute of Water & Atmospheric Research
[2] The Clarence at Jollies site is not actually within the Marlborough District but it is immediately upstream of about 20 km of the Clarence River which is within the Marlborough District, and the 45 km where Marlborough shares a river boundary with Environment Canterbury

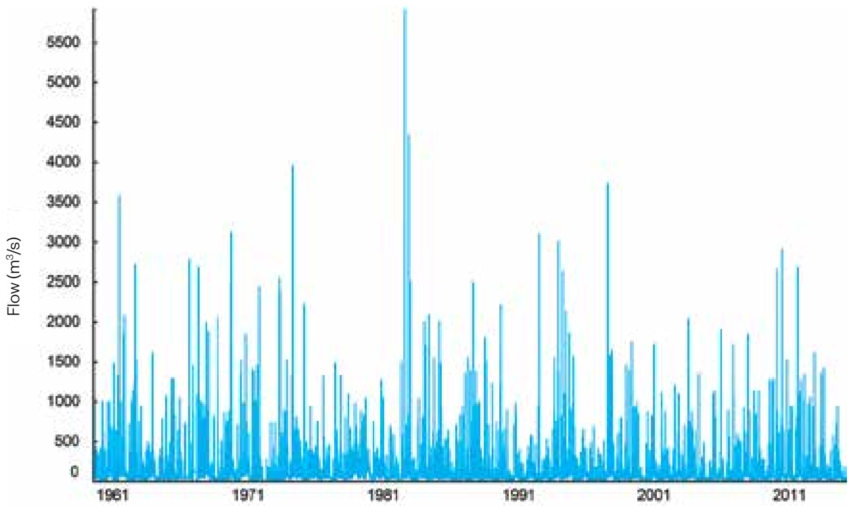


Figure 2: Wairau River at Tuamarina flow record

Data for eight long-term Marlborough flow sites shows that flows over the last decade have all decreased when compared to the long-term average (Table 1). Flows in all the monitored rivers have been below the long-term average over the past decade. The Upper Clarence and Acheron Rivers had the greatest change, about 12% below normal, while the Upper Wairau at Dip Flat was only 1.5% below normal. Flow at the other rivers decreased by about 5-6%, apart from the Wairau at Tuamarina (see case study).

Climate variability and climate change

These two factors are often confused. Climate variability is the year by year, season by season, or even month by month variation which gives us more rain or drought, more heat or cold. Variability of climate happens locally over a relatively short time and is more noticeable than climate change.

Climate change describes the long-term trend for the climate on a global scale, such as the current increase in temperature and the associated changes in rainfall and severe weather events. Climate change is assessed by averaging out climate data over longer periods rather than the shorter term climate variability.

Change in land use

Changes in land use have an impact on the water in a catchment or area. For instance, deep drainage ditches and subsurface drainage reduce stream and groundwater levels and change the seasonal pattern of flows, often affecting headwater springs and wetlands.

Changes in land cover have a bearing on runoff and base-flow patterns. For example, converting hill pasture to pine forestry has been shown to reduce the amount of water downstream by up to 50% as the tree roots take up the water. Some councils have introduced restrictions on land use to prevent a reduction in flows and to protect sensitive water resources.

Irrigation

Rivers, streams and lakes are an important part of our environment and contribute significantly to Marlborough's economy. This requires a balance between water being drawn off for irrigation and commercial use, while keeping enough in the rivers for recreation and to protect environmental values. This is done through the Resource Management Act and the policies and rules in the Council's Resource Management Plans.

Anyone wanting to use water has to do so according to these policies and rules and often that means applying for a resource consent. Most of our larger rivers have an allocation limit and a minimum environmental flow which dictates how much water can safely be taken while still maintaining environmental values.

Consents are issued with conditions, including how much water can be taken and at what rate. A water meter must be installed to measure the water taken and where possible this information is sent electronically to the Council, usually as daily readings.

Wairau River, February 2015

CASE STUDY - Rai River

The Rai River in northern Marlborough shows the effects of the combination of climate variability and irrigation abstraction on a water resource. The area has a relatively high rainfall, about 1800-2600 mm per year, and is well suited to dairying.

After the 2000-2001 drought there was a rapid move to irrigation, also spurred on by the dairy market wanting more consistent production throughout the milking season. Because of the reasonably reliable rainfall in the Rai area, irrigation is only used to cover the periods between rain. This is in contrast to the almost continuous irrigation in drier parts of Marlborough.

The Council's Resource Management Plan specifies a sustainable flow regime (SFR) for rivers under pressure from irrigation. The minimum flow at the Rai Falls recorder is 1.00 m^3/s, with a maximum water allocation of 0.344 m^3/s. Of this, about 0.234 m^3/s has been allocated to 15 consents for dairy farmers to irrigate their pasture.

During the 2000-2001 drought there was an extended time when the flows fell below this figure naturally. Since then, with the start of widespread irrigation, the 1.00 m^3/s threshold has been reached regularly for short periods in years which are not considered to be exceptionally dry.

The Rai Falls recorder is downstream from all of the water takes and the effect of the water being pumped out for irrigation means there is an increase in the number of days when flows are at or below the threshold of 1.00 m^3/s (Figure 3). Before 2000, the flow dipped below 1.00 m^3/s only once.

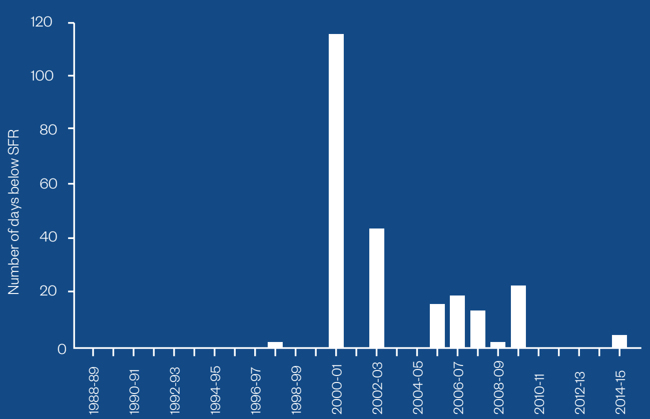


Figure 3: Restrictions on irrigation water from the Rai River

Rai Falls

There are good records of use from this area, particularly since 2012 when the 15 consent holders installed telemetered loggers to send their water take information directly to Council. With no cell phone coverage in the area this required overcoming a few technological hurdles, which were solved with a linked combination of short-hop radio systems and satellite phones or traditional phone lines.

Irrigation in this area usually starts in mid-November and finishes in mid-April (Figure 4). The actual pattern of irrigation varies, depending on when there is rain during the season. The total allocated water take is a maximum of 20,233 m^3/day, which is 4,290,000 m^3 over the seven-month irrigation season (October to April) (Table 2).

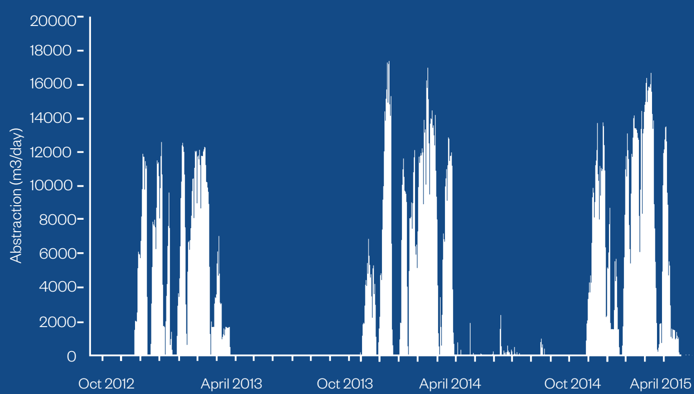


Figure 4: Water take from the Rai River

SEASON	TOTAL SEASONAL USE (m^3)	PERCENTAGE OF SEASONAL ALLOCATION	PEAK DAILY USE (m^3)	PERCENTAGE OF PEAK ALLOCATION
2012-13	912,300	21%	12,585	62%
2013-14	1,114,000	26%	17,340	86%
2014-15	1,133,000	26%	16,662	82%

Table 2: Peak daily and seasonal use over the past three years.

CASE STUDY - Wairau River

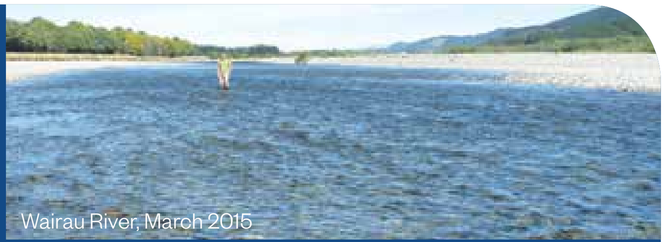
The Wairau is a significant braided river that defines much of Marlborough. With a catchment covering 25% of the region, the Wairau River is our most important water resource for farming, grapegrowing, recreation and environmental values.

The Wairau rises in the Spenser Mountains south of St Arnaud and flows 257 km into Te-o-Kupe / Cloudy Bay. The river is monitored at sites along its length and readings at Tuamarina since 1960 show the flow has decreased by 9.5% (Figure 5).

This is a notable trend and much more significant than the modest changes at most other river sites in Marlborough where trends are less conclusive.

This decrease in flow has been about 20 m^3/s over 55 years, or 0.35 m^3/s per year. A number of factors, either individually or collectively could possibly be influencing this change:

Climate: A general decrease in rainfall over time is one possible contributing cause of flow decline. Because of the number of factors that can influence rainfall on both the short and long-term basis, it is difficult to analyse rainfall trends by looking at individual sites, as some individual sites show decreases, and some show increases. Some initial work has been done on aggregating rainfall across the Wairau catchment using the NIWA climate network model, and there is a suggestion that on a catchment-wide basis, that the average rainfall for the Wairau catchment has decreased over the period of the study. However, there are a number of factors which could cause bias in this analysis and further work is required before any conclusions can be made.


Wairau River, March 2015

Irrigation: An increase in water pumped out of the river for irrigation will have reduced the recorded flows to some degree – about 7m^3/s of actual irrigation has been allocated since 2000. However irrigation does not occur year-round, and the effect of irrigation on annual mean flows is estimated to be less than 2.5 m^3/s, which is only a small portion of the recorded change.

Vegetation: As large areas of the catchment revert to scrub or are planted in forestry, there is a reduction in run-off of water into the river. The Council's hydrological records begin at the peak of subsidised pasture development in the high country, when there was minimal natural forest or scrub cover and maximum runoff. Since then, many areas that proved unsuitable for farming have been allowed to regenerate. This increased vegetation, together with land conversion to exotic forestry and wilding pine results in a lower water yield from the catchment.

Record accuracy: While all care is taken in measuring river flows, it is possible that earlier records may not have had the same degree of calibration, particularly at low flows, as more modern records. It is proposed that the low to medium flow records be reviewed for accuracy, to be sure that the observed trend is valid.
If the downward trend in flows in the Wairau River continues, it will have significant impacts on environmental values and irrigation water availability, and therefore needs to be investigated carefully for validity and cause.

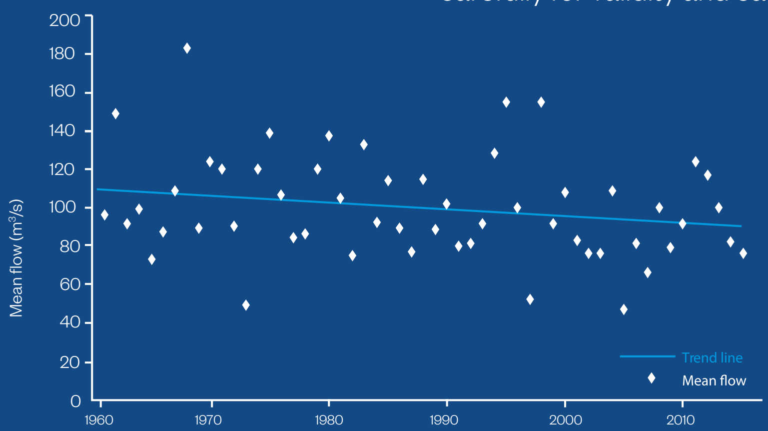


Figure 5: Decrease in the flow of the Wairau River since 1960, measured at SH1 Bridge, Tuamarina

SURFACE WATER QUALITY

We all depend on having fresh water that is safe to use and drink. The Council is responsible for monitoring the quality of surface water to protect our health and the health of instream ecosystems. Marlborough has a wide variety of surface waters including mountain tarns, braided rivers, steep bush streams, spring-fed streams and lowland wetlands.

PRESSURE

Water quality is affected by humans and nature. Natural influences include the steepness and geology of the catchment and the amount of snow and rain that falls. Human influences include contaminants discharged into waterways (for example fuel spills or sewage) or runoff from land such as effluent from farming or sediment from forestry harvesting.

In rural areas, arable farming and stock put the most pressure on water quality. Stock in waterways create several issues – cattle instinctively defecate into water causing bacterial and nutrient levels to increase, as well as releasing sediment by disturbing banks and stream beds. Waterways without riparian plantings are more vulnerable to contaminants, sediment and faecal matter washing off the land during rainfall.

Streams and rivers come under significant pressure when land is cleared for forestry and other activities that cause sediment to run off the land, especially in the steep valleys of Northern Marlborough and the Marlborough Sounds.

In urban areas the main issue for surface water quality is contaminants getting into the stormwater system which then discharges into waterways. These include chemicals and fuels discharged into the system or washed off the roads, private driveways and down the drains.

CHANGES SINCE THE 2008 SOE REPORT

- Reduced nitrogen concentrations in a number of rivers, including the Ōpaoa, Omaka and Taylor Rivers.
- Increased *E. coli* concentrations in the Flaxbourne and Taylor Rivers.

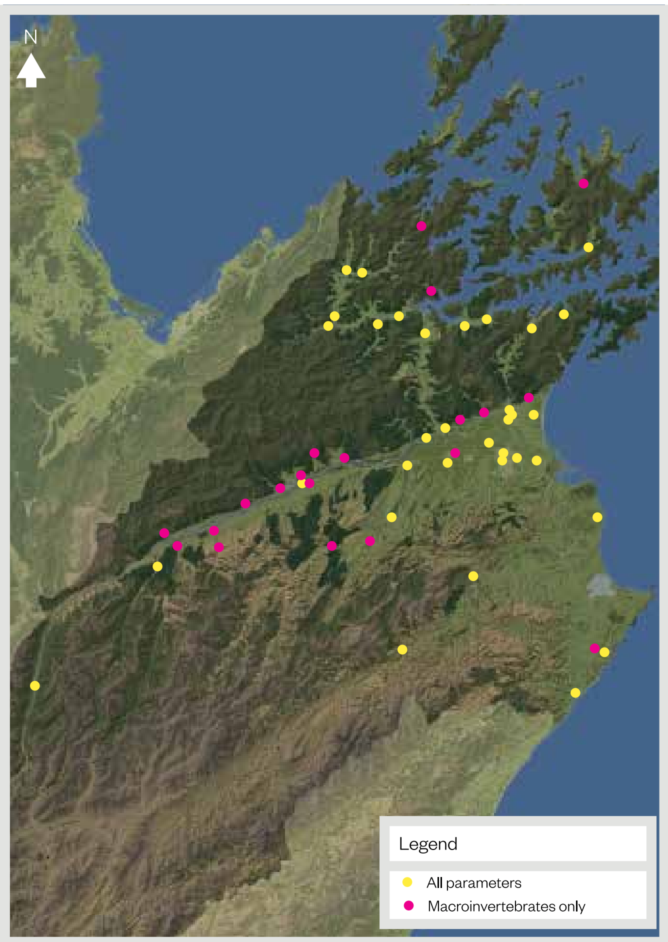


Figure 1: Surface Water Quality monitoring locations

RESPONSE

The Council monitors the water quality at 34 streams and rivers across Marlborough each month (Figure 1). The testing includes nitrogen and phosphorus levels, ammonia and pH. The data gathered over a three-year period are summarised and ranked using the Water Quality Index (WQI), with the poorest sites receiving further investigation (Figure 2). The WQI also helps staff to see what trends are emerging and whether future action may be needed.

Macroinvertebrates – tiny animals that live in streams and are an indicator of water health – are monitored at 51 sites each year. The number of individuals and species in each place can provide valuable information about water quality over time.

The Council's annual Dairyshed Effluent Survey checks that farmers have effluent systems and stream crossings in place to protect the waterways. The Council has also worked closely with industry groups and is developing new policy to protect water quality as part of its review of the Resource Management Plans.

Several Council environmental education programmes aim to increase awareness about water quality. For example, the Blue Fish on Drains and Wai Korero programmes show primary school students the connection between our stormwater systems and the local rivers. The Council also works with community groups and is actively involved with sharing information as part of the Conservation Marquee at the Marlborough A&P Show.

STATE

The WQI shows that three of Marlborough's 34 monitored streams and rivers have good water quality (Figure 2). The Black Birch Stream is ranked the highest, with turbidity and dissolved reactive phosphorus being the only factors that were above the guideline levels. The other waterways with good water quality are the Wakamarina River and the Upper Te Hoiere / Pelorus River, although there are occasional raised *E. coli* levels and higher summer pH in the Upper Te Hoiere / Pelorus.

Most of the monitored sites are assessed as Marginal or Fair, often because of the amount of soluble inorganic nitrogen associated with pastoral farming on nearby land. Concentrations are particularly high in spring-fed streams such as Murphy's Creek and Mill Creek because of nitrogen leaching into the groundwater.

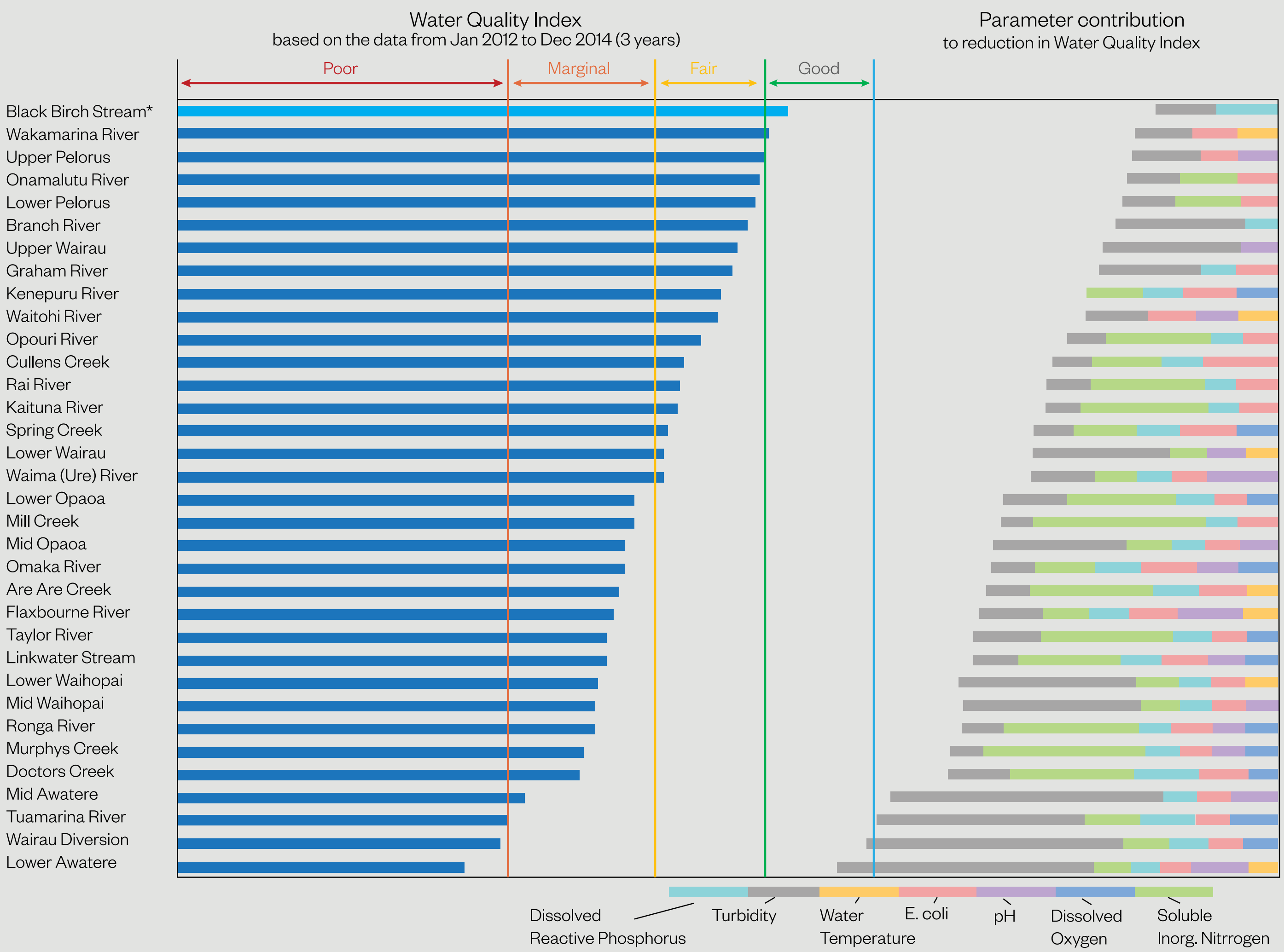


Figure 2: Water Quality Index 2012-2014

The Upper Wairau River was top of the WQI in 2012 but since then has dropped to a Fair ranking because of increased turbidity. There was also a significant increase in turbidity in the Tuamarina River and another site along the Wairau River, that was linked to higher river flows. In 2013 the Tuamarina River had the two highest floods since continuous flow monitoring started in 2004.

The Waihopai River also recorded increased turbidity, but rather than being caused by increased flows it appears to be due to very fine sediments in the geology in parts of the catchment. Slips caused by heavy rainfall carry this fine material into the river and increase the turbidity. This puts the Waihopai River in the marginal band of the WQI, along with the Awatere River which has high turbidity levels as a result of the mudstone geology within the catchment.

Lower Te Hoiere / Pelorus, Wakamarina and Mill Creek showed the greatest improvement in ranking from between 2010 and 2013 due to a reduction in *E. coli*. The Taylor River, Doctors Creek, Are Are Creek, Black Birch Stream and the Lower Ōpaoa also showed slight improvements.

Catchment investigations for the Taylor River and Are Are Creek have identified stock access and poor riparian management as the main contributors to degraded water quality. The Council is working with landowners in these catchments to reduce the level of contaminants.

FUTURE RESPONSE

The monitoring programmes will continue to gather water quality information to gauge the state of Marlborough's waterways and any developing trends. Investigations have started in the Tuamarina and Linkwater catchments to investigate causes of the poorer water quality.

The Wai Korero and Blue Fish on Drains programmes are continuing to be offered to all schools in Marlborough.

Surface Water Quality Monitoring information is available to the public through the Land Air Water Aotearoa website: www.lawa.org.nz

Water quality sampling - Te Hoiere / Pelorus River

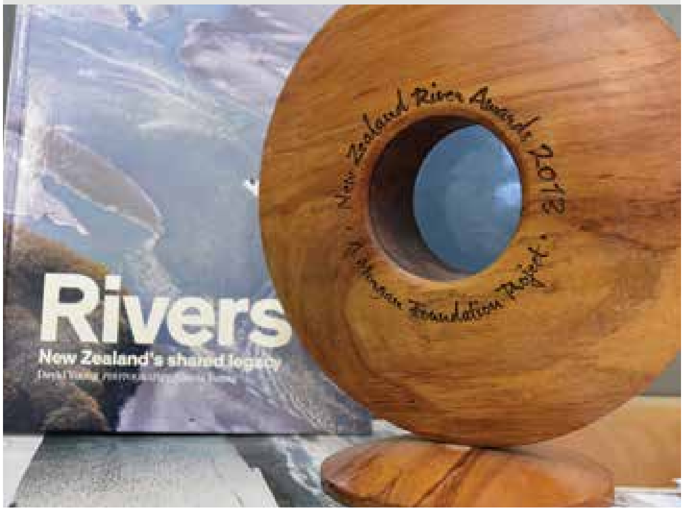
National Policy Statement for Fresh Water

The National Policy Statement for Freshwater Management 2014 (NPS-FM) defines numerical ranges for four states or bands ('A', 'B, 'C' and 'D') for a number of water quality attributes based on ecosystem health and recreational values.

State 'A' represents best water quality, while state 'D' characterises unacceptable water quality. The NPS-FM requires that attribute limits are set for all waterways within a region that are monitored at representative sites. Attributes relevant in regard to rivers and streams in Marlborough are nitrate-nitrogen, ammonia-nitrogen, periphyton and *E. coli*. Of these attributes, all but periphyton are currently monitored as part of the State of the Environment programme.

Between 2011 and 2104 all 34 monitored sites had ammonical nitrogen concentrations within the attribute state of 'A' for both the annual median and maximum concentrations. Four sites had nitrate-nitrogen concentrations above the limits of the 'A' band in some or all of the years. These sites were located at Doctors Creek, Mill Creek, Murphys Creek and the Taylor River. Nitrate-nitrogen concentrations in Doctors Creek and the Taylor River were within the 'B' band in 2011, but have remained within the 'A' band in the recent years.

All sites other than Are Are Creek, Cullens Creek, Doctors Creek and the Kaituna River are within the limits of the *E. coli* 'A' band. Those sites not consistently in the 'A' band were in the 'B' band at some stage through not every year.



Rivers award for improvement in *E. coli* levels in the Rai River

Monitoring Are Are Creek

WANT TO FIND OUT MORE?

- State of the Environment Surface Water Quality Monitoring Report, 2013, MDC Technical Report No:13-011
- State of the Environment Surface Water Quality Monitoring Report, 2014, MDC Technical Report No:14-006
- Taylor River/Doctors Creek Catchment Investigation 2015, MDC Technical Report No:15-001
- Are Are Creek Catchment Investigation 2015, MDC Technical Report No:15-004
- Wai Korero – A Waterways Education Resource of Marlborough Primary Schools, Marlborough District Council
- Land Air Water Aotearoa website: www.lawa.org.nz

GROUNDWATER QUANTITY

Marlborough, especially the Wairau Plain, depends on underground water for everyday life and economic prosperity. This underground water (known as groundwater) is a more reliable than rivers and streams which can dry up in summer.

CHANGES SINCE THE 2008 SOE REPORT

Since 2012 Marlborough has experienced a succession of dry summer seasons with the lowest annual rates of rainfall ever measured. Less rainfall, runoff and river flow, compounded by higher demand, has resulted in record low aquifer or well levels across the province with the exception of the Southern Valleys Aquifers and Rarangi Shallow Aquifer.

The layers of rock, gravel and sand that contain groundwater in useful quantities are called aquifers, which act like natural storage tanks, recharged by rain or seepage from rivers (Figure 1). Aquifer water is pumped for town supplies, crop irrigation and industrial use. Aquifers also supply natural water systems such as springs and wetlands.

The Council manages how much groundwater is pumped up and used from season to season. This requires an understanding of how each aquifer behaves over time, measuring how much water is stored, how it is topped up (recharged) and what are safe amounts of water to draw off.

Monitoring groundwater levels

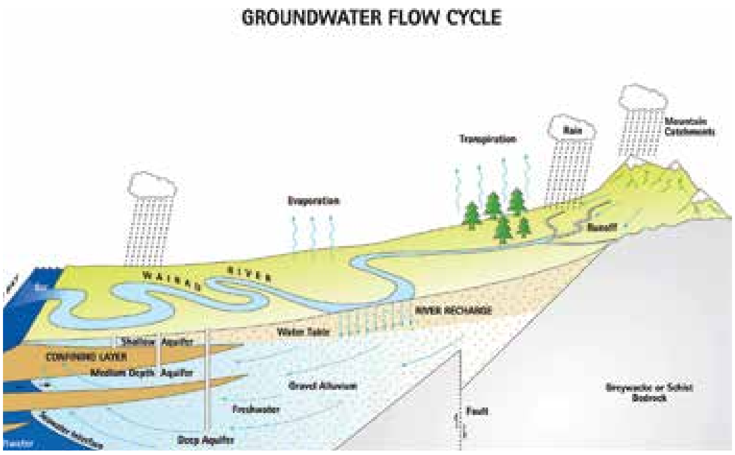


Figure 1: The connection between rain, river and aquifers on the Wairau Plain

The aim of groundwater monitoring is to make sure the amount drawn off the Wairau and Southern Valleys Aquifer systems does not significantly affect our spring-fed rivers and the life-supporting capacity of their water and ecosystems. We need to know how much water we have and how much is needed to confidently manage aquifers.

PRESSURE

The amount of groundwater stored in an aquifer depends on natural processes and human activities. Pumping up groundwater to irrigate crops is the largest human effect on well levels in the drier months when natural recharge rates are at their lowest. Pressure also comes from the large amount of groundwater taken all year round for town water supply.

Monitoring shows that the amount of water stored in the Wairau Aquifer has dropped by about a metre over the past 30 years. Several factors may be causing this:

- Improved flood control and drainage has reduced the land area for Wairau River water to spread and seep into the aquifer
- Gravel extraction is compacting the river channel and edges
- The increase in water taken from the river or pumped from the aquifer for irrigation
- Wairau River flows have changed.

A long-term decline in the aquifer may cause springs to dry up and well levels to drop further.

There is the potential for land-uses to change to activities that are more intensive and require more water. Irrigation rates for grape vines on the Wairau Plain average 1 mm per day compared with 5 mm per day for pasture. Grapes are the main crop on the Wairau Plain and most are only irrigated in summer.

RESPONSE

The Council has a network of 30 monitoring wells that cover Marlborough's economically and ecologically important aquifers (Figure 2). These monitor how much water is in the aquifer, the water temperature and whether salt water is coming in. This real-time information, recorded every 15 minutes, is used to ensure that too much water is not pumped out of the aquifers. Water use is regulated by Council resource consents that allocate a certain amount to each user.

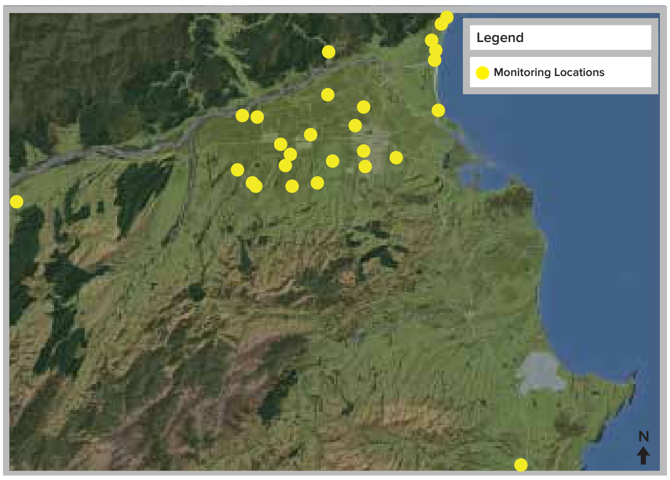


Figure 2: Groundwater monitoring locations

Since 2010 water meters have been required for consented water takes that take 5 litres per second or more. Meter readings are sent to the Council to check that users (such as farmers and vineyards) are not taking more than they are allowed and that water is being allocated efficiently.

This information is graphed and put on the Council website so consent holders can see how much water they have used. It can also help landowners detect problems with their well, pump or irrigation system.

Long-term record-keeping is a valuable resource for plotting the rise and fall of our aquifers and identifying possible causes. Records from the Council's monitoring wells indicate the change in groundwater stored in each aquifer and the effects of recharge, drainage and abstraction (Figure 3).

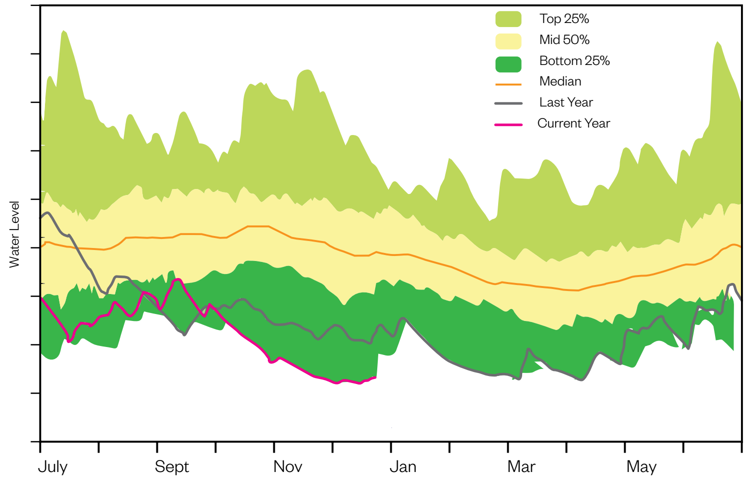


Figure 3: Conders Bend water level variation (1982-2015)

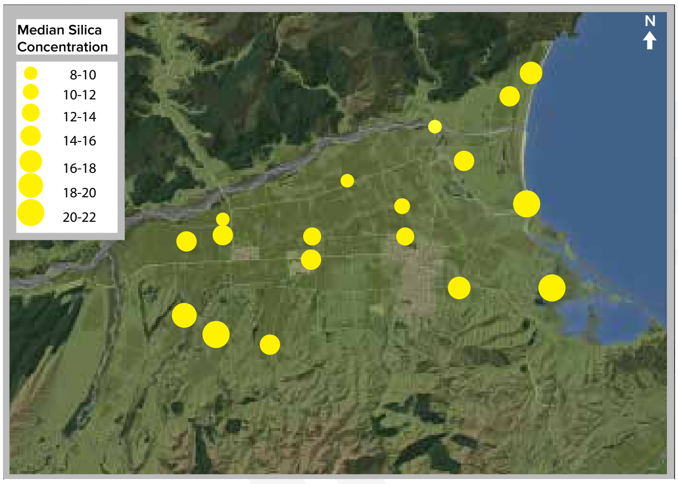


Figure 4: Dissolved Silica Concentrations on the Wairau Plain

The Council also measures the flow of springs that are fed from the aquifers, including Spring Creek, Murphys Creek, Doctors Creek and Fultons Creek. These spring-fed creeks reflect variations in aquifer levels and are an indicator of the state of the aquifers.

As well as directly observing seasonal changes in well levels, Council uses other tools including isotope tracers, groundwater chemistry, groundwater temperature and abstraction rates to isolate which parts of the hydrological cycle are caused by natural processes rather than human activities.

Council are working with scientists in New Zealand and Germany to find out why the water level in the Wairau Aquifer is dropping, with investigations focused on how the Wairau River seeps into and recharges the aquifer. Data from wells on the Wairau Plain between the Waihopai River and Tuamarina go into a computer model to estimate aquifer recharge rates and help manage our water resources.

One of the ways to measure how long groundwater has been in place is to look at the dissolved silica concentration. The longer groundwater is below the surface, the more silica it dissolves from the rocks (Figure 4). The age of groundwater that seeps into aquifers can be determined by dissolved silica concentrations in the monitoring wells.

Records of annual groundwater abstraction rates for the Southern Valleys deep aquifers have been kept since the mid 1980s and show that much of the changes in the level of groundwater are due to pumping rather than variations in natural recharge.

Marlborough aquifers are increasingly being managed according to their individual storage, drainage or recharge characteristics. The naturally sluggish recharge rate of the Southern Valleys deep aquifers makes them ideally suited to a bulk seasonal allocation. In comparison, the more dynamic Wairau Aquifer is treated as an extension of the Wairau River. Small groundwater systems such as the Rarangi Shallow Aquifer, with saltwater forming one boundary, are handled more carefully.

These different management approaches rely on monitoring and knowledge accumulated over many seasons. As demand on groundwater resources grows, having the information to set limits on water abstraction provides certainty for everyone into the future.

STATE

Demand for water is reasonably stable on the Wairau Plain, as much of the flat land areas that can be used intensively have already been developed.

Monitoring records over many years are needed to identify patterns in groundwater to separate seasonal effects from long-term trends. This information is starting to become available at a few sites such as the Conders Well near the SH6 bridge near Renwick.

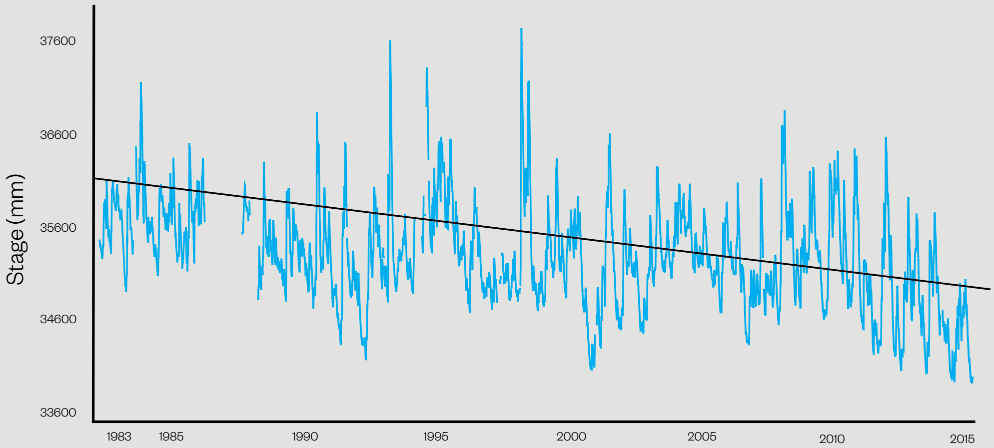


Figure 6: Level of Wairau Aquifer at the Conders Well 1982-2015

Deep Southern Valleys Aquifers

The Southern Valleys south of Renwick had a history of water shortages dating back to the 1970s. Water levels dropped significantly following the 1997/98 and 2000/01 summer droughts, when the amount taken exceeded the natural rate of recharge and groundwater storage was massively overdrawn for several seasons.

This stress on the deep aquifers resulted in the Southern Valleys Irrigation Scheme (SVIS) being established in 2004. The SVIS draws water from the Wairau River immediately below the confluence with the Waihopai River to provide irrigation for about 4,500 ha. By 2011 well levels had recovered in most of the Southern Valley aquifers and were higher than before the droughts.

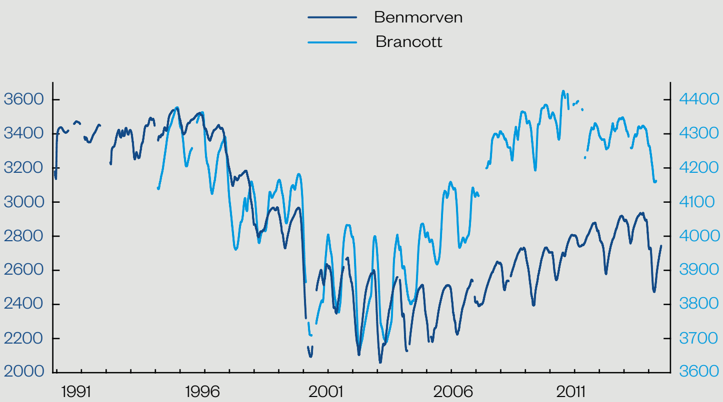


Figure 5: Brancott Aquifer versus Benmorven Aquifer groundwater elevation 1990-2015 (mm)

Of the three deeper aquifers in the Southern Valleys, only the Benmorven Aquifer has not recovered to the level before the 2000/01 drought. This aquifer is more confined and has a sluggish rate of natural recharge (Figure 5).

The level of the Deep Southern Valleys Aquifers remained relatively high throughout the dry 2014/15 summer despite the strong demand on irrigation, as most of the water came from the SVIS rather than local deep wells.

Any large draw-off of old groundwater has geochemical effects. In the case of the Brancott Aquifer, the refilling appears to have introduced younger water into the system, as indicated by a decrease in groundwater silica concentrations in the well water.

Other aquifers on the Wairau Plain behave much more dynamically because they are hydraulically linked to rivers or have higher rainfall recharge. This results in regular top-ups and well levels generally recover in the following winter or spring.

Wairau Aquifer

Water levels in the recharge sector of the Wairau Aquifer have dropped by nearly one metre since the early 1980s (Figure 6). The declining trend is not caused by irrigation (the aquifer keeps falling over winter when there is little irrigation draw-off). The main contributing factor causing the decline is less recharge in general.

The Wairau Aquifer is the largest and most important groundwater system in Marlborough in terms of the amount of water it supplies, the ecological habitat and the number of people who depend on it. The decline in level is mimicked at the other three Council monitoring sites as well as in the flow of Spring Creek, which is fed by the aquifer.

Based on readings since 1996 there is a strong correlation between Wairau Aquifer well levels and Spring Creek flow at the motorcamp site. This shows groundwater level largely controls spring flow (Figure 7).

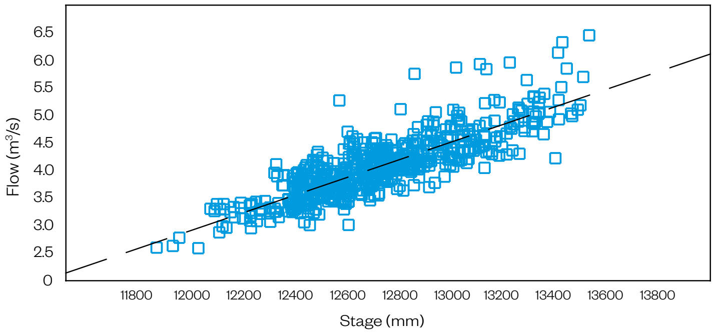


Figure 7: Spring Creek flow at motorcamp

Rarangi Shallow Aquifer

The Rarangi Shallow Aquifer sits over the top of the Wairau Aquifer at the northern end of Te-o-Kupe / Cloudy Bay. It supplies domestic water through a community water scheme or individual house bores. The level of the Rarangi Shallow Aquifer has increased slightly since records started in 1989.

Omaka River Aquifer

The Omaka River Aquifer is on the south-west edge of the Wairau Plain. It is a riparian system and relies on surface water for recharge. Average Omaka River Aquifer levels have fallen by about 1.5 m since 1981, although it is hard to detect as the annual aquifer range is similar. The difference is that groundwater levels stayed lower for longer in 2015 than in 1980. Levels in the monitoring well at Spy Valley Wines have shown a slight fall over the past 18 years.

Riverlands Aquifer

The Riverlands Aquifer is recharged by a combination of Wairau River, Southern Valleys and local water. Due to its naturally low storage it is sensitive to abstraction and there are increasingly large seasonal changes in the aquifer level. Demand for this water has not yet peaked.

Water is pumped from the Riverlands Aquifer beyond the traditional irrigation season because of wine production and meat processing in the area, as well as for watering crops. The Council has two monitoring wells for the Riverlands Aquifer and both show a downwards trend in the water level.

Monitoring coastal well for seawater intrusion

Saltwater intrusion

The electrical conductance (EC) of groundwater indicates how much dissolved salt it contains. Salts can originate from land-use, the sea or the natural weathering of minerals. Most shallow Marlborough groundwater is very young and is chemically dilute, with low levels of dissolved salts. Deeper Marlborough groundwaters are older and contain higher levels of salts due to longer contact with the rocks that form the aquifer.

If too much water is pumped out of the aquifer, particularly near the coastline, saltwater can be sucked into the aquifer. The Council has been monitoring the EC of coastal groundwaters since 2000 to keep a look-out for seawater intrusion. There has been no sign so far - in fact EC levels have fallen since 2000 as pumping induces younger groundwater from free-flowing central areas of the Wairau Aquifer into the margins at Rarangi and Riverlands.

Monitoring wells on the Rarangi Shallow Aquifer show that most increases in EC come from leaching of wind-blown sea-spray by spring rains rather than wells pumping over summer.

Seasonal samples of EC across all Marlborough monitoring wells show higher concentrations of salt are associated with the soluble marine geology at Ward, in ancient groundwater down 200 m at Fairhall and recent wind-blown salts into the Rarangi Shallow Aquifer. On the other hand, the most dilute groundwater is linked to the productive aquifers recharged by the Wairau River. Wairau River water is relatively dilute compared with most aquifer water and is similar to the Wairau Aquifer, which it recharges.

Temperature

Groundwater temperatures have also been measured at many wells to provide more information about individual aquifers. The Deep Wairau Aquifer has the highest groundwater temperatures as it is 200 m below the surface and is partially affected by the heating of the Earth's crust.

Groundwater from very shallow aquifers such as Rarangi is relatively warm because it is recharged by lowland rainfall and is close to the surface.

Lagoon Well

FUTURE RESPONSE

The Council will continue to monitor water levels in Marlborough's aquifers as well as how much is pumped up and used. This growing record of information will help efforts to manage groundwater and give a greater degree of certainty for all water users and natural ecosystems.

Most water processes on the Wairau Plain are well understood, but the Council is still gathering information on aquifer levels and recharge rates to specify limits or quota. The weakest link is the rate of abstraction from wells, but monitoring for a further five years should allow the Council to characterise actual water use patterns for combinations of particular soil type, crop, climate and aquifer.

WANT TO FIND OUT MORE?

- The Council website has more information on groundwater in Marlborough and real-time readings from water meters.
- www.marlborough.govt.nz/Environment/Groundwater
- www.marlborough.govt.nz/MDC/Home/Environment/Water%20Metering

GROUNDWATER QUALITY

The quality of Marlborough's underground water is just as important as having enough of it in the right place at the right time. This underground water (known as groundwater) is the preferred source for drinking water and is a more reliable supply than rivers and streams that can dry up in summer.

Groundwater seeps through layers of gravel and sand called aquifers which filter out microbes and impurities and act like natural storage tanks. However, if groundwater gets too old it can become mineralised, making it unsuitable for drinking.

Groundwater recharges with water seeping down through the ground from the overlying land, rivers and streams. It takes several years for groundwater to travel the length of a catchment such as the Rai-Te Hoiere / Pelorus system and as a result the groundwater is a blend of ages and origins within a catchment. The quality and chemistry of the water depends on surrounding land use and hydrological processes such as flooding, so measurements need to be made over several years to get an accurate picture.

The Council monitors groundwater quality to make sure it is safe for humans to drink and use and is able to sustain our natural ecosystems.

PRESSURE

Groundwater quality is a direct reflection of the natural geology and the level of contaminants from human activities within a catchment.

Some of our groundwater also contains natural contaminants such as chloride, iron, manganese and arsenic – usually in environments where oxygen is limited such as wetlands, confined aquifers and fault zones. These minerals are dissolved in groundwater as it flows over the sediments that form the aquifer. We can't do anything about the natural processes altering water quality, but we can identify risks and treat the water to make it suitable for humans to drink.

The most common contamination from human activities in Marlborough's aquifers are elevated microbial and nitrogen levels from farming. Agrichemicals and other contaminants used on the land above an aquifer may also reduce the quality of the groundwater if the chemicals are not applied or disposed of correctly.

CHANGES SINCE THE 2008 SOE REPORT

- The relatively wet winter and spring seasons experienced between 2008 and 2010 caused high rates of leaching of land-surface contaminants and especially nutrients into Marlborough's groundwater systems. The current drier conditions have reversed this pattern and presumably there is a build-up of contaminants in the soil zone or gravels above the water table.
- The MDC monitoring network has identified increasing concentrations of nitrate-nitrogen, silica and chloride in some aquifer , but whether these represent trends remains to be seen.

Installing groundwater recorders

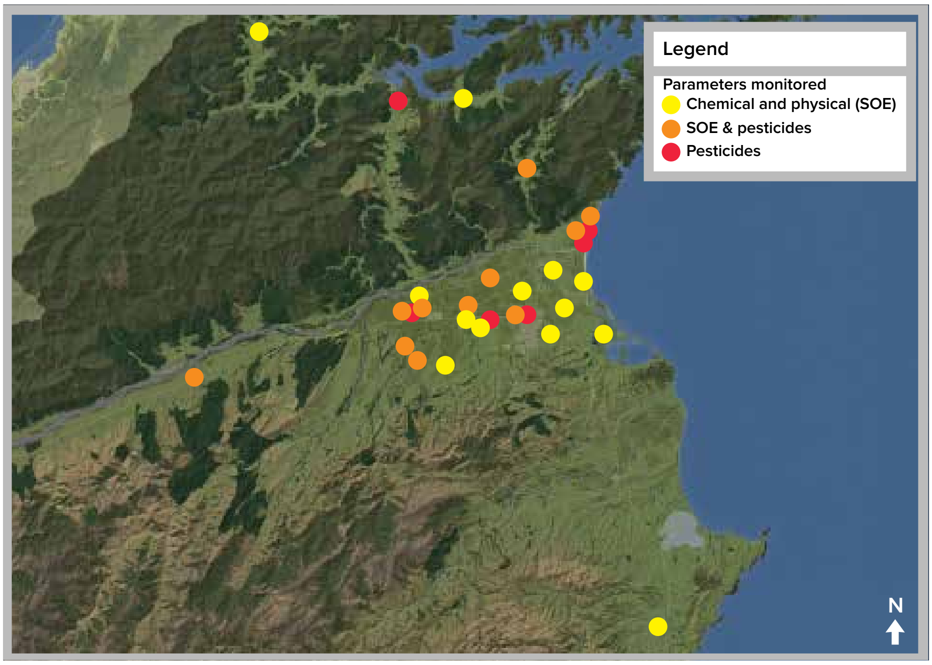


Figure 1: The network of wells that monitor groundwater quality in Marlborough

RESPONSE

The Council has a network of 22 monitoring wells to measure groundwater quality including pesticides, microbes, nutrients, minerals, chemical contamination and physical changes. The network focuses on the economically and ecologically important aquifers in the district.

Eight of the wells are part of the National Groundwater Quality Monitoring Network programme run by GNS Science to create an inventory of aquifer quality, including the impact of land use.

Free flowing well, late 1980s

This long-term survey monitors groundwater to isolate natural changes from human impacts and keeps track of any cycles or trends. The programme aims for a long-term understanding of the relationship between land-use and groundwater quality.

Every four years the Council takes part in the national Pesticide Survey, sampling wells for pesticides in spring. The testing focuses on aquifers vulnerable to land-use contamination and public water supply. Council also measures microbe levels at susceptible aquifers after spring rain, as this is when they are most likely to be found in groundwater.

As well as laboratory analysis of water samples to see what chemicals are in the aquifers, the Council has sentinel wells along the Te Koko-o-Kupe / Cloudy Bay coast for real-time warnings of any seawater intrusion into inland groundwater. There has been no sign of seawater intrusion since the sentinel wells were established in late 2000.

STATE

A well in Blenheim near the hospital contains the oldest known water in New Zealand. Isolated from rivers or rainfall for over 39,000 years, it is highly mineralised with arsenic and other chemicals and is unsuitable for drinking.

Marlborough groundwater is generally of a high standard, especially in the more transmissive aquifers under the northern Wairau Plain which tend to dilute any contaminants leaching from surrounding land. Groundwater moves at about 40 metres per day beneath Rapaura and turns over within a year, which means land contaminants are also flushed out.

This process is helped by the generally high quality of recharge water from the Wairau River and the low nutrient use on vineyards, which is the main land use

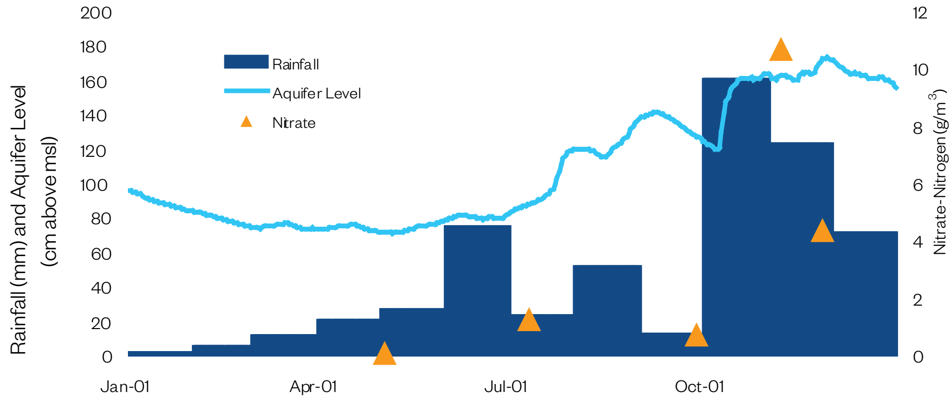


Figure 3: Nitrate response to rainfall – Rarangi Shallow Aquifer

in this area. However, Council monitoring shows some nutrient leaching from vineyards, even in deeper soils where the water table is low.

Monitoring shows that the levels of nitrate-nitrogen in the Wairau Aquifer are higher than in the river (Figure 2). This is a result of landuse activities on the Wairau Plain leaching nitrogen through the soil profile. Vineyards with drip-irrigation produce low rates of leachate compared with other land uses, including as spray-irrigated dairy pasture and arable crops.

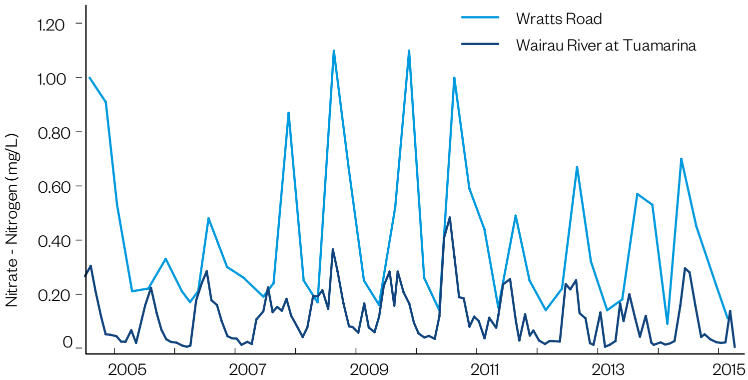


Figure 2: Nitrate-nitrogen levels in the Wairau River

On the southern edge of the Wairau Aquifer where it meets the Southern Valleys Aquifer, the underground gravels are not as good at transmitting and diluting the water. This results in a higher concentration of nitrate-nitrogen in southern groundwater and aquifer-fed springs such as Murphys Creek, even though the land use is mainly vineyards as on the northern plain.

WANT TO FIND OUT MORE?

The Council website has monitoring reports and investigations for Marlborough's groundwater.

- www.marlborough.govt.nz/Environment/Groundwater/Reports-and-Special-Investigations.aspx

Nitrate leaching off the land and into the aquifer is seasonal and mainly occurs during spring rain when the soil becomes saturated and water leaches through the soil, moving the nitrates with it to the underlying groundwater (Figure 3).

There is a wide range in nitrate-nitrogen concentrations across Marlborough's unconfined aquifers, depending on land use and aquifer processes. Nitrate-nitrogen levels increased in most aquifers from 2008 to 2010. This coincided with higher rainfall and runoff and therefore more nutrient leaching into groundwater. Since then concentrations of nitrate-nitrogen have been falling since then due to the exceptionally low rainfall and less leaching into groundwater. However, nutrients are still being applied at the same rate and organic matter is breaking down,

Well sample

so it is simply a matter of time before these nitrates turn up in the groundwater. It is important to keep long-term records to untangle seasonal cycles from longer term patterns. Nitrate-nitrogen is less of an issue in confined aquifers because they lack oxygen and contain microbes that consume nitrate.

Poor quality groundwater is found in aquifers with low water movement, where the interaction between water and rocks or a lack of oxygen causes higher levels of mineralisation. This is the situation for the Deep Southern Valley Aquifers, Confined Wairau Aquifer, Riverlands Aquifer, parts of the Flaxbourne groundwater resource, Wairau Valley Fault area and older wetlands linked with the Rarangi Shallow Aquifer.

Council surveys over the past 30 years have found very few microbes or pesticides in the groundwater, but sampling will continue as some chemicals persist for decades and land-use or settlement patterns can change and introduce new risks to aquifer quality.

FUTURE RESPONSE

Our current knowledge of groundwater quality comes from monitoring over the past 15 to 38 years, but much more remains to be learnt. Future research aims to match water quality with land-use, based on measured rates of leachate and aquifer flow. This is required by the Government and is a sensible way to define the carrying capacity of a catchment.

Council is also studying the relationships between rainfall, aquifer flow and the concentration of chemicals. These factors, as well as the impact of different land uses, all contribute to the ongoing water quality in our aquifers.

Pesticide sampling

RECREATIONAL WATER QUALITY - RIVERS

Kayaking on the Ōpaoa River, swimming at Te Hoiere / Pelorus or rowing a boat on the Wairau add to the enjoyment of living in Marlborough, but these recreational activities all rely on clean water.

The Council monitors nine popular swimming places every week from November to March to check how they rate according to standards set by the Ministry for the Environment. The results for swimming water quality are updated regularly on the Council's website.

Swimming in or making contact with polluted water can cause skin and eye irritation and/or diarrhoea. The weekly monitoring of swimming sites measures the concentration of *E. coli* to assess the risk to human health. *E. coli* are gut bacteria of warm-blooded animals and a good indicator of faecal contamination and other micro-organisms harmful to health.

PRESSURE

Discharges from stormwater, poor agricultural practises, clogged septic tanks and other sources can result in *E. coli* and other pathogens getting into waterways and causing people to get ill.

Usually rivers only become contaminated with faecal matter during heavy rain or for several days after when animal droppings from surrounding land are washed into waterways. The Council advises people not to go swimming for 24-72 hours after rain. During dry weather other sources can also cause faecal contamination, such as wildfowl droppings, dog poo and livestock entering waterways.

Discharges from stormwater systems have significant potential for elevated *E. coli* levels, as any contamination that lands on the roads or roots of houses that are connected to the stormwater system will be washed into the system when it rains.

CHANGES SINCE THE 2008 SOE REPORT

- Improved recreational water quality at Rai Falls and Te Hoiere / Pelorus River at Totara Flat.
- Slight improvement in recreational water quality of the Wairau River at Ferry Bridge and the Blenheim Rowing Club.

Te Hoiere / Pelorus River - a popular swimming spot

RESPONSE

Nine popular river swimming sites are monitored each week to see if they meet the Microbial Water Quality Guidelines for contact recreation (Figure 1). When *E. coli* concentrations are above these national guidelines, the Council puts up warning signs and advises people to avoid contact with the water.

As well as weekly monitoring, investigations are carried out to determine the sources of faecal contamination. Samples from sites with frequently high *E. coli* concentrations are analysed for genetic markers that indicate what has caused the contamination, such as cows, wildfowl or humans.

Sampling of the wider catchment also helps identify problem areas that affect the water quality of swimming spots further downstream. The next step is to eliminate or minimise these sources. For example, in the Rai River catchment the Council and NZ Landcare Trust have been working with dairy farmers to keep stock out of the waterways and plant native trees along the banks. As a result, *E. coli* concentrations in the Rai

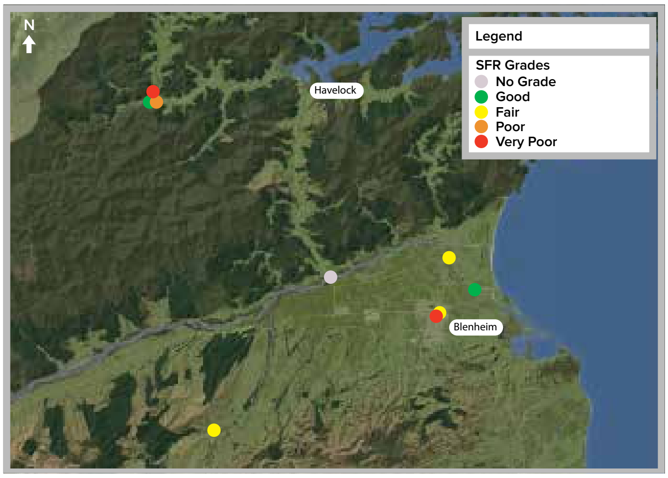


Figure 1: Monitoring locations

River at Rai Falls have decreased significantly (Figure 2). This has also led to lower concentrations in the Te Hoiere / Pelorus River at Totara Flat downstream from the Rai River confluence. This effort and improvement was recognised with a New Zealand River Award in 2013.

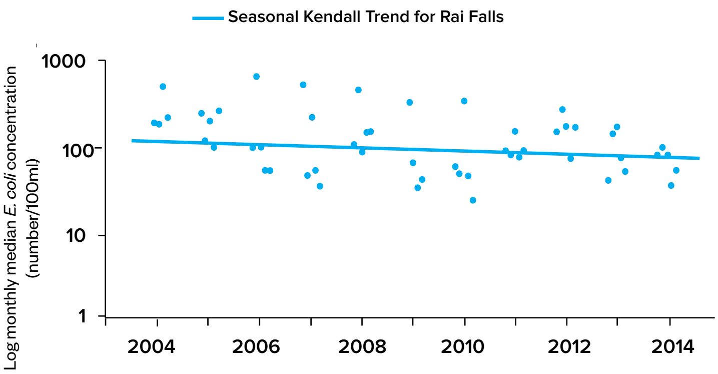


Figure 2: Trend of *E. coli* concentrations in the Rai River at Rai Falls

STATE

The Council uses a national system for assessing recreational water quality at each sampling site. The Suitability for Contact Recreation Grades (SFR Grades) are based on data collected during five consecutive summers. The best water quality is graded as Very Good, the worst Very Poor. Marlborough rivers range from Good to Very Poor (Table 1). Long-term trend analysis shows that recreational water quality at four sites is improving. The Taylor River at Riverside in central Blenheim is the only site with a significant increase in *E. coli* concentrations in recent years. In an effort to find the cause, a two-part investigation began in 2012. The first part focused on rural influences and the findings were published in a 2015 report showing stock access to the tributaries was a major contributing factor. Based on this, a catchment enhancement plan will be developed with a co-operative approach between land owners and the Council to improve the water quality. The second part of the study focused on the effects of the urban environment, particularly stormwater inputs.

FUTURE RESPONSE

The Council will continue regular monitoring of popular swimming spots and will seek to improve water quality in rivers that currently have an SFR Grade of Poor or Very Poor.

Table 1: Water quality grades for river swimming sites monitored by the Council.

SITE	SFR GRADE (SUITABILITY FOR CONTACT RECREATION GRADE)
Rai River at Rai Falls	Very Poor
Te Hoiere / Pelorus River at Te Hoiere / Pelorus Bridge	Good
Te Hoiere / Pelorus River at Totara Flat	Poor
Wairau River at State Highway Six	Insufficient data
Wairau River at Ferry Fridge	Fair
Wairau River at Blenheim Rowing Club	Good
Taylor River at Riverside Park	Very Poor
Ōpaoa River at Elizabeth St Bridge	Fair
Waihopai River at Craiglochart #2	Fair

WANT TO FIND OUT MORE?

- Council website: www.marlborough.govt.nz/Recreation/Swimming-and-Boating/Swimming-Locations.aspx
- Land Air Water Aotearoa website: www.lawa.org.nz/explore-data/marlborough-region/river-quality/
- Taylor River Catchment Characterisation – Doctors Creek - MDC Technical Report No:15-001

FRESHWATER BIOSECURITY

Invasive weeds and introduced exotic fish are both threats to Marlborough's rivers, streams and lakes. Aquatic pest weeds such as yellow flag iris and oxygen weed are now established, harming the aquatic environment as well as limiting the recreational value of our waterways. There is also an ongoing risk of other aquatic weeds establishing or new invasive fish being introduced.

PRESSURE

The level of biosecurity threat depends on several factors:

- The impact of invasive aquatic pest weeds that are already established
- The risk of new aquatic pest weeds becoming established
- The risk of invasive pest fish being liberated and becoming established
- The impact of invasive aquatic pest weeds already established
- Marlborough has two common aquatic pest weeds known as oxygen weed – *Lagarosiphon major* and *Egeria densa*. Both species create dense mats that impede flow and choke the waterway. *Egeria* is more limited in spread and found mainly in Spring Creek and the Taylor River though both have been established for some time, probably after being thrown out from a home aquarium.
- Yellow flag iris (*Iris pseudacorus*) is a pest weed that grows in dense mats along the edges of creeks and streams on the Wairau Plain. It displaces native plants and increases the risk of flooding.

CHANGES SINCE THE 2008 SOE REPORT

- Substantial reduction in infestation levels of a number of species such as parrot's feather, eel grass and reed sweet grass.
- Marlborough waterways continue to remain free from invasive pest fish species.
- The invasive algae didymo continues to be restricted to South Island waterways only.
- Marlborough continues to remain free from the invasive aquatic weed species hornwort, phragmites, salvinia and manchurian wild rice.

Yellow flag iris

- The invasive algae didymo (*Didymosphenia geminate*) is established in many of Marlborough's waterways. Also known as "rock snot", didymo forms a thick brown layer on the bottom of the waterway, smothering rocks, underwater plants and habitats.
- Some pest weeds have been found before they spread too far, such as parrot's feather (*Myriophyllum aquaticum*), reed sweet grass (*Glyceria maxima*), purple loosestrife (*Lythrum salicaria*) and eel grass (*Vallisneria australis*). These are a high priority to manage before they become more established.

The Council is also on the lookout for other pest species such as hornwort *(Ceratophyllum demersum)*, salvinia *(Salvinia molesta)*, alligator weed *(Alternanthera philoxeroides)* and water hyacinth *(Eichhornia crassipes)* that have been found elsewhere in New Zealand but not yet seen in Marlborough.

RESPONSE

The Council Biosecurity team focuses on aquatic pest weed species that have been found recently as well as working to prevent others making their way to Marlborough. There are active control programmes for parrot's feather (eradication), reed sweet grass (sustained control), purple loosestrife (sustained control), and eel grass (sustained control).

To prevent new invasive aquatic weed species spreading into Marlborough, the Council has signed up to the National Pest Plant Accord with the Ministry for Primary Industries and other local authorities. The Accord lists a range of species as Unwanted Organisms under the Biosecurity Act 1993 and it is illegal for anyone to sell, propagate or move a listed species. Council also has ongoing surveillance that aims to detect any new pest species arriving in Marlborough.

The pest fish rudd *(Scardinius erythrophthalmus)* and tench *(Tinca tinca)* were found in the Taylor Dam in 2002. Their feeding habits endanger native plants, destroy indigenous habitat, remove food sources for native fish and invertebrates and muddy the water by stirring up bottom sediments. After intensive efforts by the Department of Conservation and the Council, both species were eradicated by 2005. No other pest fish have been found in Marlborough since then, although surveillance is limited.

Public awareness and education plays an important part in controlling aquatic weeds and pest fish. The Council's message to the public is that releasing invasive fish or dumping aquatic weed from a home aquarium puts our waterways and native habitats at risk. This is highlighted through community advocacy and education programmes. Council staff also work with the Ministry for Primary Industries on campaigns such as "Check, Clean, Dry" and "Stop the Spread" of didymo.

STATE

The following table provides an overview of the state and distribution of aquatic pests in Marlborough.

Table 1: Status of aquatic pest species in Marlborough

SPECIES	STATE	MANAGEMENT STATUS
Lagarosiphon and egeria	Well established	Asset protection - river flow maintenance Support research into biological control Community education to slow spread
Yellow flag iris	Well established	Asset protection - river flow maintenance Community education to slow spread
Didymo	Well established	Community education to slow spread
Parrot's feather	Established at very low density	Council-led eradication programme Commmunity education to detect any new infestations
Reed sweet grass	Established at moderate density	Council-led sustained control programme Community education to detect any new infestations
Purple loosestrife	Established at low density	Council-led sustained control programme Community education to detect any new infestations
Eel grass	Established at low density	Council-led sustained control programme Community education to detect any new infestations
Pest fish	Not yet established	Department of Conservation and Council-led community education to prevent and deter illegal release Passive surveillance
Unwanted aquatic weeds	Not yet established	Community education to prevent and deter illegal or inadvertant release Active and passive surveillance

Parrots feather control using old carpet to smother the plants

Figure 1: Volumes of herbicide required for parrots feather control

CASE STUDY
Parrot's feather on the lower Wairau Plain

Parrot's feather was first found growing wild in Marlborough streams in the early 1990s, which sparked an immediate response by the Council to stop it establishing.

This South American aquatic pest is a sprawling perennial that forms a dense mat, clogs up the waterway and smothers native habitats. It was originally introduced for aquatic gardens and fish tanks but it spread – either by escaping or being dumped – and infested many freshwater systems throughout New Zealand.

A Council surveillance operation in 2006 discovered substantial infestations in Ruakanakana Creek (formerly known as Gibsons Creek) and the Ōpaoa River as well as some in small ponds and home gardens. The Council launched an eradication programme through the Regional Pest Management Strategy that targeted all known infestation sites. Contractors used herbicide and other methods to dramatically reduce the amount and distribution of parrot's feather.

In 2015 there was only one very small infestation left, on Ruakanakana Creek. Herbicide control has been difficult on this site so Council staff have innovated by placing large sections of old carpet over the backwater to smother the remaining parrot's feather, which is still being managed.

Spraying reed sweet grass at Grovetown Lagoon