Our Health

Southland Water 2010: Part 1

Te Ao Marama Inc.

environment SOUTHLAND
Te Taiao Tonga

Te Punawai o Te Ao

The source of the waters of the world

Na te pō, ko te Ao,	From eternity came the universe
Tana ko te Aomārama,	From the universe the bright clear light
Tana ko te Aotūroa,	From the bright light the enduring light
Tana ko te Kore te Whiwhia,	From the enduring light the void unattainable
Tana ko te Kore te Rawea,	From the void unattainable, the void intangible
Tana ko te Kore te Tāmaua,	From the void intangible the void unstable
Tana ko te Kore Mātua,	From the void unstable the void endowed with paternity
Tana ko Māku,	From which came the moisture
Te Punawai o Te Ao	The source of all the waters of the world

Our Health: Is our water safe to play in, drink and gather kai from?

Southland Water 2010: Part 1

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Foreword

As a child growing up on a farm, I remember being fascinated by what lived in our creek. We would take a billy to scoop up cockabullies, get excited at the sign of an eel and generally spend many hours paddling around in the water. I also remember how farm discharges from the cow-byre and the sheep dip were deposited directly into the creek and no-one thought anything of it. The big difference between now and then is that the low intensity of the discharges were able to be absorbed into the system with little environmental effect.

Half a century later the pressures of development, population growth and various land use practices have altered the state of our waterways. We are seeing a growing awareness of our waterways and how we manage our freshwater resources sustainably is coming under increasing scrutiny.

This report, the first in a series of four written in collaboration with Te Ao Mārama Inc, represents a significant amount of work since the last State of the Environment report was published in 2000. It reports results and trends from an extensive monitoring network against values that we as Southlanders place on our waterways – is it safe to swim here, is it safe to drink the water, is it safe to eat and gather food?

There are many positives that can be taken from this report, but it also highlights where more work is required to ensure we are on track to meet our Water Plan targets. We are also at a point where many Southlanders are working to do more for water quality. But there is always more that can be done. I hope that this report is your 'call to action' to become involved in some way, at school, at home or at work. We all need to do more to improve water quality for future generations of Southlanders.

Stuart Collie
Environment Southland Chairperson

Ko te Waimāori ko au, Ko te Waitai ko au, Ko te Wairua ko au.

My spiritual wellbeing is dependant on the health of the waters

Water is a taonga (treasure). It sustains life. It is life. It is the life blood of Papatūānuku (mother earth), and the harming of its state harms all connected life, including our own.

Water also has spiritual values of mauri and wairua. The physical water quality can impact on these values, and in turn this has impacts on the health of the people reliant on this resource.

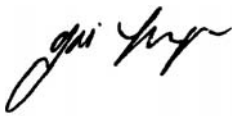
Mahinga kai, the gathering of resources and food, from Murihiku/Southland waters is an important expression of our Ngāi Tahu identity, and is part of the way Māori monitor the state of the environment. In Murihiku we are fortunate to still be able to harvest important freshwater kai species, such as tuna/eels, kanakana/lamprey, īnanga/whitebait, watercress, shellfish etc. However those harvesting are now expressing concern about the health of our waterways and the continuing pressures on them.

Cultural monitoring and reporting has been identified by the Murihiku Papatipu Rūnanga as an important tool for our resource management mahi. It is a way of gathering information about our taonga and assists us to carry out our role as kaitiaki. Together with Environment Southland as part of Southland Water 2010, we report against our cultural values for freshwater, with this first report linking water quality with our health. We view this as the beginning of the collaborative journey in being able to incorporate cultural monitoring as part of the overall monitoring and reporting on the state of Southland's environment.

Aspects of this project also help to achieve our "ki uta ki tai" (mountains to the sea) aspirations, based on a traditional Ngāi Tahu concept of resource management that recognises the interconnectivity of all resources, and requires coordination by all management agencies.

It is the responsibility for the present generations as kaitiaki (guardians) to ensure that this taonga is available for future generations in as good as, if not better quality.

Mō tātou, ā mō ka uri ā muri ake nei (for all of us, and the generations that follow).



Gail Thompson
Te Ao Mārama Incorporated Chairperson

At a glance

Our Health is the first in the *Southland Water 2010: Report on the State of Southland's Freshwater Environment* four part series. Here we provide a brief overview on whether our waterways are safe to play in, drink and gather kai from?

Is it safe to swim and play in our waters?

- During summer, water quality at most of our monitored popular freshwater bathing sites is generally safe for swimming, except after heavy rainfall and/or when water flow is higher than usual.
- Our safest swimming spots are in the less developed areas of the region, such as Lakes Te Anau and Manapouri, and Mararoa River at South Mavora Lake.
- Mataura River at Gore and the Waikaia River at Waikaia, have often recorded bacteria levels breaching the standards and guidelines during fine weather and low flow, when people are more likely to swim.
- Nine out of ten bathing sites breached the Water Plan standards set for bathing.
- Lowland waterways and the Mataura River catchment frequently breached Water Plan standards set for faecal contamination and secondary contact with water (eg sport fishing and boating).

Is it safe to drink our water?

- Generally groundwater sites sampled met the drinking water standards for the indicators measured.
- Faecal contamination is encountered in 22% of bores, but is thought to be generally localised (or restricted to areas directly adjacent to the well head) and caused by poor well siting and construction, rather than overall contamination of the aquifer.
- Elevated nitrate concentrations are found in localised areas, where 7% of samples breached drinking water standards.
- Groundwater contamination from pesticides, heavy metals and hydrocarbons only occurs in localised areas around a specific source.
- Pesticides occur at concentrations well below levels of health concern.

Is it safe to gather and consume kai from our waters?

- Preliminary results of a survey of wild food harvesting in Southland show that a range of species are gathered from Southland waters for food.
- While there are no specific water quality standards or guidelines for freshwater food gathering or consumption, we can report on guidelines for faecal contamination of water at shellfish gathering sites. Five of the eight shellfish sites we monitored breached this guideline.

How water quality has changed over time, the causes of poor water quality, and what we are doing about them are outlined in later sections of the report.

Introduction to Southland Water 2010

Ko te aroha, te waipuna o te ao Māori
We cannot live without love or water

Water is life. We, and everything around us, cannot exist without it.

In our natural environment, water can be categorised as rainfall, surface water (eg rivers, lakes and wetlands), groundwater and coastal marine waters. These forms of water are all connected in the hydrological cycle; rainwater supplies our rivers and groundwater aquifers; groundwater supplies some of our surface waters; surface waters contribute to some of our aquifers; and rivers and some aquifers discharge water to the sea.

For Māori, water or wai also has categories according to its spiritual and geographical features. These categories include: waiora (pure water used for healing), waimāori (ordinary water), waitohi (pure water used to remove tapu), waimate (dead water), wai whakaheke tūpāpaku (burial waters), waipuna (important springs) and waimātaitai (brackish/estuarine waters).

Southland's social, cultural, economic and environmental wellbeing is supported by and interwoven with the quality and quantity of these waters.

Every day, our quality of life depends on a constant and clean supply of water to our homes and businesses, and the ability to flush or drain away unwanted liquid wastes.

Our recreational pursuits and cultural and regional identity rely on the health of our waters. Poor water quality in turn impacts on our individual and collective health and wellbeing.

The value which Southlanders place on their environment is the basis of the *Regional Water Plan for Southland* and our *Regional Policy Statement*. *Ngāi Tahu ki Murihiku Natural Resource and Environmental Iwi Management Plan 2008: Te Tangi a Tauira - the Cry of the People* consolidates the manawhenua values for the freshwater environment.

The management outcomes for the freshwater environment within these documents in turn provide the framework for *Southland Water 2010: Report on the State of Southland's Freshwater Environment*. This framework enables the monitoring and reporting to inform our management of Southland's freshwater resources, and help determine the planning for the work programmes within the next Long Term Plan 2012–2022.

Southland Water 2010 builds and expands upon Environment Southland's first *Southland's State of the Environment Report for Water* published in October 2000, and provides a baseline to measure the success of the Water Plan which became operative in January 2010.

Southland Water 2010 will consist of a series of four reports:

- Our Health
- Our Ecosystems
- Our Uses
- Our Threats.

Our Health, reports on the health aspects of freshwater quality that Southlanders value. This report asks is it safe for bathing and recreation, human and animal drinking water supplies and for gathering and consuming kai/food. We report on the current state of the water and the changes that have occurred over time.

Southland / Murihiku: Our place and our people

Southland is the second largest region in New Zealand. It covers an area of 34,000km^2 (12.5% of New Zealand's landmass). Its coastal boundary extends from Awarua Point (Fiordland) on the west coast, to Waiparau Head (Catlins) on the fringe of the east coast, and includes Stewart Island/Rakiura (Figure 1).

In all, 53% of Southland's land area is managed as public conservation land. Farms occupy 85% of the remaining lands.

Climate

Southland lies deep within the Southern Hemisphere's westerly wind belt.

Wet westerly winds drop most of their moisture on the western side of the partial barrier formed by the Fiordland mountain ranges (5,000–10,000mm/yr); rainfall on the eastern or lee side is much lower, although still reasonably common (700–1,500mm/yr).

Coastal Southland near Foveaux Strait can experience periods of strong and persistent westerly winds, combined with regular rainfall (1,000–1,200mm/yr).

Surface water

Four major river catchments extend over Southland: the Waiau, Aparima, Oreti and Mataura. Combined, these catchments cover 54% (18,305km^2) of the region.

The cultural importance of these four rivers to Ngāi Tahu is formally recognised as mahinga kai areas (food and resource gathering areas) and traditional trails in the Ngāi Tahu Claims Settlement Act 1998. National Water Conservation Orders on the Mataura and Oreti Rivers reflect their national significance, particularly as brown trout fisheries.

Groundwater

Groundwater (the freshwater found beneath the ground) forms an integral part of the water cycle and therefore has a significant influence on the health of our rivers and wetlands. The majority of Southland's aquifers are shallow and unconfined, so they are largely replenished by rainfall infiltrating through the soil. As a consequence, water quality in these aquifers can be directly influenced by overlying land use.

Confined aquifers are generally less directly affected by overlying land use because of intervening layers of low permeability sediments and sometimes, depth. However, the effects associated with natural geochemistry (eg the minerals from surrounding rock dissolving into the water) can affect an aquifer's suitability for drinking water supply.

Estuaries and coastal waters

The Southland coastline is 3,000km long, one seventh of the New Zealand total. Southland's coastal waters lie in the Tasman Sea, Foveaux Strait/Te Ara a Kiwa, and the Pacific Ocean.

Te Mimi o Tū Te Rakiwhānoa (Fiordland Coastal Marine Area) and Rakiura/Te Ara a Kiwa (Stewart Island/Foveaux Strait Coastal Marine Area) represent areas of significant historical and cultural identity for Ngāi Tahu and this association is recognised in the Ngāi Tahu Claims Settlement Act 1998.

Southland features several estuaries including the Waiau Lagoon, Jacobs River Estuary, New River Estuary, Bluff Harbour and Awarua Bay, Waituna Lagoon, Haldane Estuary, Fortrose Estuary, and Waikawa Harbour.

Poor freshwater quality can impact upon our estuarine and coastal environments.

Population and ethnicity

There are 90,873 Southlanders (2006 Census) and we make up 2.3% of New Zealand's population. In terms of ethnicity, 78.6% of Southlanders identify as of European descent, 16.5% as New Zealander, 11.8% as Māori, 1.7% as Pacific people, 1.3% as Asian and 0.2% as another ethnicity (you can identify with more than one ethnicity).

Manawhenua

Māori have a long history in Southland/Murihiku with a major settlement on Ruapuke Island and other settlements along the Southland coast at Waikawa, Bluff, and Riverton/Aparima.

Manawhenua refers to the iwi or hapū that holds the traditional/customary authority over resources within a particular area.

In Southland/Murihiku there are four Ngāi Tahu papatipu rūnanga (traditional local Māori councils) which hold manawhenua status within the region:

- Te Rūnaka o Waihōpai: centred on Waihōpai/Invercargill,
- Te Rūnanga o Awarua: centred on Awarua/Bluff,
- Te Rūnanga o Oraka/Aparima: centred on Oraka/Colac Bay, and
- Te Rūnanga o Hokonui: centred on Gore.

Where we live

Southland's main urban centre is Invercargill, with 50,328 people. Other significant population areas are Gore (9,870), Winton (2,088), Te Anau (1,899), Riverton/Aparima (1,512) and Otautau (753). Southland's 27% rural population is almost twice the national average of 14%.

What we do

Economy and employment

Agriculture and primary production, followed by manufacturing, are the main contributors to Southland's economy. Nearly 19% of Southlanders are employed in the agriculture, forestry and fishing industries, and 15% in manufacturing.

Ninety percent of Southland farms are involved in livestock production, with the main farming types being sheep (45%), dairy cattle (16%), beef cattle (8%), sheep-beef (10%) and deer (7%).

Dairying has increased over the last two decades, with the number of dairy cows increasing from 114,378 in 1994 to 589,184 in 2009. Dairy farms now occupy 9% of all farmland in Southland.

Tourism accounts for 10–12% of Southland's workforce, servicing a mixture of international and domestic visitors. In New Zealand as a whole, a large proportion of the international tourism (70%) is based around activities in the natural environment. In 2008, Fiordland (with its very high natural values) had 1.06 million visitors (72% from overseas) while in the same year the remainder of the Southland region had 1.46 million visitors (14% from overseas).

Southland trout fisheries attract international anglers. The region is the most frequently fished by international visitors with over 25% of the total overseas visitors fishing experience in New Zealand occurring in Southland over an estimated 174,000 angler days in 2007/08.

Play and recreation

Southlanders enjoy outdoor recreation. Our top sport and recreational activities include walking, gardening, fishing and jogging. Hunting is also a major activity for Southland males, with 19.5% participating in this activity.

Southland seasons are often described in terms of what can be hunted or gathered in the environment at that time of year. Such seasonal harvests include whitebait, trout, duck, kanakana (lamprey), tītī (mutton bird) and deer (eg the stag hunts of the "roar", the "rut" and the "bugle").

Southlanders are also involved in the all year round recreational and customary harvests of flounder, crayfish, blue cod and pāua.

Figure 1: Southland Region

How this report works

This report has been written to:

- Raise awareness and understanding of issues that affect our shared environment
- Tell us how effective our decisions and actions have been
- Help us set priorities for future action
- Help people and organisations to make informed decisions to protect what they value in the environment
- Inspire community action.

State of the environment reporting

State of the environment (SOE) reporting is the equivalent of a report card on the environment. Within this SOE report we look at current conditions and trends, identify pressures and discuss our response.

SOE reports are not technical documents although they are based on large amounts of technical information. They instead set out to show the health and other specific environmental qualities of a particular aspect of our environment, against an agreed set of measures, and to identify how things can be improved when they fall short of the agreed standard. SOE reports therefore give an overview of the complex and interwoven relationships that make up environmental systems.

Approach taken in this report

Southland Water 2010 focuses on the freshwater environment but also includes the estuaries and coastal areas influenced by freshwater.

Nationwide, a network of regional councils work together collaboratively to ensure or improve national consistency and robustness of the environmental information collected. As such Environment Southland's monitoring programmes encompass aspects that are traditionally monitored by Regional Councils in New Zealand, and are consistent with current national best practices.

By reporting collaboratively, Environment Southland and Te Ao Mārama Incorporated, seek to strengthen monitoring and reporting to encompass a more holistic picture of environmental and cultural health.

Report structure

The report's structure is based on the *Regional Water Plan for Southland* (the Water Plan) and presents the results of monitoring programmes conducted by Environment Southland and Te Ao Mārama Incorporated (Table 1).

The following sections present these monitoring results:

- Is it safe to swim and play in our waters?
- Is it safe to drink our water?
- Is it safe to gather and consume kai from our waters?

Want more detail on SOE reporting?

Visit: http://www.es.govt.nz/environment/reporting/state-of-the-environment/index.aspx.

Table 1: Summary of the monitoring results presented

Section	Issue	Monitoring programme	Indicator/measure reported
Is it safe to swim and play in our waters?	Faecal contamination at freshwater bathing sites	Freshwater bathing sites – river and lakes	*Escherichia coli (E. coli)*
	Faecal contamination of Southland waterways	Regional state of the environment freshwater surface water quality sites	Faecal coliforms and *E.coli* (depending on Water Plan standard)
			Case study: Waituna Lagoon
		Marine bathing sites	Case study: Freshwater quality and impacts on marine bathing sites (Enterococci)
	Toxic cyanobacteria	Cyanobacteria monitoring	Case study: Cyanobacteria
Is it safe to drink our water?	Human drinking water quality	Groundwater quality sites	*E. coli*
			Nitrate (Nitrate-Nitrogen)
			Manganese
			Case study: Nitrate leaching risk
			Case study: pesticides in groundwater
			Case study: Heavy metal and hydrocarbons
	Aesthetic human drinking water quality		pH
			Chloride
			Total Hardness
			Sulphate
			Sodium
			Iron
	Stock drinking water quality	Regional state of the environment freshwater surface water quality sites	Faecal coliforms
Is it safe to gather and consume kai from our waters?	Potential health risks from gathering and consuming kai	Mahinga kai survey	Preliminary results listing kai gathered in Southland waterways
	Faecal contamination of recreational shellfish gathering sites	Shellfish gathering sites water quality	Faecal coliforms
		Investigation of shellfish gathering site water quality and shellfish flesh	Case study: Riverton/Aparima shellfish study
	Faecal contamination of other food gathering sites	Regional state of the environment freshwater surface water quality sites	Faecal coliforms levels at whitebait and trout gathering areas

Reporting on our standards

Each section compares the monitoring results against the relevant national guidelines, and the standards stated within the Water Plan and *Ngāi Tahu ki Murihiku Natural Resource and Environmental Iwi Management Plan 2008: Te Tangi a Tauira - the Cry of the People* (Te Tangi a Tauira).

Surface water and groundwater are classified in different ways.

The Water Plan divides all of Southland's rivers and lakes into different classes (natural state, lowland hard bed, lowland soft bed, hill, mountain, lake-fed, spring-fed, lowland/coastal lakes and wetlands, hill lakes and wetlands, mountain lakes and wetlands, and Mataura 1, 2 and 3) based on source and existing water quality (Figure 2). Water quality standards have been identified for each class.

In this document, surface water quality monitoring is predominately reported against the faecal bacteria standards within the Water Plan for each class (Figure 2).

'Natural state' waters are within public conservation land and are largely unmodified or unaffected by human activities. These waters have no numerical standard for faecal bacterial counts, but have a desired standard of no change to the natural water quality.

Shallow unconfined aquifer systems are classified into 29 groundwater zones – these zones are based on the aquifer areas and are managed as separate groundwater resources in the Water Plan. The Water Plan specifies that the *Drinking Water Standards for New Zealand 2008* published by the Ministry of Health are used as the main criteria for assessing the suitability of groundwater for human consumption.

The standards that manawhenua apply to water quality have come from Te Tangi a Tauira, and from consultation with Te Ao Mārama Incorporated.

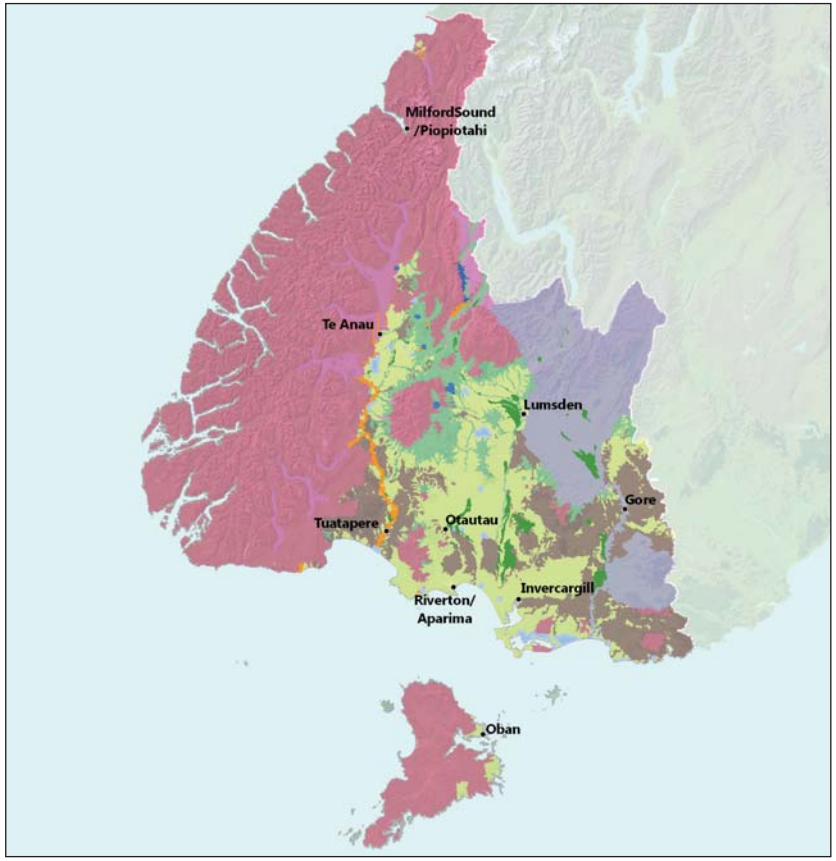
Water quality changes over time or 'trends'

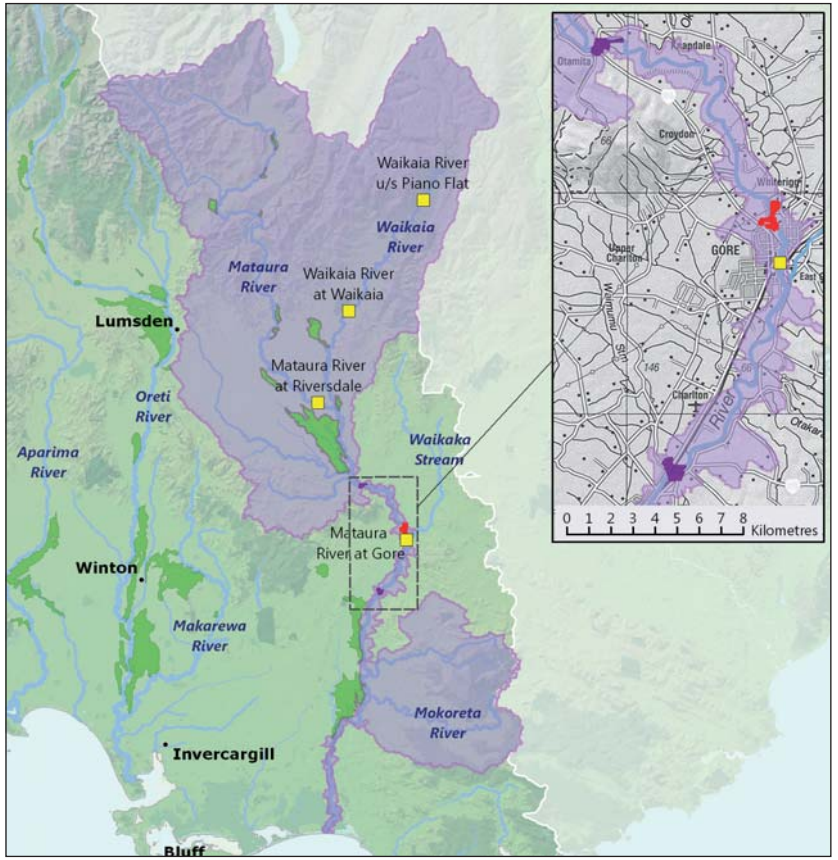
In order to be able to tell if something is changing over time we require a number of samples to obtain enough 'data' to conduct our statistical tests. Therefore, when we become interested in a new site, there is a delay before we have enough data to determine trends. This is why you will see the term 'our monitoring is sufficient to… ' prior to us reporting a trend. All trends reported are statistically 'significant' and based on a minimum of 60 samples. The trends produced within this report have been determined using national best practice and advice from both surface water quality and groundwater quality experts.

Because this report considers water quality in relation to our health we are primarily interested in the *concentrations* of pollution in our water; therefore we have not incorporated river flow ('flow-adjustment') into our surface water trend analyses.

Flow-adjustment is important in order to determine the amount of pollutant coming from a particular catchment. Therefore in the following 'Our Ecosystems' report we will examine the relationship between contaminants and river flow, and other relevant measures such as clarity and turbidity.

Figure 2: The *Regional Water Plan for Southland* water body classes and associated faecal bacteria standards for: a) the Southland region, and b) the Mataura water body classes.





Maximum of 130 E. coli per 100ml at site and for 1km upstream	Bathing Sites			
Maximum of 130 E. coli per 100ml	Mountain	Lake Fed	Hilly Lakes	Mountain Lakes
No change	Natural State			
Maximum of 2,000 faecal coliforms per 100ml	Mataura 1			
Maximum of 200 faecal coliforms per 100ml	Mataura 2			
Maximum of 1,000 faecal coliforms per 100ml	Mataura 3	Hill	Spring Fed	Lowland Hard Bed
	Lowland Soft Bed	Lowland/Coastal Lakes		

Managing water quality for Southland's health

Environment Southland

Environment Southland is the brand name of the Southland Regional Council, whose 12 elected councillors are responsible for the governance and management of Southland's natural and physical resources: air, land, water and coast.

The 'outcomes' we aim for in our management of freshwater resources are the community expectations set out within the *Regional Policy Statement* and The Water Plan. The Water Plan further sets out in detail the community's standards and targets for water management within the Southland region.

Environment Southland's legal responsibility is to monitor the overall state of the region's environment.[1] As part of this we monitor and report on water quality measures that relate to public health. For instance, if a health issue is detected, we notify the health agencies, such as Public Health South, the Medical Officer of Health, and the environmental health officers at Southland District and Invercargill City Councils. They are the experts in health risks posed by water quality issues and they notify and work with the potentially affected communities to mitigate the risk.

> *" ...the quality of Southland's water resources is the key indicator of the sustainability of land use."*
>
> ***— Environment Southland Long-term Council Community Plan 2009–19***

Te Ao Mārama Incorporated

Te Ao Mārama Incorporated looks after manawhenua interests in resource management and other aspects related to local government in Southland. It is authorised to represent the four Ngāi Tahu papatipu rūnanga in Murihiku/Southland. It is involved in the protection of the spiritual and cultural values of the region, including wāhi tapu (sacred places), mahinga kai (gathering of food and resources) and other natural resources.

Kaitiakitanga (guardianship) is a central traditional principle behind Ngāi Tahu management of the environment.

Te Tangi a Tauira consolidates manawhenua values and perspectives on natural resource and management issues. This planning document assists Ngāi Tahu ki Murihiku in carrying out kaitiaki roles and responsibilities. Te Tangi a Tauira also recognises the role of communities in achieving good environmental outcomes and healthy environments, and thus is designed to assist others in understanding manawhenua values and policy.

> *"Water is held in the highest esteem because the welfare of the life that it contains determines the welfare of the people reliant on those resources. Ensuring water that is meant for drinking is of drinking water quality, and that water where mahinga kai is harvested is safe to eat from, and the water where our kids swim is safe for them to swim in, is our kaitiaki responsibility as Ngāi Tahu ki Murihiku."*
>
> ***— Ngāi Tahu ki Murihiku, Te Tangi a Tauira, 2008***

[1] Resource Management Act 1991, section 35(2)(a).

How water and health are interwoven

Homai to waiora ki au, kia tū pakari

Pass me the health giving waters, that I may stand tall, strong and healthy

The health of our environment and natural waterways are interwoven with our community's health. Te Whare Tapa Whā model of Māori health emphasises this interconnectedness with the four dimensions of Tinana (physical health), Wairua (spiritual health), Whānau (family health) and Hinengaro (mental health). These elements are usually described as four walls of a whare/house, embedded in the foundations of the environment. Weaken one wall and the whole whare becomes unbalanced and the individual and community become unwell.

In Māori culture the concept of manaakitanga (the support, caring and hospitality to guests) relates directly to environmental health. Being able to provide safe traditional kai/food from the local area is a source of pride for iwi, hapū and whānau groups, and the inability to do so can not only have direct effects on the physical health of whānau and their guests, it can impact on the way Māori feel about themselves and their wellbeing.

Poor water quality directly impact individual and community health. Contaminants such as human sewage or animal waste contain disease-causing micro-organisms including viruses, bacteria and protozoa. These can affect us through polluted water when we swim, gather kai/food, drink water or eat improperly cooked food.

In most cases, human health problems resulting from exposure to water contaminated with faecal bacteria while unpleasant, are minor and of short duration. There is, however, a more serious health risk posed by diseases such as hepatitis A, giardia, cryptosporidium, campylobacter and salmonella.

Nutrient enrichment of rivers, lakes and coastal waters, which can occur as a result of fertiliser and effluent runoff, can lead to growth of toxic algae and phytoplankton growth. These can adversely affect the health of people, livestock and pets.

Toxic cyanobacteria growths are known to occur in Southland waters and in the past have resulted in dog deaths. These can also occur in rivers where there is no nutrient enrichment. Some forms of cyanobacteria are potentially harmful to humans (Case Study: Cyanobacteria in Southland Rivers pg 26).

Other waterborne health hazards for people, their animals and plant life include chemical contaminants such as metals and metalloids, and organic micro-contaminants such as pesticides, industrial and pharmaceutical chemicals. These can get into our waters through direct discharges, leaching through the soil, through stormwater drains and through natural processes, eg the natural interactions of water with rock can lead to elevated concentrations of arsenic and manganese in some aquifers.

Recreation in a healthy outdoors environment has direct health benefits through physical activity and the 'feel-good factor'. For example, two of Southland males' most popular physical sport and recreational activities are fishing (44%) and hunting (20%).[2] How healthy would our community be if our environment's wellbeing deteriorated to a state where fishing and hunting were no longer attractive or even safe?

As Southlanders, our identity and community are closely connected to our surrounding environment. This interconnection strongly links our health and wellbeing to the overall health of our environment and ecosystems and is the basis on which this report is structured.

[2] Active NZ Survey; Sport, Recreation and Physical Activity Profile 2007/08 (Sport and Recreation New Zealand).

Is it safe to swim and play in our waters?

Introduction

In Southland the most significant known human health risk from recreation in our waterways is posed by disease-causing micro-organisms.

We monitor faecal bacteria as an indicator, to determine the level of disease-causing micro-organisms in our waters. A high concentration of faecal bacteria means a higher potential health risk. However, it does not mean that anyone swimming in the water at a particular time will necessarily be affected.

We report how safe our waters are for swimming and recreation in different ways based on different monitoring programmes in the region.

The first reported measure is of a single 'indicator' bacterium, *Escherichia coli (E. coli)*, which is tested regularly at 11 popular freshwater bathing sites. Seven sites are tested weekly between December and March each summer, and four sites are tested monthly over the whole year (Table 3). The main purpose of this monitoring is so we can warn of any potential public health risks.

The second measure is of faecal coliforms (six different bacteria), which are tested monthly at 71 representative river sites across Southland. The results provide a regional picture of faecal bacteria contamination. Faecal coliforms have been monitored since 1994, so we can use this data to track long-term trends at some sites.

This section also contains three case studies.

The first case study examines freshwater quality and its impacts on our marine bathing sites, and reports on the weekly monitoring of 13 marine bathing sites between December and March each year. At these sites enterococci is tested weekly because it is a better indicator of faecal contamination in saltwater.

The second case study looks at *E. coli* concentrations at Waituna Lagoon – a wetland of international importance. The final case study reports on the occurrence of potentially toxic cyanobacteria in Southland Rivers.

The sources of contamination, and what we are doing about them, are outlined in later sections of this report.

Our management targets

The Water Plan's long-term target is that water quality of all surface water bodies in the region will be suitable for contact recreation. In the short-term, within 10 years, the goal is that water quality is maintained and enhanced so that it is safe to swim at popular bathing sites, and 'natural state' water quality is maintained. 'Natural state' waters are within public conservation land, which are largely unmodified or unaffected by human activities.

To achieve these targets, the Water Plan identifies that we will need to *maintain* water quality where it is already suitable for recreation and *improve* it where it is not; in particular by reducing faecal contamination. Our aim is to achieve a minimum 10% reduction in levels of faecal contamination within 10 years in degraded surface water bodies, ie lowland, hill and spring-fed surface water bodies.

Policies within Te Tangi a Tauira strive for the highest possible standard of water quality. For manawhenua, the target is therefore for good water quality to be reinstated in water once used for bathing or swimming, as well as for current contact recreation. While such improvements in water quality may take a long time, they nevertheless should be the ultimate target.

The standards we use

The Water Plan sets the maximum limit for faecal contamination at 1,000 faecal coliforms[3] per 100ml for most sites. This limit is comparable to national guidelines set by ANZECC and ARMCANZ[4] in 2000 for secondary contact recreation (ie sports fishing, boating etc where you do not fully submerge in the water).

[3] Note that some standards are in terms of 'faecal coliforms' in general, while others use a measure of only *E. coli*.

[4] Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand.

The Water Plan standard requires this to be a single sample limit. However the national guideline is a median value, which allows half the samples to be above 1,000 faecal coliforms per 100ml.

Defined popular bathing sites and surface water bodies classified as 'mountain', 'lake fed', 'hill lakes' and 'wetlands' have higher standards: 130 *E. coli* per 100ml, while the Mataura 1 and Mataura 2 classes have lower standards – they must not exceed 2,000 and 200 faecal coliforms per 100ml, respectively. 'Natural state waters' have no numerical bacteria standards but must not deteriorate in water quality (Figure 2).

National bathing quality guidelines use a three tier approach of 'surveillance', 'alert', and 'action' modes. The action mode indicates that levels present a high health risk for bathers and consider such waters unsuitable for bathing (Table 2).

For manawhenua the cultural standards are much higher than in the Water Plan. Not only do manawhenua require bathing waters to meet the bathing water standards and guidelines, but any level of human sewage in bathing waters is culturally offensive and unacceptable. Environment Southland's current monitoring programmes are unable to report against this standard, but we are working together to rectify this for future reporting.

Table 2: National bathing guideline thresholds (MfE and MoH, 2003[5])

Mode	Freshwater bathing sites	Marine bathing sites
	Number of *E. coli* per 100ml	Number of enterococci per 100ml
Surveillance mode	Less than 260	Less that 140
Alert mode	260 to 550	140 to 280
Action mode	More than 550	More than 280


M. Poole

[5] Ministry for the Environment and Ministry of Health.

The quality of our freshwater for recreation

Freshwater bathing sites' compliance with our standards and guidelines

During the 2008/09 bathing season[6] 8 out of the 11 monitored bathing sites breached the Water Plan standard of 130 *E. coli* per 100ml, three or more times. These same sites also breached the national guideline 'action' mode of 550 *E. coli* per 100ml at least once (Table 3). Sites that complied with the regional standard and the national guideline were the more remote sites of Mararoa River at South Mavora Lake, Lake Manapouri at Frazers Beach, and Lake Te Anau at Boat Harbour Beach.

From 1999–2009, 9 out of 10[7] of the bathing sites breached the Water Plan standards, and 8 out of 10 sites breached the national guidelines at least once (Table 3). Sites at the Mararoa River at South Mavora Lake and Lake Manapouri at Frazers Beach have never breached the national guidelines.

Compliance with the guidelines can vary from year to year. Over the last decade (1999–2009) Water Plan standard compliance varied between 33% to 54% of all samples. While compliance with the national guideline 'action' mode varied between 66% to 94% of all samples (Figure 3). This variation can be partly attributed to variations in annual rainfall - ie some summers can be wetter than others. High rainfall can wash more faecal matter into the rivers as 'runoff', while increased river flows can disturb or wash away faecal bacteria attached to the sediments on the river bed.

Most river sites in New Zealand, even those considered pristine can be expected to breach the guidelines at least once over a ten year period due to environmental factors such as high rainfall or high river flows or the influence of feral animals. Therefore we need to also examine the proportions of compliance with our standards and guidelines to examine the quality of our freshwater for recreation.

Compliance with our Water Plan standards ranged from being very good to very poor over 1999-2009 (Figure 4). Four very good bathing sites complied in over 90% of samples and three sites complied in fewer than 25% of samples. The other three sites' compliance ranged from 38% to 52%.

The freshwater bathing sites' compliance with the national freshwater bathing guideline 'action' mode level of 550 *E. coli* per 100ml is much better over the same ten years (Figure 4). Four sites complied in over 90% of samples, five sites complied in between 90 to 75% of samples and one site (Mataura River at Gore) complied in 62% of samples.

We are not certain about the relative contribution of different sources of the faecal contamination (i.e. human, livestock or feral animals) at our freshwater bathing sites. We consequently are unable to report on the level of human faecal contamination, which is an important component of the manawhenua standards.


N. Watson

[6] 1 December to 31 March.

[7] The Mataura River at Riversdale site is excluded because monitoring here only started in summer 2008/09.

Table 3: Faecal contamination of freshwater bathing sites in Southland – median values, the number of breaches of national guidelines, and the relationship with rainfall and river flow

Bathing site	Current 'state' 2008/09			Whole data set 1999–2009			
	Median *E. coli* per 100ml	Breaches of national guideline (550 *E. coli* per 100ml)	Percent of breaches associated with rainfall/high flow events	Median *E.coli* per 100ml	Maximum *E.coli* per 100ml	Breaches of national guideline (550 *E. coli* per 100ml)	Percent breaches associated with rainfall/high flow events
Waiau at Tuatapere	97	2 out of 17	100%	120	10,000	26 out of 169	54%
Aparima River at Thornbury	189	2 out of 17	100%	275	37,000	40 out of 158	55%
Oreti River at Wallacetown	75	1 out of 18	100%	202	10,000	34 out of 146	55%
Oreti River at Winton Bridge	80	2 out of 18	50%	150	16,000	34 out of 152	23%
Mataura River at Gore	243	4 out of 17	0%	405	130,000	60 out of 158	27%
Mataura River at Riversdale	148	1 out of 16	nd	nd	nd	nd	nd
Waikaia River at Waikaia	309	5 out of 18	40%	310	13,000	37 out of 148	43%
Waikaia above Piano Flat*	21	3 out of 12	66%	20	15,000	4 out of 111	75%
Mararoa at South Mavora Lake*	3	0 out of 12	0%	1	200	0 out of 132	0%
Lake Manapouri at Frazers Beach*	5	0 out of 9	0%	2	180	0 out of 112	0%
Lake Te Anau at Boat Harbour Beach*	1	0 out of 8	0%	1	670	1 out of 111	nd

nd no data

* sampled monthly over the whole year. All other sites are sampled weekly over summer (December to March)

Individual bathing sites

The Mataura River at Gore is one of Southland's worst bathing sites monitored, with the highest faecal bacteria median (405 *E. coli* per 100ml) and recorded level (130,000 *E. coli* per 100ml) over the last 10 years. In 2008/09 none of the national guideline breaches at this site were associated with high rainfall runoff or flow, and over the past 10 years only 27% of the breaches resulted from such events. This suggests the site has high levels of faecal contamination even during periods of low flow and stable weather without heavy rainfall. In terms of health, this poses the greatest risk to the public since that is when contact recreation is most likely.

The Waikaia River at Waikaia has the second highest median level of 310 *E. coli* per 100ml. Less than half of the national guideline breaches related to high rainfall or increased flows: 40% in 2008/09 and 43% over the last ten years. This suggests this site also has high background faecal contamination even during periods of low flow, settled weather and low rainfall. The site drains a developed catchment where farming has intensified, with increasing sheep, beef, deer and dairying stock density.

At Piano Flat we also monitor a site in the mid to upper Waikaia catchment, surrounded by native bush within a reserve. We would expect such a site to breach the national guidelines very rarely, so this site has been monitored only monthly rather than weekly. However, three breaches occurred over the 2008/09 season. The only other recorded breach within the last 10 years occurred

Figure 3: Annual water quality of all freshwater bathing sites (1 December to 31 March in the years 1999 to 2009) compared with the Water Plan standards and national bathing guideline thresholds.

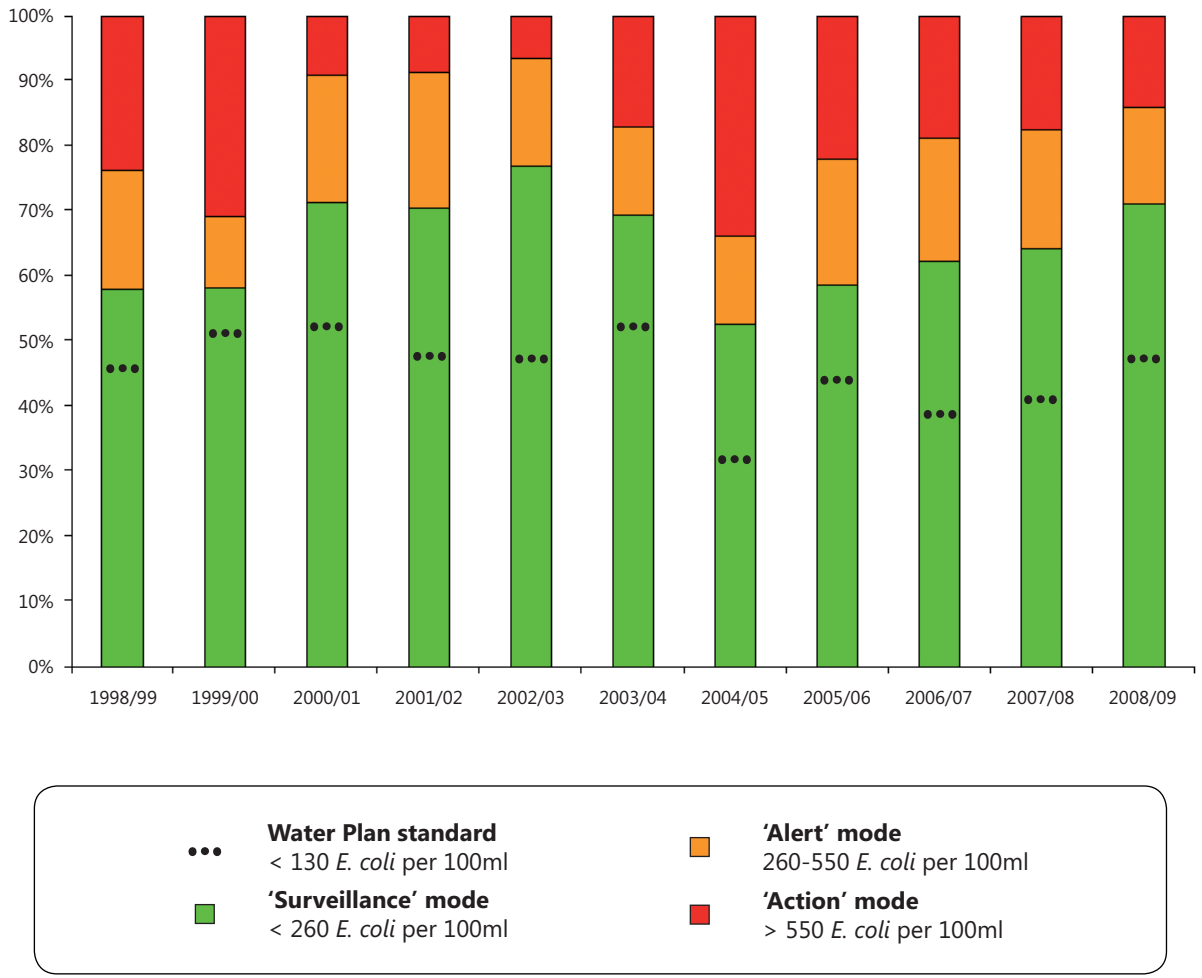
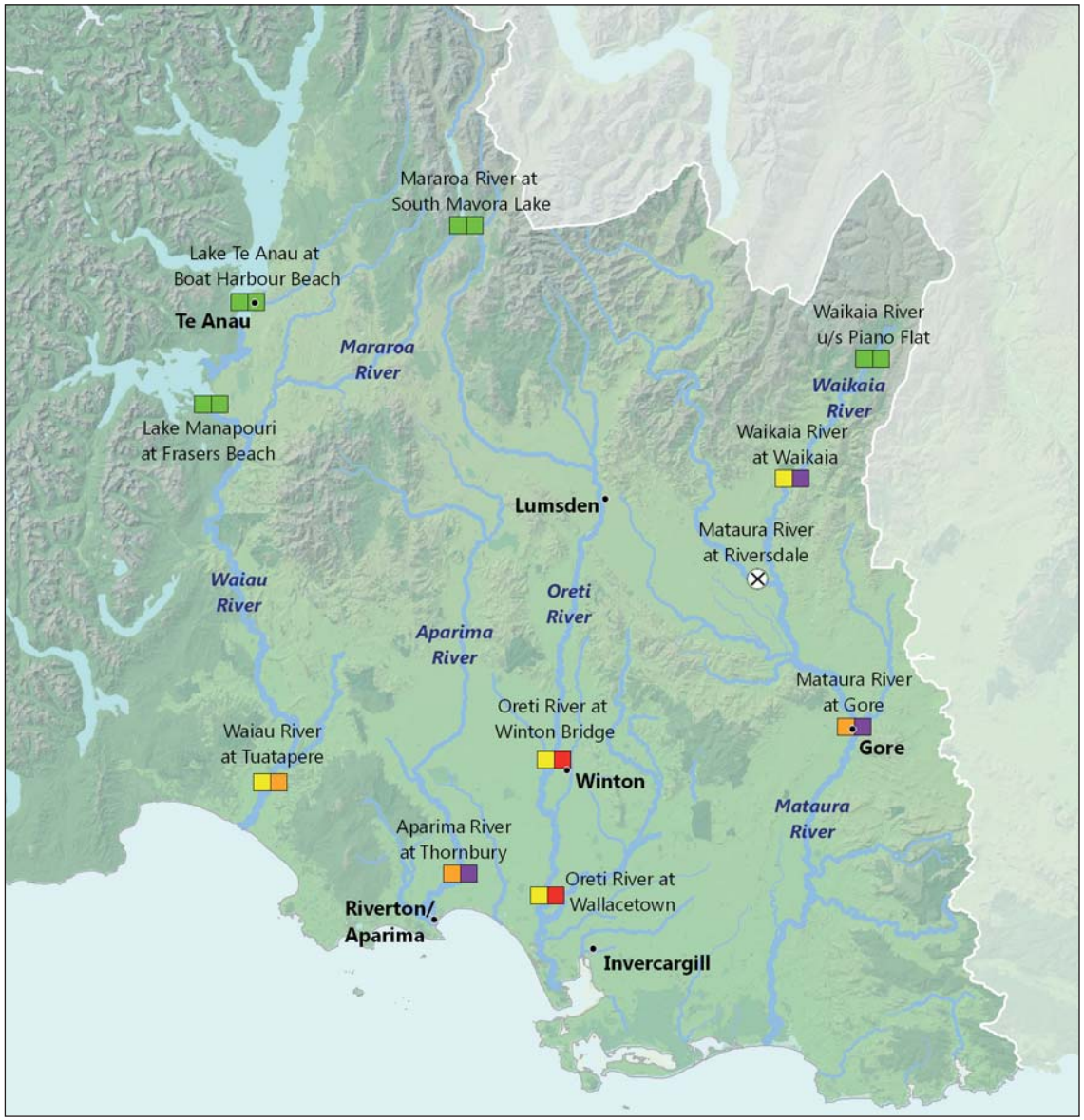
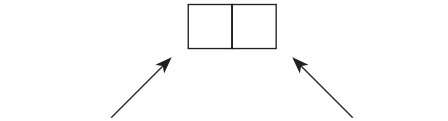


Figure 4: Southland freshwater bathing sites' compliance with the Water Plan standard and national guidelines from 1999 to 2009



Percentage compliance

	>90%	Very good
	75 to 90%	Good
	50 to 74%	Average
	26 to 49%	Poor
	<25%	Very poor
⊗	Not enough data	



in 2004. This indicates an emerging issue for this bathing site.

The lowland bathing sites of Aparima River at Thornbury, Oreti River at Wallacetown and Waiau River at Tuatapere showed similar patterns to each other in their breaches of the national guideline. In 2008/09 all breaches related to high rainfall and flow, while over the past 10 years just over half of the breaches related to such events. These sites are at the bottom of their respective catchments so there is more land upstream where faecal matter can come from.

For the Oreti River at Winton Bridge site, the two breaches in 2008/09 occurred in successive weeks when faecal bacteria levels were low at all other bathing sites. Offal pits have been identified as the likely source of bacterial contamination for this site at times when the river is low; however, further investigation is required to confirm the link between offal pits contaminating surface water and groundwater.

Is the quality of our freshwater changing at our bathing sites?

Our monitoring is sufficient to show trends in the *E. coli* bacterium concentrations over the summer bathing season at 10 of the 11 bathing monitored sites from 1999 to 2009. Records for the Mataura River at Riversdale only start in 2008/09.

Two out of 10 sites shows decreasing faecal bacteria concentrations over summer (the Oreti River at Wallacetown and the Mataura River at Gore).

One site (the Waikaia River at Waikaia) shows faecal bacteria concentrations over summer have increased.

Most freshwater bathing sites (70%) showed no detectable change in faecal contamination between summers.

The two improving sites still breach Water Plan standards and national bathing guidelines (Table 3 and Figure 4), with the Mataura River at Gore still having the highest frequency of breaches of all the freshwater bathing sites. Similarly, while these results highlight some improvements in summer *E. coli* concentrations over time, the majority of sites show no change at all, and the lowland sites, such as Aparima River at Thornbury consistently breach the Water Plan standard (Figure 4).

How do we compare nationally?

Comparison with national freshwater bathing reporting is problematic, because Regional Councils have different sampling regimes and considerable variation in the types and numbers of sites sampled. For example Environment Southland samples in predominately rural areas in all conditions regardless of rainfall and flow conditions, but some other regional councils do not sample for several days after significant rainfall, and will include urban sites. Therefore we have chosen not to compare our results nationally.

Southland-wide freshwater faecal bacteria contamination (regional monitoring)

We conduct monthly tests all year round for faecal coliforms (six different bacteria) at 71 representative river sites across Southland. The results provide a regional picture of faecal bacteria contamination and can be compared against the standards set within the Water Plan.

In 2008/09 all but one water body class breached the relevant Water Plan standard at least once. The exception was 'mountain lakes and wetlands' with the Mararoa River at South Mavora Lake the only site monitored within this class. Between 1994 and 2009, the standards have been breached in all water body classes we monitor[8] (Table 4). Overall, the classes 'hill' and 'mountain lakes and wetlands' are more likely to meet the water quality standards than the other classes.

In 2008/09 the compliance of the surface water quality sites with their relevant Water Plan standard ranged from Very Good to Poor, with the majority of sites (42%) being scored as Average, Very Good (26%) and Good (20%) (Figure 5).

Want more detail on the results of a particular site?

Visit: http://www.es.govt.nz/environment/reporting/state-of-the-environment/water-2010.aspx

[8] Note: currently there is no monitoring that corresponds with the Water Plan faecal bacteria standards in four water body classes.

Table 4: Microbial water quality of Southland surface water bodies (1994 – 2009)

Water Body Classification (number of sites in classification)	Water Plan standard faecal bacteria per 100ml	Current 'state' 2008/09	Whole data set (13/09/1994 to 11/06/2009)			
		Percent breaches Water Plan standard	Percent breaches Water Plan standard	Median faecal bacteria per 100ml	Maximum faecal bacteria per 100ml	Number of samples
Natural state (2)	–	–	–	47	7,700	215
Lowland soft bed (13)	1,000 FC	41.7%	34.0%	590	200,000	1,310
Lowland hard bed (18)	1,000 FC	39.8%	33.0%	450	130,000	1,985
Hill (10)	1,000 FC	7.5%	5.0%	63	32,000	1,257
Spring fed (1)	1,000 FC	25.0%	24.0%	405	12,000	96
Lowland/ coastal lakes & wetlands (4)*	1,000 FC	nd	nd	nd	nd	nd
Mataura 1 (0)	2,000 FC	nd	nd	nd	nd	nd
Mataura 2 (1)	200 FC	50.0%	60.5%	290	19,000	119
Mataura 3 (22)	1,000 FC	25.5%	20.4%	290	130,000	2,043
Mountain (0)	130 *E. coli*	nd	nd	nd	nd	nd
Lake fed (3)	130 *E. coli*	22.2%	26.1%	54	12,000	348
Hill lakes and wetlands (0)	130 *E. coli*	nd	nd	nd	nd	nd
Mountain lakes and wetlands (1)	130 *E. coli*	0.0%	0.7%	1	200	134

- not applicable
FC Faecal coliforms
nd no data
* Case study: Waituna Lagoon - faecal bacteria levels and changes over time (pg 26)

Is the quality of our recreational freshwater changing across the region?

Our monitoring is sufficient to show trends in faecal coliforms concentrations for 64 of the 71 sites we monitor across Southland.

Two sites (the Mokoreta River at Wyndham River Road and the Mokotua Stream at Awarua) show a strong increase in faecal bacteria concentrations over the periods they have been monitored (6 and 8 years respectively). Eleven sites (17%) show a strong decrease in faecal bacteria concentrations. The majority of the sites (51, or 80%) show no detectable change in faecal bacteria concentrations (Figure 6).

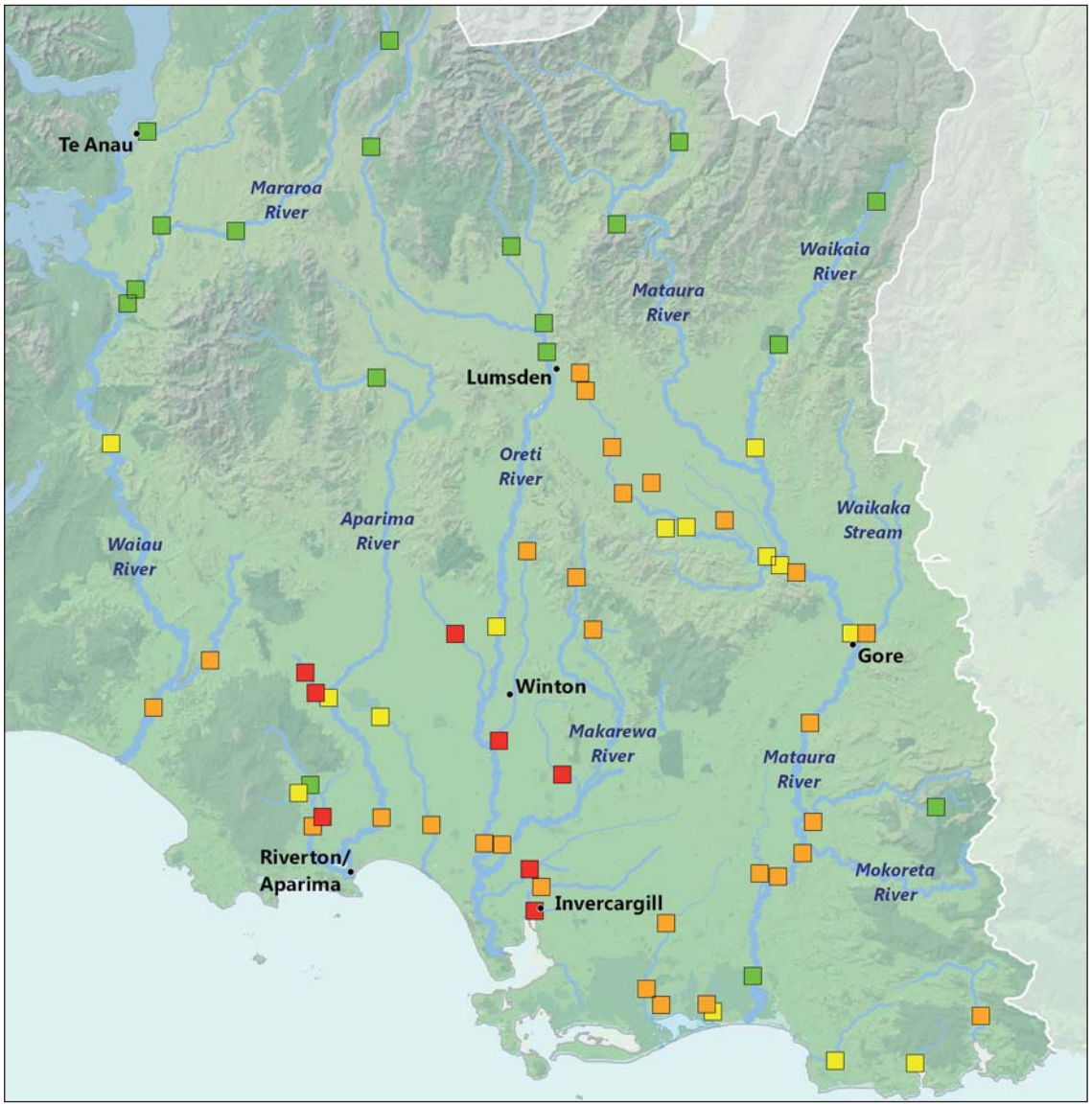
The deteriorating trend in the Mokoreta River at Wyndham River Road highlights a potential issue and further investigation of the sources of the contamination is therefore a high priority for Environment Southland.

The Mokotua Stream at Awarua site rarely breaches the national bathing guidelines, with no breaches in 2008/09 and only one over the entire data record of 7 years and 11 months. However as this is a 'natural state' site any decline in quality is still a breach of the Water Plan standard. Further investigation will be carried out to determine the causes of deterioration in water quality at this site.

Figure 5: Compliance of with the Water Plan water quality standards at Southland surface water sites in 2008/09

Percentage compliance of relevant Water Plan Standards

	>90%	Very Good
	75 to 90%	Good
	50 to 74%	Average
	26 to 49%	Poor
	<25%	Very Poor



Note: Natural state waters and Waituna Lagoon results are absent from this figure, as they do not easily correspond to the measure used. Natural state waters have no numerical standard for bacterial counts, while Waituna Lagoon monitoring is reported to a different standard than the rest of its Water Plan class as a wetland of international importance - Case study: Waituna Lagoon - faecal bacteria levels and changes over time (pg 26).

Case study: Freshwater quality and impacts on our marine bathing sites

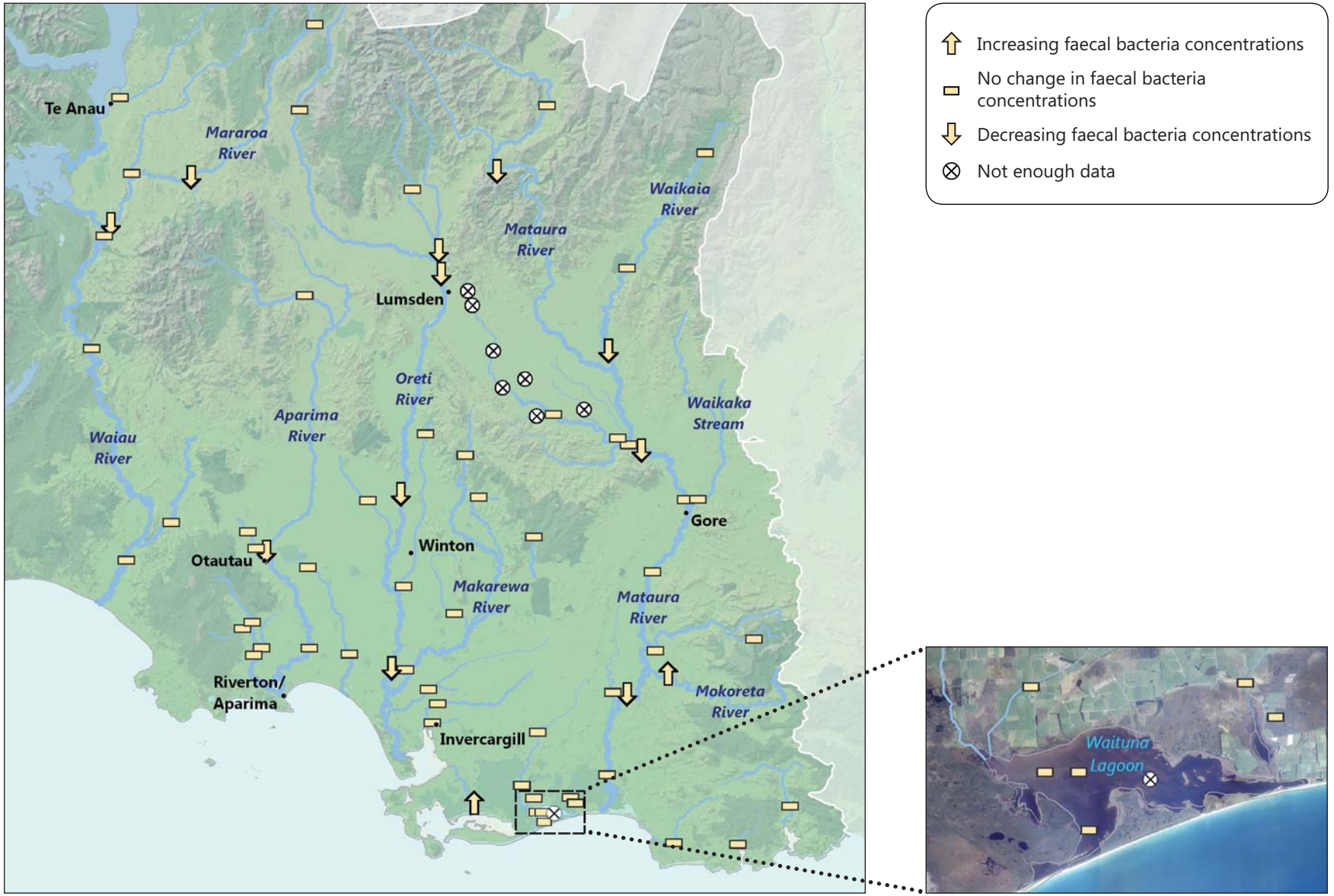
We monitor 13 marine bathing sites over summer (1 December – 31 March) for the faecal bacteria enterococci. The national marine bathing guidelines indicate that levels above 280 enterococci per 100ml pose an increased health risk for bathers.

In 2008/09 only three breaches of the national bathing standard out of 197 samples were recorded at the monitored sites. All three, Bluff Harbour at Morrison Beach, Monkey Island at Frentz Road, and Riverton Rocks at Mitchells Bay, were recorded immediately following high rainfall.

Over the entire period from 1995 to 2009, three sites did not breach the national marine bathing guideline: Awarua Bay, Oreti Beach at Dunns Road and Porpoise Bay at the camping ground. Breaches at the other ten sites have been less than 10% of all the samples (in the 10 years to 2009), with most of those equal or below 4% of all samples.

The more frequent breaches were recorded at three sites with strong freshwater influences: New River Estuary at the water ski club (8.3% of all samples over the 10 years), Jacobs River Estuary at Railway Bridge (5.9%), and Monkey Island at Frentz Road (5.3%).

Figure 6: Changes in Southland freshwater faecal bacteria contamination concentrations for 1994 to 2009[9]



[9] Length of the data period varies depending on the monitoring site. The smallest data period analysed was 5 years and 11 months and the largest was 14 years and 9 months.

Case study: Waituna Lagoon – faecal bacteria levels and changes over time

Waituna Lagoon and its associated wetland are designated as a wetland of international importance under the 1976 Ramsar convention. As such, we give it special attention, including more intensive water quality monitoring, at four separate sites.

The danger in including four sets of data for one lagoon is that the results for its overall class of 'Lowland/coastal lakes and wetlands' could be skewed. To avoid this, we report faecal bacteria concentrations in Waituna Lagoon separately.

We have monitored faecal bacteria concentrations in the Lagoon monthly since 2003. *E. coli* is used as the indicator for faecal bacteria, whereas faecal coliforms are used as the indicator for the other water bodies in the 'Lowland/coastal lakes and wetlands' class. Waituna Lagoon sites therefore cannot therefore be reported against the Water Plan standard; however, all Lagoon sites did comply with the national bathing guidelines 'action' mode in 2008/09. The highest *E. coli* concentrations in 2008/09 were recorded at the 'west' site of the lagoon: which had a median of 31 *E. coli* per 100ml and a maximum value of 305 *E. coli* per 100ml.

Our monitoring is sufficient to demonstrate trends in faecal bacteria concentrations for three out of the four sites. All three sites showed no detectable change in faecal contamination from 2003 to 2009. There is not enough data to show a trend for the 'east' site. These results must, however, be treated with caution, as the lagoon is periodically open to the sea, meaning that water quality will be influenced by incoming coastal water. Once sufficient data is available faecal bacteria trends will be reported on separately for times when the lagoon is opened and when it is closed.

Case study: Cyanobacteria in Southland Rivers

Cyanobacteria, sometimes called blue-green algae (even though they are actually bacteria), can be seen when they form large unattractive brown, green or black mats on river beds. Cyanobacteria can produce toxins (called cyanotoxins) that are harmful to animals and humans when eaten, even licked, or when water containing the toxins is swallowed. Some people will have an allergic reaction to just touching these mats. These forms of cyanobacteria usually grow when there are stable, low river flows and are therefore more abundant in summer – when people are more likely to come into contact with the water.

Toxic cyanobacteria are now known to be widespread in New Zealand water bodies. Cyanobacteria are widespread in Southland, being present in 96% of monitored sites in 2009. Scientists do not know what stimulates cyanobacteria growth, or the production of toxin.

Southland's most common cyanobacteria species are Phormidium, which is known to produce neurotoxins (anatoxin-a and homoanatoxin-a) linked to reported dog and stock deaths in 1999/2000 in Southland. Since then there have been no confirmed cases of cyanobacteria-related animal deaths. Other cyanotoxins found in Southland rivers are hepatotoxins, such as microcystin, which can cause liver damage to humans.

In summer 2008/09 the Waikaia, Mataura, and the Oreti Rivers were found to contain Phormidium species producing medium-to-high concentrations of anatoxin-a. Further monitoring was carried out at five sites during summer 2010. The resulting samples are awaiting toxin analysis, and the results will help Environment Southland to understand how and why cyanobacteria toxin production fluctuates over summer. A report on these results is due in late 2010 – available from Environment Southland.

National guidelines for cyanobacteria in recreational waters have recently been developed. In 2010 two of the five sites monitored for cyanobacteria over summer reached the 'alert' mode (20-50% cover of the river bed).

Not enough is known about when and why cyanotoxins are produced, so a precautionary approach is recommended: people, dogs and stock should avoid drinking river water in summer, and should avoid touching, licking or eating the cyanobacteria mats.

Is it safe to drink our water?

Introduction

Access to good quality drinking water is essential for our everyday lives, our businesses, our community and culture.

One of the reasons Environment Southland monitors water quality is to ensure that water is safe to drink. While it is difficult to put exact figures on how frequently people become sick from contaminated water, it is a known health risk to the community.

Health risks associated with drinking contaminated water in Southland's larger urban centres are managed by Invercargill City and Southland District Councils by treating water before it is piped into homes. However, many small community and individual household supplies, particularly in rural areas, do not have these safeguards in place. It is estimated about one third of Southland's population use groundwater in this way for their domestic drinking supplies. Other users of groundwater such as dairy sheds and industrial plants also require a reliable supply up to potable/drinkable quality. Groundwater is also widely used to supply livestock with drinking water.

Our drinking water reporting focuses mostly on groundwater supplies. We report against the Drinking Water Standard for New Zealand (DWSNZ).

There is also some reporting of the quality of surface water in relation to its suitability for stock, but it is rarely used for human consumption without treatment.

We do not monitor or report on the quality of rainwater supplies used for drinking, eg rainwater collection tanks. While it is recognised that the water quality issues associated with rainwater supplies can be significant, as these do not occur as a result of land use practices they are the responsibility of individual property owners. The quality issues of these supplies are managed by individual users, regulated by the building code, and typically reflect localised factors such as system setup and maintenance.

The causes of poor water quality, and what we are doing about them, are outlined in later sections of the report.

Our management targets

The Water Plan sets two main targets for groundwater quality in terms of 'potable (drinkable) supply':

a) that water quality is maintained or enhanced in aquifers that already meet DWSNZ; and

b) that aquifers degraded by land use and discharge activities will have their quality enhanced so that they meet the Drinking Water Standards in future (with the exception of those aquifers where ambient water quality is naturally less than the Drinking Water Standard).

For surface water, the Water Plan target is that all surface water bodies in the region be suitable for stock drinking.

Policies within Te Tangi a Tauira strive for the highest possible standard of water quality that is naturally characteristic of a particular place and/or waterway. This means the manawhenua target is that drinking water quality is maintained in waters that have historically been used as a source of drinking water, as well as those currently used.

The standards we use

The Water Plan specifies that the DWSNZ published by the Ministry of Health are used as the main criteria for assessing the suitability of groundwater for human consumption. These standards outline Maximum Acceptable Values (MAV) for a wide range of potential contaminants. Drinking water with contaminants above those values is considered to be a significant risk to human health (Table 5). Faecal contamination is measured against the DWSNZ in terms of a single indicator bacterium, *E. coli*, as an indicator of the risk of a whole range of bacteria and viruses which could be present in contaminated water supplies.

For nitrate we also report on concentrations as percentages of the MAV, as a way of illustrating how many sites are close to being 'unsafe'.

The DWSNZ also outline aesthetic guideline values (Table 5). These values are not directly related to human health but indicate thresholds above which there can be negative effects on water quality in terms of taste, odour, palatability, corrosion etc.

In terms of suitability of surface water for stock drinking water, the Water Plan sets the maximum limit for faecal contamination at 1000 faecal coliforms per 100ml for most sites. This is based on the guidelines established for stock drinking water by ANZECC[10] in 1992.

Table 5: Human drinking water standards and aesthetic water quality standards (DWSNZ 2008)

Parameters reported	Drinking water quality standards MAVs	Aesthetic water quality guideline values
E. coli	<1 per 100ml	
Nitrate (Nitrate-Nitrogen)	11.3 mg per L	
Manganese	0.4 mg per L	0.04 mg per L
pH		7.0 - 8.5
Chloride		250 mg per L
Total Hardness		200 mg per L
Sulphate		250 mg per L
Sodium		200 mg per L
Iron		0.2 mg per L

The importance of groundwater in Southland

In Southland, our drinking water comes from three different sources: rainfall, surface water and groundwater. The source we use depends on the availability and access to water where we live and work.

In Invercargill and Riverton, drinking water comes from the nearby Oreti and Aparima rivers respectively. These water supplies are treated before they are piped to end users.

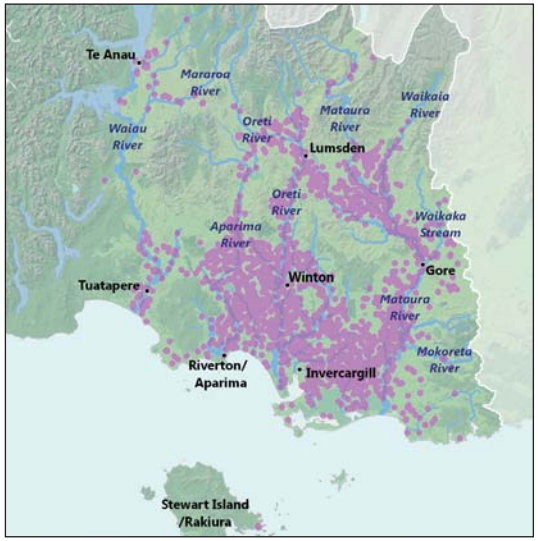
Almost all other major public reticulated supplies in Southland are sourced from groundwater[11]. These supplies service approximately 20,000 residents in Te Anau, Winton, Gore, Balfour-Lumsden, Mossburn, Tuatapere, Milford Sound, Edendale-Wyndham and Otautau. The Southland District Council is also proposing to develop a reticulated supply for Riversdale. Each supply has a differing level of treatment.

Outside of the piped water schemes developed for domestic supply, many rural properties rely on groundwater. We do not have exact figures for how many bores there are; however, mapping of all bores 'known to be used for potable supply' (over 2,000, Figure 7) shows that groundwater is extensively used for drinking across Southland.

[10] Australian and New Zealand Environment Conservation Council.

[11] The exceptions are a few schemes in the Waiau catchment, which have surface water sources, and Mataura, which uses two spring sources (of surface water).

Figure 7: Distribution of bores and wells used for domestic, municipal or stock supply recorded on the Environment Southland WELLS database, May 2010



Previous studies suggest over 50% of rural properties in the region use groundwater for domestic supply, with many also using groundwater for stock supplies. Because a large proportion of Southland's population is located in Invercargill, overall, we estimate about one third of Southland residents use groundwater for drinking.

Groundwater is also used to supply dairy sheds and industries with potable water. In 2010 there are approximately 670 resource consents for dairy farm supplies sourced from groundwater in the Southland region. Food processing facilities also use groundwater. The Fonterra Co-operative dairy plant at Edendale is the largest, using up to 13,000m^3 per day when at full production.

How groundwater can be compromised as a drinking water source

Human activities and natural interactions between rock and water both influence the safety of groundwater to drink. Groundwater can be compromised by factors including the presence of micro-organisms, nitrate and other chemical contaminants including organic compounds such as hydrocarbons and pesticides, and inorganic compounds such as metals.

Most groundwater in Southland is recharged by rainfall infiltrating from the surface. As water moves down through the soil, into an underlying aquifer, it can transport dissolved contaminants into the underlying groundwater. Most potable groundwater supplies come from unconfined aquifers less than 30 metres deep. As these aquifers are relatively shallow their quality and therefore suitability for drinking can be at risk from contamination from overlying land use activities.

Disease-causing micro-organisms, and elevated nitrate concentrations, are the main health risks associated with groundwater supplies from shallow aquifers. Contamination of drinking water supplies by micro-organisms (typically bacteria or viruses) can affect human and stock health. Nitrate is the dominant form of nitrogen in groundwater and elevated nitrate levels in drinking water supplies can cause ill-health in both animals and humans. In humans this mainly relates to a rare condition, methemoglobinemia or 'blue baby syndrome' in bottle-fed infants. It is also recommended that pregnant women and nursing mothers avoid drinking water with elevated nitrate concentrations.

Nitrate and bacteria concentrations can vary depending on a range of factors including climatic conditions and land activities. For example, heavy rainfall can increase contaminant concentrations especially in shallow bores or wells and water may become unsuitable as an untreated drinking water supply.

Due to their greater depth and associated higher drilling costs, confined aquifers are generally only used for potable supplies when unconfined aquifers or other water supplies are unavailable or unreliable. Groundwater in confined aquifers is partially sealed by low permeability sediments, which gives the aquifer a 'ceiling'. As such, groundwater quality in confined aquifers is generally isolated to some degree from adverse short-term effects associated with land use. However water quality in these aquifers may change in response to changes in water quality in overlying shallow unconfined aquifers which can eventually infiltrate through the low permeability layers over time.

Groundwater is also often influenced by the surrounding geology, which can result in elevated concentrations of certain ions, reducing the palatability of the water or making it unpleasant to use. The water can have an unpleasant smell or taste, hardness, and/or corrode pipes and stain baths and basins. In some cases concentrations of these naturally occurring substances may also be elevated above levels considered suitable for drinking water.

The quality of our freshwater for drinking

Groundwater monitoring

Table 6 summarises groundwater quality monitoring data, and illustrates how often in 2009 the relevant standards were breached at the sites Environment Southland test. These samples provide us with 'baseline data' to characterise how groundwater quality is changing over time and indicate the general level of compliance with the DWSNZ. Compliance is measured in two different ways: against Maximum Acceptable Values (MAV) of particular potential contaminants, and also against guideline values for aesthetic water quality.

Micro-organisms: The risk of disease-causing micro-organisms being present in groundwater is generally assessed by measuring levels of the indicator bacteria species *E. coli*. DWSNZ specifies that *E. coli* should not be present in water used for potable supply, to minimise the potential for adverse health effects.

In 2009 *E. coli* was found in 22% of sampled groundwater bores (Table 6). This frequent occurrence of faecal contamination represents a significant health risk as, in the short-term, it can result in acute impacts on human and animal health ranging in severity from mild stomach upsets to severe, potentially fatal illnesses. However, in most cases the faecal contamination is a localised issue which can be reduced by better protection of wellheads and better placement of wells (eg ensuring bores are located away from potential contamination sources such as septic tanks, offal pits, livestock etc). Although treatment of faecal contaminants is relatively simple and low-cost (eg UV filters), the preferred way to keep groundwater safe for drinking is to minimise the occurrence of these contaminants in groundwater used for drinking.

Table 6: Number of breaches of DWSNZ Maximum Acceptable Values (MAV) and aesthetic guidelines for baseline water quality sites sampled in 2009

Parameter measured	No. of sites sampled	Water quality standards	Aesthetic water quality guidelines
		% of sites breaching	% of sites breaching
E. coli	209	22%	
Nitrate-Nitrogen	314	7%	
Manganese	45	4%	20%
pH	45		84%
Chloride	45		0%
Total Hardness	38		2%
Sulphate	45		0%
Sodium	45		0%
Iron	45		11%

Nitrates: In 2009, approximately 7% of bores sampled exceeded the Maximum Acceptable Value (MAV) for nitrate, and 15% had concentrations greater than 75% MAV ie nearing the threshold of being unsafe. Sites with more than 75% of the MAV tend to be clustered around known nitrate 'hotspot' areas (Figure 8 and 11). Elsewhere, isolated nitrate concentrations exceeding the MAV are commonly associated with contamination resulting from poor wellhead protection, or the proximity of the bore to a specific contaminant source ie leaking effluent ponds and poorly maintained septic tank systems.

Treatment to remove nitrate from domestic water supplies is prohibitively expensive. The simple approach of boiling water can increase rather than decrease nitrate levels. If you are concerned about nitrate concentrations in your bore water we suggest you seek advice from either Public Health South or your medical professional.

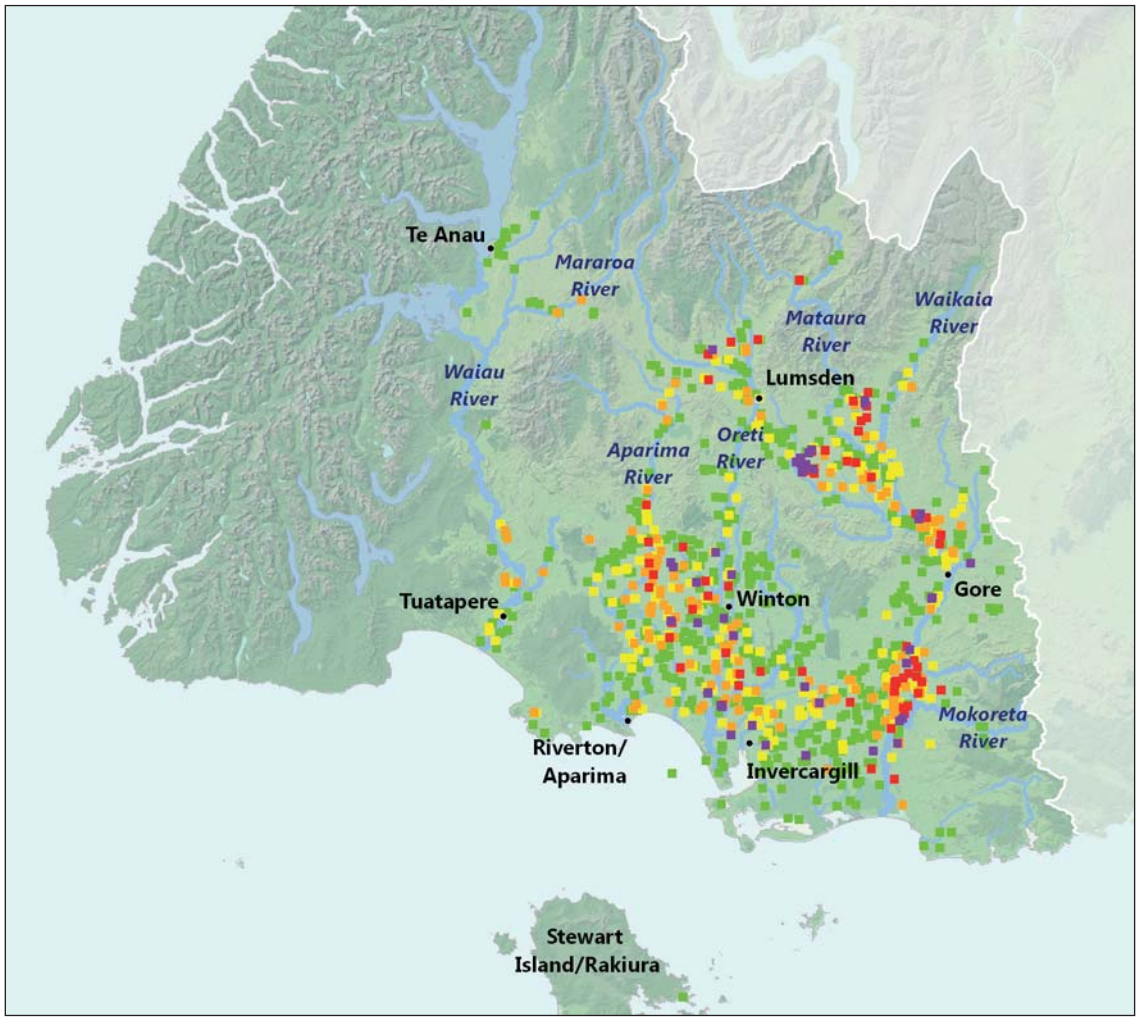
Groundwater nitrate levels may be elevated in areas where land use activities increase the amount of nitrate leached through the soil (Case study: Nitrate leaching risk pg 35). The significant change in land use in Southland over recent years raises concern about the associated increase in nitrate leaching to groundwater through such land use activities as urea fertilisers and cow urine patches. Intensification has the potential to increase groundwater nitrate concentrations which may affect its suitability for potable supply and the quality of surface water that is fed by groundwater.

Manganese: The results of the 2009 monitoring showed that naturally occurring manganese levels exceed the MAV at only 4% of the sites

which were sampled. In many cases, bores where manganese levels exceed the MAV are also affected by elevated iron concentrations. This combination of iron and manganese typically reduces aesthetic water quality to the point where these bores are seldom used for potable supply.

Other quality parameters: The limited data which is available tends to suggest that other factors which can affect the suitability of groundwater for potable supply, (such as pesticides, heavy metals and hydrocarbons) only occur in localised areas around specific contaminant sources and, in the case of pesticides, occur at concentrations well below levels of concern for health.

Figure 8: Median concentrations of groundwater nitrate compared to DWSNZ for 1999 to 2009



Is the quality of our drinking water changing?

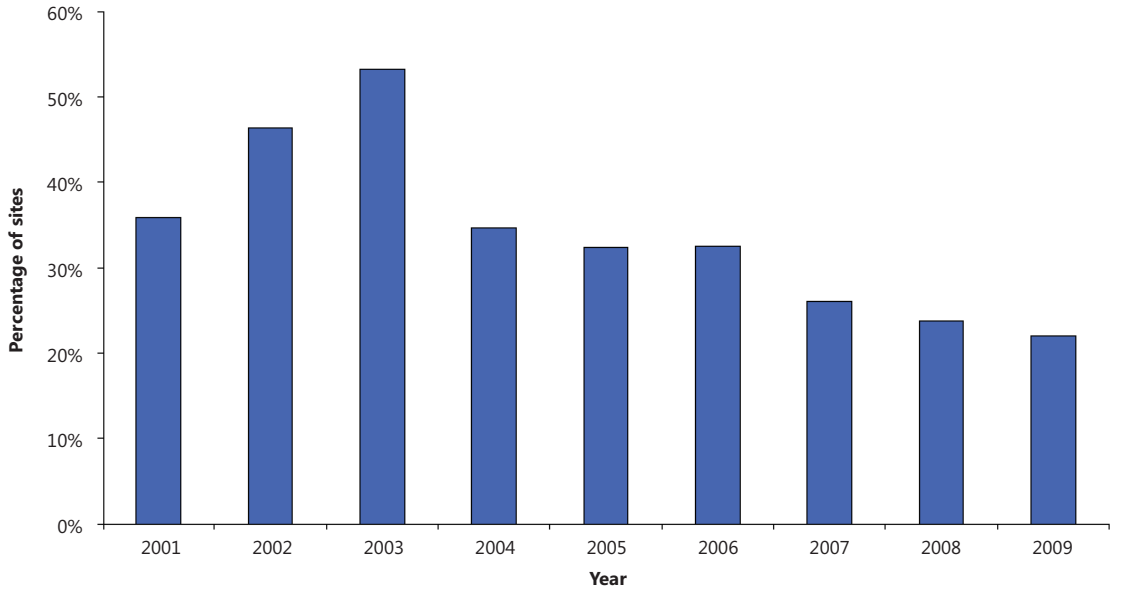
Monitoring indicates that more of our groundwater sources are free of *E. coli* than nine years ago. The percentage of groundwater sites breaching the drinking water standards for faecal contamination has reduced since 2001, dropping from 55% of sites sampled in 2003 to 22% in 2009 (Figure 9). The ongoing reduction is most likely the result of the increasing number of newly constructed bores that have good wellhead protection and access water from deeper levels of the aquifer. The improvement is assisted by Environment Southland's ongoing efforts to increase awareness among groundwater users of the need for good wellhead protection and bore maintenance.

Our region's faecal contamination results are on par with the rest of the country, judging by monitoring results reported for the whole of New Zealand by Geological and Nuclear Sciences (GNS) in 2009.[12] This report indicates that 23% of sites breached the DWSNZ for faecal contamination, out of a total of 701 groundwater monitoring sites sampled across New Zealand between 1995–2008.

We are also able to report on trends in nitrate concentrations in groundwater. This is based on 58 monitoring sites that have sufficient data to permit analysis of changes over time. Results of the trend analysis show 29 sites (50%) with no statistically significant change, while 21 sites (36%) show increasing nitrate concentrations, and 8 sites (14%) showed decreasing concentrations (Figure 10).

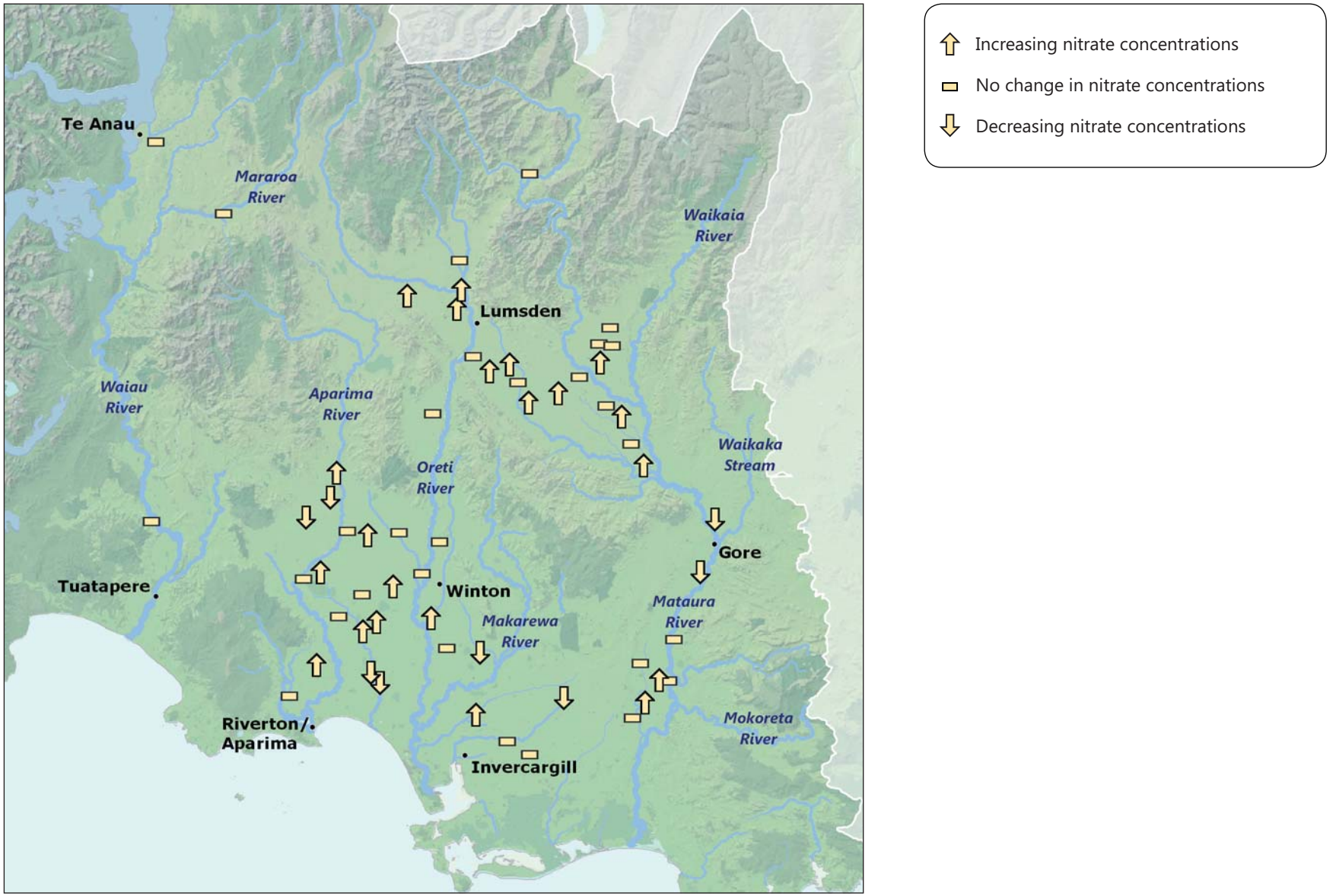
Overall, our region's figures for nitrate concentration in groundwater are high compared to other regions. The 2009 GNS report calculated the national median groundwater nitrate level from all sites at 1.7mg/L nitrate-N. The median level for Southland calculated in this report is higher, at 2.4mg/L nitrate-N, which puts Southland's groundwater nitrate concentrations higher than all other regions with the exceptions of Waikato and Canterbury. Analysis of results from all regional council state of the environment monitoring programmes in the GNS report also indicated that 20% of sites across New Zealand showed increasing nitrate concentrations and 12% showed a decreasing level. This suggests that the percentage of sites in Southland with increasing nitrate concentrations is almost twice the national average.

Figure 9: The percentage of monitoring bores in the Southland Region breaching the *E. coli* DWSNZ for 2001 to 2009



[12] GNS, 2009; National Groundwater Quality Indicators Update: State and Trend 1995-2008. GNS Science Consultancy Report 2009/145, September 2009.

Figure 10: Changes in groundwater nitrate concentrations over the whole data period (1 January 1998 to 31 December 2009)



Case study: Pesticides in groundwater

Trace concentrations of pesticide herbicide active ingredients were first detected in groundwater in the Edendale area in 1994, as part of a national survey of pesticides in groundwater led by Environmental Science and Research. Environment Southland has carried out semi-regular analysis of pesticide concentrations in groundwater in this area ever since.

In total, nine different herbicide active ingredients have been found. They include members of the triazine and uracil chemical groups, the characteristics of which (including persistence, and mobility in the subsurface environment) make them particularly likely to leach into groundwater. The main sources of contamination are thought to be horticultural operations and roadside spraying, with the widespread use of soak holes for local drainage providing a pathway for these compounds to bypass the soil zone (where they are typically broken down into less harmful compounds) and leach directly into groundwater.

The ingredients have not been detected at high concentrations, although they have been found over considerable distances from their likely source. The highest concentrations of the individual compounds range from 5% to 20% of MAV, while one particular compound was detected six kilometres down gradient of the potential source. Monitoring shows a gradual decline over time, with only 4 of the 8 compounds originally detected still present in 2009. This decline is thought to result from awareness among horticultural operators of potential effects on groundwater, and the discontinuation of some products containing individual active ingredients.

Overall, as the maximum concentration of the active ingredients detected was well below the MAV, the presence of these compounds was not considered to pose any significant risk to groundwater used for potable supply. However, their ongoing detection highlights the potential for chemical contaminants to leach from the land surface and be transported over relatively significant distances in underlying groundwater.

Limited monitoring of pesticides in groundwater has been undertaken across the rest of Southland. The limited data available indicates some specific instances of localised groundwater contamination, either due to spot spraying in the vicinity of individual wellheads or, in one case, backflow during the filling of a spray tank.

Individual bore owners are therefore advised to avoid the storage and/or use of agrichemicals in the vicinity of bores and wells, and to ensure suitable backflow prevention devices are installed where groundwater is used to fill spray tanks.

K. Yardena

Case study: Nitrate leaching risk

Nitrate accumulates in the soil zone from the natural breakdown of organic matter (including animal waste and human sewage) as well as the application of nitrate fertilisers to aid plant growth. Nitrate can leach through the soil into groundwater, where it can accumulate over time to high concentrations.

High nitrate concentrations can pose a risk to human health if the water is consumed. Elevated nitrate concentrations can also harm the ecology of surface waters by promoting aquatic plant growth (a process termed *eutrophication*), and may become toxic to aquatic life.

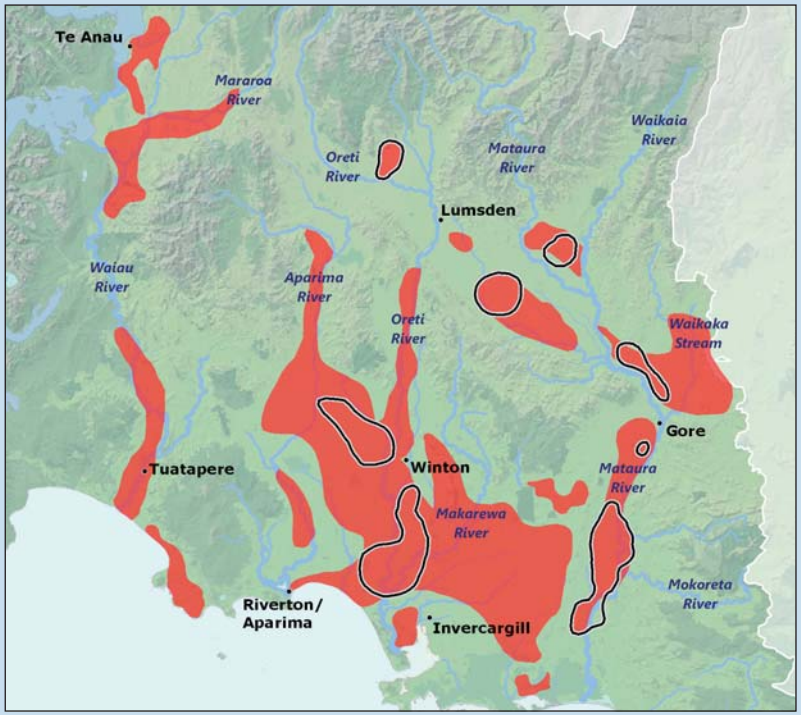
The amount of nitrate that leaches from soil into underlying groundwater can vary widely. It depends on factors including the intensity of land use (such as stocking rate and fertiliser application rates), the timing and nature of land management practices (eg soil cultivation, winter grazing), and the physical properties of the soil materials (eg water-holding capacity, drainage characteristics). In turn, the potential for nitrate concentrations to build up in underlying groundwater is influenced by the physical characteristics of the aquifer materials and how the aquifer is recharged.

Historical groundwater quality monitoring has identified several areas in Southland where groundwater nitrate concentrations are above the drinking water standard. These areas, commonly termed 'nitrate hotspots,' are generally restricted in area, and appear to reflect the cumulative effect of past and present land use.

In 2009, Environment Southland combined an assessment of groundwater quality data with an earlier assessment of the relative risk to groundwater quality associated with intensive land use. This identified areas 'most likely to exceed' the DWSNZ MAV for nitrate. The outcome of this process (Figure 11) highlights the areas of Southland at risk of groundwater nitrate concentrations exceeding drinking water standards.

The hotspots have average groundwater nitrate concentrations greater than 75% of the MAV, while the areas showing elevated risk are those considered most likely to have high nitrate concentrations in future. The map should only be used as a guide for average water quality in unconfined aquifers. Individual sites will vary depending on the bore depth, location, geology, aquifer properties and land use activities (past and present). This means that groundwater from a bore within an existing nitrate hotspot has a higher risk of having elevated nitrate concentrations than outside these areas. However, it does not mean that it will definitely have elevated nitrate concentrations. Conversely, groundwater from a bore outside a hotspot has a lower risk of having elevated nitrate concentrations but these may still occur.

Figure 11: Areas of elevated groundwater nitrate risk 2009



Case study: Heavy metals and hydrocarbons

Groundwater drinking supplies can be affected by a wide range of heavy metals and hydrocarbons, even when these are present in relatively low concentrations. Such contaminants can be found in groundwater as a result of historical land use, or where naturally occurring concentrations are elevated due to geological and geochemical conditions within an aquifer system. Many of these compounds are persistent in the environment, and can accumulate to relatively high concentrations in soil.

Heavy metals

Several sites in Southland have been identified as potentially contaminated by heavy metals, and these pose a health risk to humans through direct exposure to contaminated soil or through contamination of the underlying groundwater. These include historical industrial sites where material containing heavy metals was discharged to the ground. In many cases the possible presence of these contaminants is recorded on the property title, with local authorities requiring specific investigations and remedial works to be carried out to minimise risks to public health.

The most likely sites for heavy metal (as well as organochlorine pesticide) groundwater contamination in Southland are in rural areas at historical sheep dips, where chemicals including arsenic, copper and zinc, lindane and dieldren were used to treat external parasites and footrot between the 1870's and the early 1980's. Dipping of sheep via plunge or swim-through baths (or more lately spray dipping) allowed excess chemicals to drain from the sheep on to the surrounding ground, where concentrations of heavy metals and associated compounds could accumulate in the soil.

In 2006 the Ministry for the Environment estimated there were approximately 50,000 historical sheep dip sites across New Zealand. While exact numbers are uncertain, given the historical extent of sheep farming in the region it is likely a significant number are located within Southland. Due to the way in which heavy metals and organochlorine compounds bind to the soil, it is generally considered that the level of risk to groundwater quality posed by historical sheep dip sites is limited, unless the soil is disturbed. However, property owners are advised to avoid siting bores used for potable or stock supply near the known location of sheep dips, particularly large-scale communal dips typically located near former railway sidings or near stock yards which were in use before the 1980s.

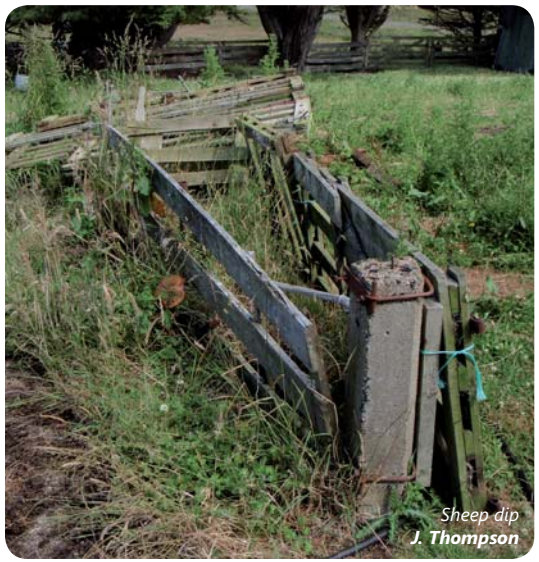
Hydrocarbons

There have been some cases of groundwater contaminated by hydrocarbons in the region. These documented occurrences have typically been associated with leaks from underground storage tanks or associated pipe work from disused petrol stations. Investigations of these incidents typically show that the overall extent of contamination was relatively localised, with little or no impact on potable water supplies. Remedial measures were undertaken at some sites to remove and/or treat contaminated soil and groundwater. In recent years the oil industry has undertaken significant steps to manage the risk of hydrocarbon contamination by upgrading storage facilities and containment measures.

Surface water monitoring

Our 2008/09 monthly monitoring of surface water at 71 sites shows that faecal contamination is common, with only one site at South Mavora Lake never testing positive for *E. coli*. However, as surface water supplies are treated before being supplied for human drinking water in Southland, we do not report these against the drinking water standards.

There is reason for concern about stock drinking water taken from surface water supplies. In 2008/2009, samples from 90% of our surface water sites (64 of 71) breached the faecal coliforms standard for stock water supplies in the Water Plan (1000 faecal coliforms per 100ml, as in ANZECC 1992) on one or more occasions. Twelve sites (17%) breached the standard in more than half the samples taken. This poses a risk to the health and productivity of livestock.



Sheep dip
J. Thompson

Is it safe to gather and consume kai from our waters?

> *"From a cultural perspective, a major value of waterways is their ability to provide for mahinga kai. In this respect, the recreational standard is insufficient to protect the values of tangata whenua, as the expectation is that water should be clean enough to eat from, not just swim in."*
>
> — ***Craig Pauling, Te Waipounamu Freshwater Report 2007***

Introduction

In Southland being able to gather foods directly from our land, rivers, lakes and coast is part of our lifestyle and identity.

Mahinga kai (gathering of food and resources) is a culturally defining activity for Ngāi Tahu, and connects manawhenua with their ancestors, awa (rivers), whenua (land), takutai (coast), and future generations. The collection and processing involved in mahinga kai is an important activity that contributes to the overall wellbeing of Māori.

Non-Māori Southlanders also have important traditions associated with gathering food from the waterways, with generation after generation going to the same area for the opening of the trout fishing and duck shooting season, and/or to established whitebait stands.

The water quality where we gather food is central to the safety of these traditions. However, to answer the question 'Is it safe to gather and then eat kai from Southland waters?' we need to know the detail of the various harvests, such as:

- what species are being harvested, from where, and when (during a specific season or all year round)?
- how is the food prepared to eat (is it cooked thoroughly or eaten raw, consumed whole or in parts)?
- how much is being eaten, and who is harvesting and consuming wild food (ethnicity and other demographics)?
- what, if any, health risks are there from consuming food from areas of poor water quality?

The preliminary results of the mahinga kai survey (carried out by Te Ao Mārama Incorporated) are reported here. However, this data is not sufficient to answer the overall question 'is it safe?' Instead, this report provides the information which is currently available and identifies where we need to increase our monitoring and analysis.

Faecal bacteria in water around eight shellfish gathering areas influenced by freshwater quality are also reported on. However, the food safety value of this information is limited.

Faecal bacteria from sewage have been linked to harvest sites for several species. However, this data doesn't show how much risk you actually face from harvesting, rather the overall condition of the sites.

Currently no information exists regarding the potential chemical contamination risks associated with eating food from our water.

The causes of contamination of waterways where we gather food, and what we are doing about them, are outlined in later sections of the report.

Our management targets

The Water Plan target is that the water quality of all surface water bodies in the region will be suitable for Ngāi Tahu cultural practices, including mahinga kai gathering. Another relevant target in the Water Plan is that the quality of our freshwater does not have an adverse effect on the quality of our coastal waters – and the implied meaning of this is that there will not be adverse effects on coastal species such as mussels and cockles.

Policies within Te Tangi a Tauira strive for the highest possible standard of water quality. This means the manawhenua target for water where mahinga kai is harvested is that it is safe to eat from, and that the water quality is capable of sustaining healthy mahinga kai.

The standards we use

There are no specific regional or national water quality standards or guidelines for freshwater food gathering or consumption. This section sets out the few that we currently apply; the limits of these measures are made clear in subsequent sections.

The general water quality standard in the Water Plan has some relevance as it is close to the national guideline for secondary contact recreation (ie sports fishing and boating etc). The Water Plan sets the maximum limit for faecal coliforms at 1,000 per 100ml for most sites, which is comparable to ANZECC and ARMCANZ 2000[13] thresholds for secondary contact recreation. This provides a useful standard for assessing if waters are safe for people gathering food, as long as the harvest method does not require you to put your head under (when you would be better to refer to the more stringent national bathing guidelines pg 17).

When assessing if the food is safe to eat, the only stated standard in the Water Plan is 'fish shall not be rendered unsuitable for human consumption by the presence of contaminants'. This standard applies to all water bodies except 'natural state' waters, which are within public conservation land and are largely unmodified or unaffected by human activities. Environment Southland, like most Regional Councils, currently does no monitoring in relation to potential contaminants in fish.

Manawhenua require standards that are higher than the Water Plan for cultural values. The waters should be clean enough to eat from. *Any* level of human sewage is culturally offensive and unacceptable for waters where kai is gathered. The current state of the environment monitoring programmes we have in Southland are unable to track the source of faecal contamination (ie human, animal or bird), so we are unable to report to this standard.

National microbiological water quality guidelines for sites where filter-feeding shellfish are gathered set maximum limits for faecal coliform counts over the year. A site complies with the guidelines if the water quality annual median is below 14 faecal coliforms per 100ml, and if fewer than 10% of the samples are above 43 faecal coliforms per 100ml.

Environment Southland tests for faecal coliforms monthly in eight areas where tuangi/cockles and kutai/mussels are gathered recreationally. Faecal coliforms have been monitored at the majority of these sites since 1995, so we can use this to track long-term trends.

However, the relationship between faecal contamination of freshwater and consequent faecal contamination of shellfish flesh is poorly understood. An investigation of shellfish at sites at Riverton/Aparima has shown that compliance with the water standard does not necessarily mean the shellfish are within guidelines for safe consumption.

No specific guideline exists for recreationally and customary gathered shellfish, however 230 faecal coliforms per 100g of flesh has been used as a historically accepted interim guideline. However, this differs from the recommended commercial guideline set by the New Zealand Food Safety Authority of 230 *E. coli* per 100g.

[13] Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand.

The quality of our water for gathering and consuming kai

Preliminary results from a 2010 Southland mahinga kai survey

In 2010, Te Ao Mārama Incorporated undertook a survey to determine what kai species were harvested from Southland waterways, the barriers to harvesting and any perceived health risks. Most of the 33 respondents identified themselves as Maori, with the rest a mix of New Zealand European and Pacific Islanders.

While the survey is small, it provides a guide to the species that are currently harvested from Southland waters (Table 7). Further survey work should expand the list of harvested species and the numbers of species that are known to be consumed raw (eg respondents did not identify that they ate tio/oysters raw, but many Southlanders say that it is the best way to consume them).

The majority (73%) of respondents totally agreed with the statement that 'gathering kai is important to me and my whānau/family'. The main barrier to gathering kai was because they perceived that 'the environment was degraded' (61% of respondents). The next most commonly reported barriers were they had 'no spare time – too busy' (42%) and 'the species I want are no longer present' (38%).

In terms of the health focus of this report, we compared mahinga kai species listed in Table 7 with potential health risk information contained in the 2005 New Zealand Food Safety Authority review of non-commercial wild foods. The review demonstrated a potential health risk associated with consuming raw watercress, and filter-feeding shellfish such as mussels and cockles, that have been taken from faecal contaminated waters.

Watercress was harvested by 62% of the respondents, with 35% stating they ate it raw. Faecal bacteria do not wash off watercress sufficiently to meet the New Zealand guideline for ready-to-eat (satisfactory level is less than 3 *E. coli* per gram), and therefore could present a health risk if the watercress came from faecal contaminated waterways.

Shellfish such as mussels and cockles filter water, retaining microscopic particles, including bacteria, and therefore can accumulate high concentrations of faecal bacteria and potential pathogens from the surrounding water.

The presence of metals or organic micro-contaminants such as pesticides, industrial and pharmaceutical chemicals in the flesh of filter feeding shellfish and fish (particularly bottom dwellers like pātiki/flounders) could potentially pose a health risk. Gathering foods in areas that receive urban stormwater should be exercised with caution.

Z. Moss

Table 7: Mahinga kai species gathered from Southland waterways

Coastal marine species		
Fish	**Invertebrates**	**Seaweeds**
blue cod*	**Shellfish**	karengo*
conger eel	clams	
greenbone	kutai/mussels*	
groper*	pāua*	
hapuka	pipi	
kahawai	tio/oysters	
ling	toheroa*	
moki*	tuaki/tuangi/cockles*	
mullet	tuatua	
pātiki/flounder*		
salmon	**Other**	
sardine/sprat	crayfish*	
shark	karahu (mudsnail)*	
star gazers	kina *	
trout	kuwharu (purple sunset shell)	
trumpeter	octopus	
Freshwater species		
Fish	**Invertebrates**	**Plants**
īnanga	waikōura/freshwater crayfish	watercress*
kanakana/lamprey		harakeke/flax, waihunga/harakeke sugar*
kōkopu		raupō
pātiki/flounder	**Birds and waterfowl**	
trout	duck	
tuna/eel	geese	
whitebait		

from preliminary mahinga kai survey results, June 2010
* indicated in survey that this was also eaten raw

Shellfish gathering sites' compliance with our guidelines

In 2008/09, five of eight monitored shellfish sites (62.5%) breached the national microbiological water quality guidelines for waters where filter-feeding shellfish are gathered recreationally (Table 8). Over the whole data record (1995–2009) only one site (Riverton Rocks at Mitchells Bay) has always complied with these guidelines.

While monitoring shows that there are times when the faecal contamination in these shellfish gathering areas is considered to be within safe limits, there are other issues to consider before we can report the shellfish as 'safe to eat'. In particular, the relationship between freshwater faecal contamination and contamination of shellfish flesh is poorly understood. The Riverton/Aparima shellfish study (pg 43) suggests that compliance with water quality guidelines as a way of assessing the health risks of eating shellfish needs to be viewed with caution.

Table 8: Faecal contamination levels in water at Southland shellfish gathering sites – median values and the breaches of the national shellfish gathering waters guidelines

Shellfish site	Current 'state' 2008/09		Whole data set 1995–2009	
	Median faecal coliforms per 100ml	National guideline breached?	Median 1995–2009	Percent breaches of national guidelines
Bluff Harbour at Ocean Beach	5	no	5	43
Colac Bay at Bungalow Hill Road	25	yes	77	93
Jacobs River Estuary downsteam of fish co-op	185	yes	160	100
Monkey Island at Frentz Road	9.5	no	17	64
New River Estuary at Mokomoko Inlet	95	yes	79	100
New River Estuary at Whalers Bay	20	yes	34	92
Riverton Rocks at Mitchells Bay	5	no	5	0
Toetoes Harbour at Fortrose	120	yes	109	100

Is the quality of the water changing at our recreational shellfish gathering sites?

Our monitoring is sufficient to show trends in faecal contamination for the time period 1995-2009 (Figure 12).

Of the eight monitored shellfish gathering sites, four show a decrease in faecal contamination in the waters surrounding the shellfish beds. These sites are New River Estuary at Whalers Bay, Bluff Harbour at Ocean Beach, Colac Bay at Bungalow Hill Road, and Monkey Island at Frentz Road.

The four remaining sites showed no detectable change in faecal contamination levels. This lack of change in itself is a concern, because three of these four sites (Jacobs River Estuary, Toetoes Harbour and New River Estuary at Mokomoko Inlet) have high median faecal bacteria levels, and a high level of non-compliance with the national guidelines. All three of these sites have strong linkages to the region's overall freshwater environment, with the three main catchments (Aparima, Mataura and Oreti Rivers) discharging to these sites.

Figure 12: Changes in faecal bacteria levels in shellfish gathering waters in Southland (over the period 1995 to 2009)[14]

[14] Length of the data period varies depending on the monitoring site. The smallest data period is for Jacobs River Estuary (2003-2009).

Case study: Riverton/Aparima shellfish study

Environment Southland and numerous regional councils throughout New Zealand monitor the water at shellfish gathering sites, to provide an indication of the relative safety of shellfish for consumption.

Environmental factors such as rainfall and river flows are known to impact on commercial mussel fisheries within New Zealand, but in Southland there is limited knowledge about pollution of our recreational cockle and mussel gathering areas. Most of the decision-making behind public health warnings is based on international literature and at best involves estimates of risks. The 2009/10 Riverton/Aparima shellfish investigation was a pilot for a larger Southland-wide study which aims to determine the environmental factors that would most likely result in high bacteria counts in shellfish during harvesting.

Both the cockle (tuangi, *Austrovenus stutchburyi*) and green lipped mussel (kutai, *Perna canaliculus*) beds at Riverton/Aparima are highly prized by iwi and the local community alike. However, concern has been raised about the condition and contamination of the beds as a result of intensive land use practices in the catchments upstream.

In the summer of 2009/10, Environment Southland investigated shellfish flesh and water faecal contamination at shellfish gathering sites at Riverton/Aparima. The summer was chosen as it was the time when most people would be gathering shellfish and/or bathing. The main aim of the study was to record faecal coliform levels in shellfish flesh and in the waters surrounding two shellfish gathering sites, one in Jacobs River Estuary (cockle) and another at Riverton Rocks (mussel). The measurements occurred during a range of river flows, rainfall and weather conditions.

The secondary aim of the study was to determine how much time needs to elapse before the shellfish and waters were free from faecal contamination.

The study found that:

1. Both cockle and mussel flesh contamination was strongly linked to the flows of the Aparima and Pourakino Rivers rather than to localised rainfall.

2. At the Jacobs River Estuary site, when river flow exceeded 20 cumecs, faecal bacteria levels in the water spiked first, followed by levels in cockle flesh the next day.

3. Mussel flesh contamination at the Riverton Rocks site had a longer time lag behind the river flow, due to the site being further down the river.

4. The maximum water contamination guideline set by the Ministry for the Environment is a median of 14 faecal coliform per 100ml of water. The Jacobs River Estuary site recorded a median of 70 faecal coliforms per 100ml and the Riverton Rocks of 1 faecal coliform per 100ml.

5. A recommended recreational harvest guideline for shellfish flesh is a maximum of 230 faecal coliforms per 100g. The Jacobs River Estuary site exceeded this guideline three sample days in a row. The Riverton Rocks site never exceeded this guideline, although it did come close on one occasion (Figure 13 and 14).

6. The historical cockle flesh data (1996–2003) for the Jacobs River Estuary site revealed that 85% of the samples were above the 230 faecal coliform per 100g harvest guideline.

7. Public health officials currently advise that shellfish should not be harvested less than two days after high flows or heavy rainfall. However, contamination clearance times after high river flows varied between the sites. The Jacobs River Estuary site took between five and six days to clear, whilst the Riverton Rocks site took approximately two to three days. The most likely reason for this is the Riverton Rocks site is exposed to marine water whereas the Jacob's River Estuary site is influenced by the river water for a longer period.

8. This investigation showed only a weak link between faecal contamination in the water and shellfish flesh.

What we need to do in the future:

1. Extend harvesting warnings out to 2-5 days after significant high flows in the Aparima and Pourakino Rivers.

2. Put information signage at likely points of entry to the harvesting areas.

3. Continue the Bathing Beach response group's awareness and education programme in Riverton/Aparima and other sites in Western Southland.

4. Repeat this investigation in the Toetoes Harbour, New River Estuary and Colac Bay over the next three years.

5. Broaden the scope of the testing to include viral and faecal source testing.

6. Consider monitoring faecal coliforms in flesh samples instead of faecal coliforms in the water.

Figure 13: Jacob River Estuary cockle gathering site

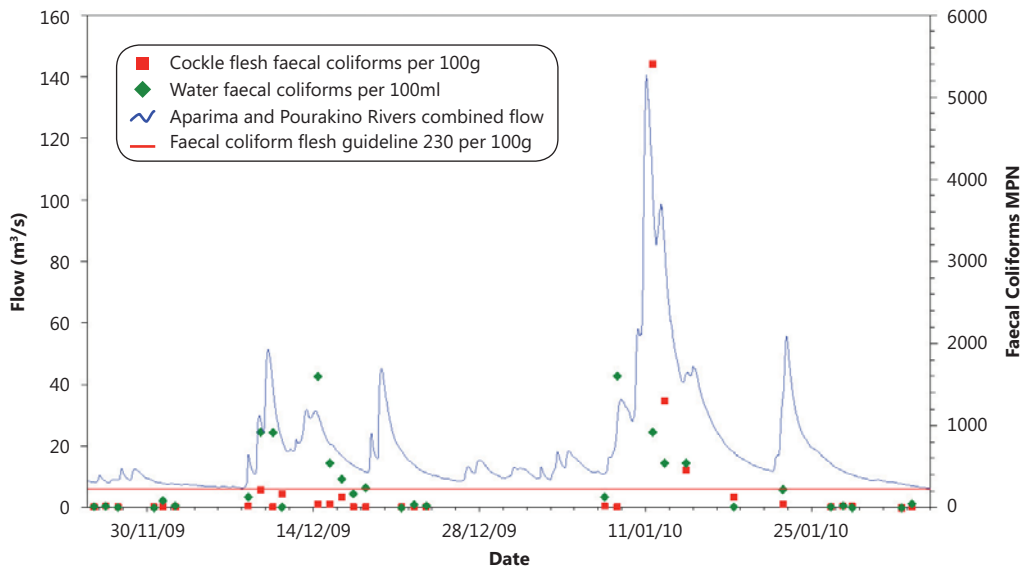
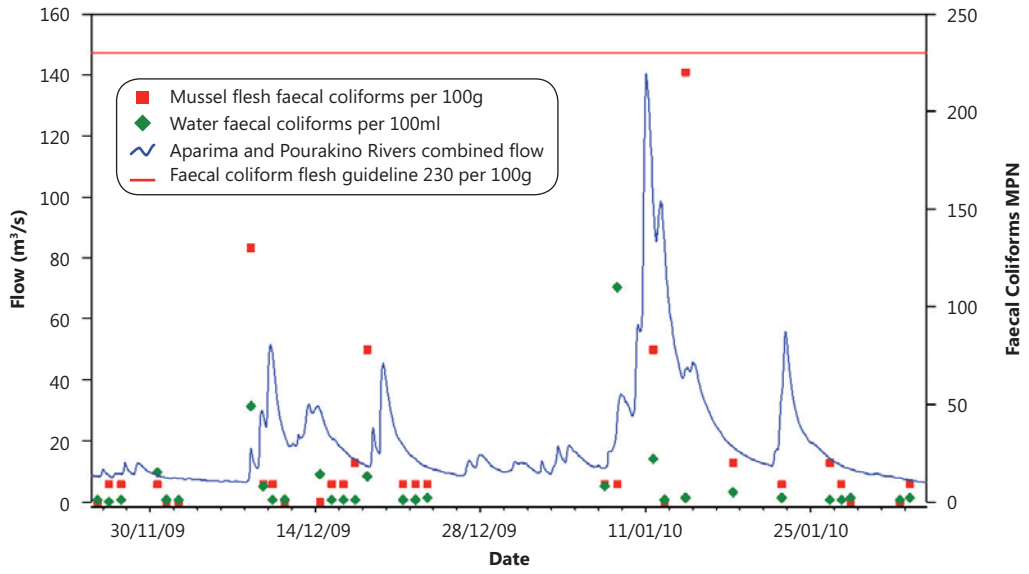


Figure 14: Riverton Rocks mussel gathering site



Faecal bacteria results in known freshwater harvest areas

This section presents median faecal coliform counts for freshwater sites monitored monthly across Southland, overlaid with the areas of two popular freshwater food gathering pursuits: whitebaiting and trout fishing.

Contact with contaminated water while gathering food presents a health risk. It is unknown if there is any risk from the consumption of the cooked flesh of these fish species.

Whitebaiting is concentrated in the tidal reaches of our rivers and streams and occurs from August through to November each year. Figure 15 shows known whitebait harvesting areas and the median faecal coliform levels during the season for the entire data period (1994–2009).

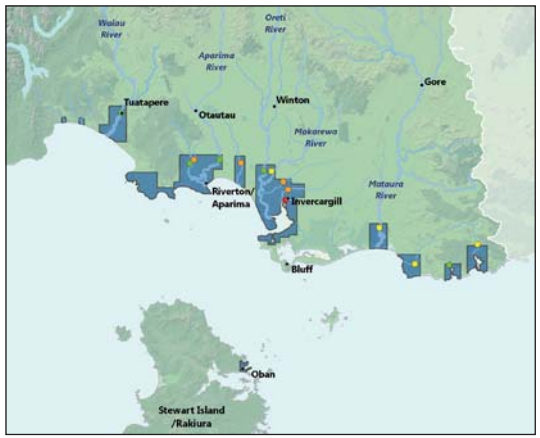
The Southland trout fishery is managed and regulated by the New Zealand Fish and Game Council - Southland Region, which conducts regular angler surveys to determine the level and extent of usage of the fishery. This fishery extends across the Southland region, and the length of season can extend for seven months to the whole year depending on the river, or stretch of river. Figure 16 shows the 2008/09 median faecal coliform levels of monitored sites, overlaid with the actual angler usage (measured as 'angler days').

Note that these figures can only indicate likely areas of increased risk to people who harvest and consume this wild food. We are unable

to accurately determine the level of risk of harvesting and consuming food from areas with high faecal bacteria levels, especially when food is cleaned and cooked prior to consumption. Further, we are currently not able to report against the manawhenua cultural standard of requiring no human faecal contamination in water where we gather kai, as our monitoring system does not analyse the source of faecal matter in the water.

We are therefore some time away from answering whether it is safe to gather and consume kai from our waters. The aim of presenting this limited information is instead to highlight potential risks, and reinforce the need to take precautions: particularly by washing hands after touching the water, and cleaning and cooking food appropriately. We definitely do not want you to stop using the waterways to gather your food – we just want you to be safe when you do so.

Figure 15: Southland whitebaiting areas (in blue) and median faecal coliforms per 100ml (over the period 1994 to 2009)



Median faecal coliforms (August to November) over the entire data period

- 1 - 250
- 250 - 500
- 500 - 1000
- 1000 +
- Whitebaiting Areas

Figure 16: Levels of trout angler usage (in 'angler days') and median 2008/09 faecal coliforms at monitored sites in Southland waterways

2008/09 Median faecal coliforms (per 100ml)

- 1 - 250
- 250 - 500
- 500 - 1000
- 1000 +

Trout/Angler Days 2007/08

- Less than 50 days
- 50-200 days
- 201-1000 days
- 1001-5000 days
- 5001-20000 days

Note: Angler usage data used with permission from New Zealand Fish and Game Council - Southland Region.

How do we affect our water quality?

Introduction

Many activities impact on water quality and the ability of our waterways to support human health. Intensive farming can cause micro-organisms or nutrients to move into streams and groundwater, while poorly managed human sewage can also affect people who contact or drink contaminated water. Other things impact on water quality as well, such as the contents of stormwater and solid waste from industry, farms and households. This section sets out the main connections between our use of the environment and its water resources in relation to health.

An important point to remember is the delay between cause and effect. Things we are doing now might not show up immediately in our water quality measurements. Groundwater quality is a good example. Overall, the region's aquifers have an average age of 30 to 40 years. However, age of the water is highly variable depending on the aquifer and bore depth. This means in some areas we are now only recording evidence of the impacts of historic land use practices, and the extent of impacts of more recent land use is yet to be fully realised. In the same way, monitoring surface water may not yet show the effect of recent changes to land use practices a long way upstream, such as hill country land development.

It is also important to note that public and community expectations have changed, with more and more people recognising how activities combine to affect the health of entire water bodies and the health of those who use them. Local iwi have noted the cultural shift that is taking place in the region.

> *"Developing environmental awareness has shifted the balance towards recognition of the natural environment's intrinsic value. This shift is consistent with Māori beliefs in regards to resource management, with the protection of mauri being a fundamental principle."*
>
> ***– Te Ao Mārama Incorporated. Submission on the Oreti Conservation Order. November 2006.***

In other words, the cultural values of New Zealand Europeans and iwi are becoming increasingly aligned. The concept of waterways being possessed of mauri (life essence) links closely to western understandings of waterways as complex living systems.

Water quality and human health

Agriculture

Agriculture is central to the Southland economy. As our region's economy has developed, pressure on waterways from agriculture has increased, and in some places reduced the mauri of water and the ability of waterways to support human health. Some agricultural activities have expanded in the past 10 years and with them the intensification of land use in the region (eg the expansion of dairying and associated winter grazing and land development activities). Contaminant losses from agricultural activities can be significantly affected by management practices and topography; some landscapes such as sloping land have a greater risk of contaminant losses than others.

Expansion of dairying

In recent years dairying in Southland has grown rapidly (Figure 17). As at 1 January 2010, there were over 800 dairy farms in the region covering 155,436 hectares.[15] Industry groups have indicated that further expansion is expected over the next few years.

Compared to most other farming systems, losses from nitrogen leaching on modern dairy farms is high, although the actual amounts vary considerably depending on soil, climate and management factors. Nitrogen losses from free-draining soils tend to be greater than from poorly drained soils.

Application of effluent from milking sheds to land can be a major source of faecal bacteria in waterways. Older style travelling irrigators

[15] 1554km^2.

applying effluent to soils with mole-tile drains on a daily basis are particularly problematic. Field studies and modelling assessments of farms in the Bog Burn catchment suggest that the irrigation of farm dairy effluent to pastures may account for approximately two-thirds of the faecal contamination generated on-farm.

Intensive winter grazing

Intensive winter grazing involves the use of areas to get stock through the Southland winter without damaging valuable pastures. Animals are normally fed forage crops and silage or baleage. Grazed winter forage crops have been identified as having relatively large nitrogen losses on a per hectare basis.

Intensive winter grazing requires a sequence of activities which can increase the risk of water contamination. These are:

a) spray off/plough in pasture (loss of nutrients from decaying plant material)

b) planting crops, when high rates of fertiliser may be used

c) grazing crop in winter (a combination of harvesting a vegetable crop and intensive rationing pasture access or 'break feeding' over winter)

d) leave pasture fallow until spring re-planting (remaining nutrients lost from topsoil)

All these activities can result in high losses of nitrogen to groundwater or surface water. Grazing the crop and leaving the ground bare in winter/spring can also cause overland flow of sediments, phosphorous and faecal material to surface water, particularly on soil types with limited drainage and/or those that are vulnerable to compaction. Wintering can potentially affect human health as nitrogen accumulates in groundwater and faecal material moves to surface water.

Stock access

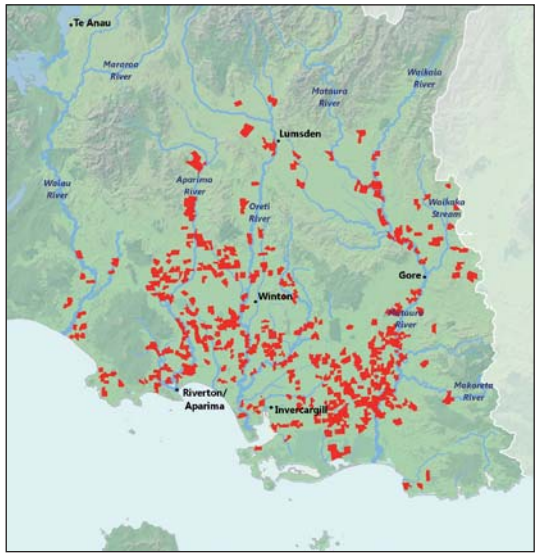
When stock, particularly cattle or deer, gain access to the beds of streams, lakes and rivers, negative environmental effects can result. Stock access to waterways can also cause erosion of stream banks resulting in sediment accumulating on stream beds, as well as discharging animal waste directly to water.

Research in 2004 showed that cows which have access to waterways are 50 times more likely to excrete directly into a river. The same study showed that while stock were in the water, concentrations of indicator microbes temporarily rose to 100 times normal levels and reached levels at least 50 times greater than the guidelines for contact recreation.

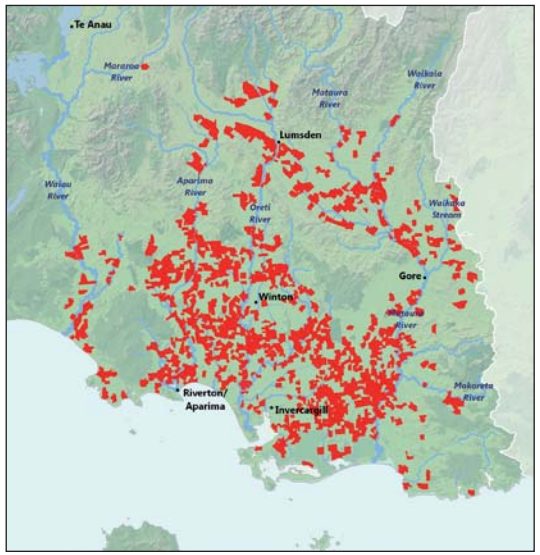
If deer have access to water, they will form mud baths (wallows). Studies show that very high levels of faecal contamination result when the wallows are linked to waterways (including groundwater). Any connection between deer wallows and surface water is of particular concern in summer when flows are low and people are more likely to be recreating.

Figure 17: The expansion of dairy farming in Southland

Dairy farm areas January 2000



Dairy farm areas January 2010



Land development

The transformation of land such as native grasses, scrub or wetlands into new pastures has always been a part of Southland agriculture. The high value of agricultural land in recent years has accelerated land development, particularly in areas such as wetlands and hill country that have previously been considered too costly to develop.

Poorly planned development in steep hill country can result in soil erosion and sediment loss. While there is no direct impact on human health, the health of entire river ecosystems can be affected, reducing their overall ability to support contact recreation, fish life, water supply and mahinga kai.

Other land use activities

Cropping systems may lose large amounts of nitrogen, although good management practices can greatly minimise these losses. Intensive horticulture operations such as bulb production or vegetable growing also have the potential to lose large amounts of nitrogen. However, there is limited scientific data available documenting contaminant loss from these operations.

Human wastewater

> *"Te Rūnanga o Ngāi Tahu's tribal policy opposes the direct discharge of wastewater, including effluent, to waterways. Discharges to land are generally encouraged…Agencies need to be aware that although discharges to water may be within acceptable biological or physical water quality standards, it may not be acceptable from a cultural perspective… It is not a question of the water being within national or international health standards – if water contains wastewater…then the mahinga kai that particular waterway sustains cannot be harvested and eaten."*
>
> ***– Aaron Leith, paper prepared for New Zealand Land Treatment Collective Annual Conference, 2001***

Human health can be directly affected by viruses, bacteria and protozoa from ineffective wastewater treatment systems. Community sewage schemes treat most human wastewater collected in Southland. These schemes have improved over recent years, as the regional, city and district councils and central government work together to ensure the wastewater is treated to a high standard.

There are approximately 12,000 septic tanks in the region.The Ministry for the Environment estimates that 15–50% of septic tanks in New Zealand are failing. Problems such as wastewater ponding, run off to surface water, or groundwater contamination result. Investigation in catchments with poor stream health has found that one such failing septic tank can cause parts of lakes, rivers, estuaries and beaches to become unfit for swimming, food gathering, and marine farming.

Poor protection of bores and wells

Poor protection of bores and wells is the cause of most cases of contaminated groundwater that have been investigated by Environment Southland. If a bore or well is not adequately protected, microbes, sediment or other substances can be drawn into the groundwater.

Stormwater and drainage systems

Stormwater and drainage systems remove water, prevent flooding, keep properties dry and allow farmers to manage their land effectively. Drains also act as a pathway to water, and anything discharged into or near a drain is very likely to get into surface water.

Stormwater drains

Stormwater drains generally discharge directly to waterways without any filtering or treatment of the liquid contents. Lack of awareness can mean that people unintentionally allow contaminants such as paint, waste oil, spilled petrol and detergents to wash into our waterways. Sediment can also be washed into stormwater when ground is cleared for construction. Environment Southland estimates that 60–70% of industrial sites in Southland do not have adequate stormwater control, permitting pollutants to wash directly into drains. Industrial areas can also have

'legacy issues' where poor control of dangerous substances in the past results in ongoing problems.

Tile drains and mole-pipe drainage systems

Tile drains or mole-pipe drainage systems are artificial sub-surface drainage networks that carry water away from otherwise wet and boggy farmland. They have been an important part of Southland's development. While these drains are effective in removing water, they are also very effective at carrying contaminants to waterways. Microbes are a particular problem, since low temperatures and lack of exposure to UV light or filtration means that tile drains carry these contaminants untreated to nearby creeks and streams. Such artificial drainage networks can also be important conduits of phosphorus and sediment flowing to some waterways.

Solid waste disposal

People generate a variety of waste in the course of everyday activities. While some solid waste is recycled, some has to be disposed of, and if not disposed of properly, it can contaminate land or waterways.

Landfill

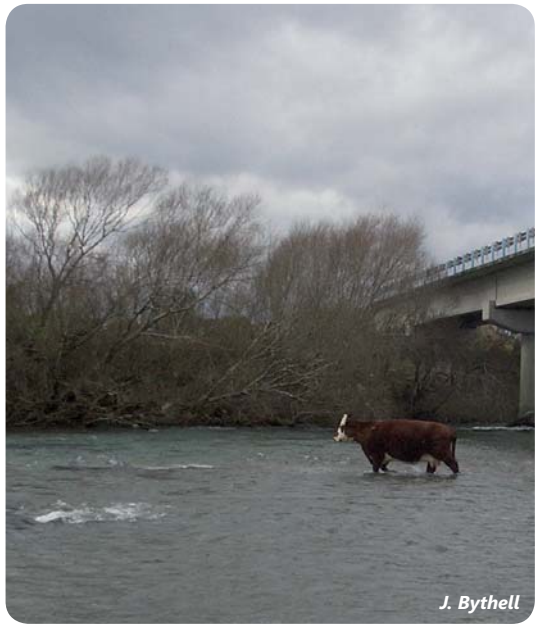
A landfill is a site where waste from a large number of households, businesses or construction and demolition projects is dumped. Some large industries have their own landfills. Leachate from landfills (the liquid that drains away from the solid waste) contains a variety of contaminants, and can cause severe health risks if it gets into waterways. In the past, landfills in Southland were mostly unsealed and unregulated, with little control or recording of what was dumped. The closure of these landfills and the opening of a central regional landfill has greatly reduced current and future environmental risks through improved leachate control and monitoring safeguards.

Farm dumps and offal pits

Many of the 3800 farms in Southland bury waste in farm dumps. Some types of waste that are buried on farms are relatively harmless. Other waste substances such as batteries, oil containers, agrichemicals, treated timber and galvanised sheeting are not permitted to be buried in farm dumps as they pose a potential hazard to public health if leachate reaches groundwater or surface water. Most Southland farms continue to bury carcasses and offal in the ground. These need to be sited well away from dwellings, bores, wells and surface waterways otherwise they can cause microbial contamination of water with associated health risks.

Industrial waste water

Major industrial activities in Southland include the processing of agricultural products and fertiliser manufacture. These industries hold resource consents to discharge treated waste to waterways and to land, and work closely with Environment Southland to prevent adverse effects on human health.



J. Bythell

What we are doing about water quality

Introduction

Communities react to environmental changes and issues in a variety of ways, and this is reflected in the action being taken to safeguard the quality of our water for the health of our community.

Around Southland, efforts to improve water quality are being initiated by individuals, landowners, landcare groups, industry, iwi, and government. Those efforts take a range of forms including regulation, promotion, education and adoption of best management practices, monitoring and reporting, cleaner production methods, and riparian planting.

This section focuses on the action Environment Southland is taking to address the region's water quality management issues. Behind these programmes is the work of many other organisations, groups and individuals who make an important contribution; some in partnership with Environment Southland, some independently.

This section also outlines action taken by Te Ao Mārama Incorporated, co-author of Southland Water 2010.

The success or failure of efforts to protect our freshwater resources, and the ecosystems that support them, ultimately depends on the collective initiatives and actions of individuals, communities, landowners, resource users, and government.

Rural areas

On-farm extension and advice provided by Environment Southland

Environment Southland works directly with farmers and landowners to support land management and farming practices that will protect the quality of groundwater and surface waterways.

- Our Land Sustainability Officers visit sites in rural areas and provide advice on land management. They can provide advice on soil capabilities, environmental farm plans, nutrient budgeting and land development. They provide individual advice, hold field days and participate in landcare groups.
- Our Soil Moisture Network identifies and classifies soil conditions so that effluent application can be carried out when it is most likely to be absorbed by pasture and not flow into a tile drain or waterway. The network will include 20 monitoring sites by the end of 2010 and can be found on Environment Southland's website www.es.govt.nz.
- We employ a specialist Dairy Liaison Officer who helps dairy farmers with resource consents, effluent systems and other aspects of environmental management.
- The Living Streams programme provides free on-farm advice and financial incentives for fencing and riparian planting in selected catchments. Staff work with communities and landowners to take ownership of environmental problems in their catchment, act to prevent pollution, and to protect stream banks. Environment Southland offers a 50% subsidy to fence off streams in Living Streams catchments. As at May 2010, over $100,000 had been granted to complete over 37km of fencing. Other activities resulting from the programme include riparian planting on seven farms, six stock water schemes, four culverts, two bridges and repairs to eroded riverbanks and a silage pad.

Urban areas

Environment Southland works with urban communities, businesses and territorial authorities to improve understanding of the links between their actions and the health of our waterways, and to reduce the incidence and effects of pollution.

Our Pollution Prevention Programme was introduced in 2008 to provide advice and assistance on reducing pollution in industrial and urban areas. The majority of pollution prevention

work is to help businesses reduce impacts on the environment by:

- reducing accidental spills of potential contaminants (eg hazardous materials),
- improving storage and handling of potential contaminants,
- implementing best practice to reduce future environmental risk.

By participating in pollution prevention, businesses can reduce clean up and compliance costs and their environmental impact.

The Pollution Prevention Programme tracks land on the Hazardous Activities and Industries List (HAIL). As at May 2010 there were 234 verified Southland HAIL sites:

- 47 of these classify the contamination as acceptable, managed or remediated
- 25 of these are considered contaminated and unmanaged
- 5 have been investigated with no contamination identified
- One of the contaminated and unmanaged sites has been approved for contaminated sites funding from the Ministry for the Environment and will be worked on in 2010/11
- The remaining 157 sites are verified and may not have been investigated

Creation of the Waihopai and Kingswell walkways by Environment Southland has enabled people to interact with the surrounding Waihopai and Kingswell river environments.

At a wider community level, Environment Southland organises a river-based recreation event. The WaiTri, which has been held annually since 2004, encourages the community to interact with the Waihopai River by participating in organised triathlon, duathlon, running or walking events. The number of participants has increased from 167 in 2004, to 635 in 2010.

Across the region

Communication and planning work supports improvements in our water quality.

- Environment Southland provides water quality information and best practice guidance to the community through press releases, regular advertisements in many Southland newspapers, website updates, consultation partnerships, and a specific dairy publication called *Enviromoos*.
- The bathing beach response group includes representatives from Environment Southland, Te Ao Mārama Incorporated, Environmental Health Officers from all territorial authorities and is overseen by the Medical Officer of Health. The group is responsible for water sampling, health risk assessment and the communication of water quality results from freshwater, marine bathing and shellfish sites to the Southland community.
- A review of the Regional Policy Statement is underway in conjunction with the Southland District Council. The Regional Policy Statement provides a framework for sustainably managing Southland's resources and highlights regionally significant matters, including freshwater and tangata whenua issues. The Regional Policy Statement sets out objectives to be achieved and the policies and methods by which they will be reached.
- The Water Plan became operative in early 2010. It sets the community's goals for water in the region, and rules and methods to help achieve them. A key focus of the plan is protecting the quality of our surface and groundwater resources. It covers activities like discharges and stock access to waterways.
- The Discharge Plan project is underway to review the regional plans dealing with discharges to land, and to merge these with the Water Plan. There will be one document which covers all discharges to land and water. The Discharge Plan is viewed as a key means of achieving the water quality goals contained in the Water Plan. Activities being looked at include discharges to land from agricultural, industrial and human sewage, as well as the cumulative effects of intensive land use. While the Water Plan has generally used non-regulatory methods to address land use impacts on water quality, if sufficient progress towards the plan's

objectives is not made then more regulation may be considered through the Discharge Plan process.

Research concerning water quality issues, which informs decisions made about water quality management include:

- Te Ao Mārama Incorporated has led research on mahinga kai species such as kanakana (lamprey) and tuna (eel). Tools have been developed to measure the decline in mahinga kai. Changes in population can be used as indicators of health of the fisheries and wider ecosystems and also the Māori health and wellbeing. This assessment will be supported by the the Cultural Health Index which allows iwi/hapū to assess the cultural and biological health of a stream or catchment in a way that can be understood and integrated into the resource management process. Cultural Health Index information increases the pool of knowledge from which Te Ao Mārama Incorporated draws on when contributing to plan changes and consents that have impacts on water and public health.
- Specific research is being carried out on the risks related to microbes (disease-causing organisms) from burying carcasses and offal, on silage leachate to groundwater, on low risk application of dairy effluent, sludges and slurries, on the environmental effects of winter grazing, and on nitrate pollution of groundwater.

Our regulation activities in the area of water quality include:

- A new focus on holders of farm dairy effluent discharge resource consents who are not performing well. We now prioritise these consent holders in our monitoring programme. The aim of first targeting poor performers is to identify and rectify issues earlier, and thereby reduce pollution of waterways.
- Conditions for dairy effluent consents have changed over time to reflect advances in science and technology. Conditions covering minimum storage requirements and fail-safe measures such as shut-off valves and timing devices have been placed on consents to reduce the environmental risks associated with applying dairy shed effluent to land.
- A toll-free pollution hotline (0800 76 88 45) allows the public to report pollution incidents. This phone is monitored 24 hours a day, every day of the year.
- We continue to issue infringement and abatement notices to environmental offenders, and to prosecute where necessary. Penalties for environmental offences are increasing.

The education programmes we support include:

- Stream Connections, a school curriculum based programme, which includes a field trip. It allows students to explore and discover their local waterway, learn about its environmental value, and encourages students to make connections with their waterway. More than 450 students participate in the programme each year.
- A partnership with the Royal Society of New Zealand through its Environmental Monitoring and Action Project (EMAP) to support schools who want to carry out ongoing monitoring of their local waterways. These programmes have led to increased knowledge and appreciation of local water resources.
- Bruce C Gull, Environment Southland's loveable mascot, continues to have his Buddies' club, with 2,000 members aged 4–14. Buddies receive information about freshwater through a quarterly newsletter.
- Enviroschools, the nationwide programme that takes a whole school approach to sustainability, has 17 participating schools in Southland in 2010. Environment Southland coordinates this programme with financial support from all territorial authorities. These schools have made a commitment to a long-term sustainability journey. The programme encourages schools to adopt and plant the banks of local waterways to help improve the water quality.

Case study – Russell Winter, Dairy Liaison Officer

In mid 2007, as a response to the increasing conversion of farms to dairying and a rise in dairy farms' non-compliance for dairy effluent discharge, Environment Southland created a specialist 'dairy liaison' role.

The Dairy Liaison Officer works alongside dairy farm owners and workers to get better compliance with environmental regulations. The main focus is on supporting farmers who are converting land to dairying, through the environmental management aspects of their system changes. The officer also helps farmers troubleshoot problems with existing effluent disposal systems.

Russell Winter has been in this specialist position since 2007. He has been working on dairy effluent related matters for the council since 1990, and brings a wealth of expertise to the role. He is well respected by the dairy farming community and has built a strong working relationship between people in the industry and Environment Southland.

Each year Russell responds to between 500 and 550 calls and information requests. A big part of his work is providing information on best management practices for the collection and disposal of effluent and leachate from wintering pads, feedlots, silage pads, underpasses and lanes. He helps farmers work within the rules set in the Water Plan, such as the intensive winter grazing rule, and the requirement to create a buffer zone between grazed areas and waterways.

Each June, dairy farm owners are sent a letter offering their staff a short information and training session on the management of dairy effluent disposal systems. These sessions are carried out on farm, to minimise disruption to the farm work schedule.

Russell believes the most rewarding part of the job is working with dairy farmers to achieve better environmental and financial outcomes. He knows the region backwards and likes the variety of the job, from effluent storage to staff training. He thinks it's valuable that this role has allowed dairy farmers to trust that they will get help from Environment Southland when things look like they might go wrong. He reckons this approach has been welcomed by the dairy community because farmers don't actually want things to 'turn to custard' with accompanying enforcement action and penalties.

Environment Southland's proactive approach helps dairy farmers to be more informed about environmental best practice and consent requirements before something goes wrong. It creates favourable conditions for farmers and allows us to work together for the benefit of our freshwater resources.

A. Henderson

Case Study – Dean Whaanga, Māori Resource Management Officer

Dean is the Māori Resource Management Officer at Te Ao Mārama Incorporated, where he works on behalf of the four rūnanga in Southland helping to improve, maintain and protect the environment and related health aspects. He is a passionate about getting the best results for the environment and public health

The Māori viewpoint on health is based on a wellness or holistic health mode. It incorporates wellbeing of the mind (hinengaro), spirit (wairua), body (tinana) and family (whānau). The quality of water and its suitability to gather kai directly impacts on Māori and non Māori health – whether its impact is mental, spiritual or physical. Through delivering a contract for the Ministry of Health, Dean works with a diverse range of community groups and agencies to improve, maintain and protect health in the Southland region, with a particular focus on Māori health.

On any given day Dean may be in the office working on submissions to plans, policies and consents where there is potential for an activity to impact on human and environmental health. Effects range from runoff from the land in the high country, to the ability to gather and consume mahinga kai, and follows the 'ki uta ki tai (from the mountains to the sea) approach. This reflects the knowledge that resources are connected and should be managed as such. Te Tangi a Tauira is an expression of kaitiakitanga and guides the submission process.

Dean can be found out on the road, meeting with people, gathering information for submissions, working alongside scientists in the field, overseeing finds and removals of archaeological remains, and blessing sites.

Through his work with the state of the environment report, Dean has been out and about getting an iwi 'snapshot' of what and where mahinga kai is being gathered across Southland, and the results were wide ranging. The survey also looked at Māori perspectives on the health of the kai they gather and eat.

Dean believes that one of the most rewarding aspects of his job is the working relationships that he has with all sorts of people, whether iwi, or staff from other agencies. He also enjoys working in a field that aims to achieve tangible results through good, sound decision making.

What we don't know and could do better

What we don't know

The previous sections explain why we cannot say for sure whether it is safe to play in, drink and gather kai from our waters. This section summarises our information gaps.

Our water quality monitoring focuses on the levels of faecal bacteria that have been shown to have a relationship with some pathogens such as campylobacter and salmonella. However, the presence or absence of faecal bacteria does not tell us about the possible presence in our water ways of other pathogens such as viruses. We do not know the range of potential pathogens present in our waterways.

We do not know how much of the faecal bacteria detected in our waterways come from different sources, such as agricultural effluent, offal pits, human wastes or feral animal and bird populations. However, emerging technology will enable some, but not all faecal sources to be identified.

An information gap exists on how safe it is to gather and consume food from our waters. We are unable to accurately determine the level of risk associated with harvesting and consuming food from areas with high faecal bacteria levels.

What we could do better

More frequent reporting

The process of compiling this report has made it clear that Environment Southland needs to produce more frequent technical monitoring reports and state of the environment reports on our water resources. *Southland's State of the Environment Report for Water* was first published in October 2000. Since then, the region has undergone significant agricultural intensification, resulting in increasing stresses on our water resources for future development. Environment Southland will be increasing reporting efforts. We intend to produce an updated report on the state of Southland's freshwater environment in five years (2015/16), which is the halfway mark in the current Water Plan's lifespan.

Refinements for future monitoring and reporting

Compilation of this report has revealed specific gaps and short-comings in our monitoring and reporting programmes.

In some instances we are not able to report on the desired outcomes or the compliance with the standards stated in the Water Plan or Te Tangi a Tauira. This highlights the need to realign our environmental monitoring and planning documents. The 2008/09 review of the surface water state of the environment monitoring programme will help address these shortcomings.

Investigations into the source of faecal contamination have begun at sites with high faecal contamination. These will enable us to report against manawhenua water quality standards.

Sites of concern that require further investigation have been highlighted, including the Mokoreta River at Wyndham River Road, the Mokotua Stream at Awarua and the bathing sites Waikaia River upstream of Piano Flat and the Oreti River at Winton Bridge.

Results also showed that climate variability could be an influence on faecal bacteria levels in our waterways, with wet summers generating higher numbers of breaches of the national bathing guidelines than dry summers. Our reporting needs to incorporate climate variability to better understand its relationship with faecal contamination.

To know exactly how safe it is to play in, drink and gather food in our waters will require work to increase our understanding of potential health risks – as in the 'What we don't know' section above, we need to determine which pathogens are present in our waterways, particularly where they would cause the most damage, such as drinking water supplies and popular swimming and food gathering spots.

What you can do

As a community we are all connected to our region's water quality issues, in terms of our recreation, drinking water supplies, and food gathering.

Here are some ways in which individuals, community and industry groups can get involved in maintaining and improving our freshwater resources.

Things to find out

- What rules, plans and policies affect you, your land, and your community? Plans and policies for water in Southland are available online at www.es.govt.nz.
- How you can become involved in decision-making.
- Where your stormwater drains are, at home, at school and at work – remember, these all drain to our rivers and coasts.
- If your septic tank is working appropriately.
- Information on the Cultural Health Index. Contact Te Ao Mārama Incorporated.
- Where your water comes from – do you know exactly where the water in your tap originates from, which river or aquifer?
- What the best environmental practices are for farming activities. Contact a Land Sustainability Officer or the Dairy Liaison Officer.
- More about your local waterway and how your school can get involved through the Stream Connections Programme. Contact the Environmental Education Officer for more information.
- What the best environmental practices are for industrial and commercial properties. Check out the Pollution Prevention Guide at www.es.govt.nz or contact the Pollution Prevention Officer.
- What the latest summer bathing water quality monitoring results are. Check online at www.es.govt.nz or ring the Environmental Data Information phone service 03 211 5010.

If you live in town, you can take action by:

- Connecting with your local waterways. Use the Waihopai and Kingswell walkways, visit your local stream, lake or river regularly. What really is being put in or taken out of the water?
- Clearly marking stormwater drains so you and others visiting your home, business or school know where they drain to. Stencils are available through the Invercargill Environment Centre.
- Being involved in submissions and public consultation and voting during elections. Remember the council acts for the community on behalf of the community – so we need your involvement all the time.
- Washing your car on the grass.
- Planting next to rivers and streams (riparian planting).
- Disposing of chemicals appropriately. Environment Southland's Pollution Prevention Officer can advise on the correct disposal method and place for different chemicals.
- Joining your local landcare group. Or form one. Call Environment Southland for more information.

If you live in the country you can take action by:

- Fencing off stock from waterways and where practical plant riparian margins.
- Inviting a Land Sustainability Officer on to your property for a consultation.
- Applying dairy effluent and nutrients at appropriate rates, in appropriate conditions – see the Soil Moisture Network on our website www.es.govt.nz.
- Keeping stock at least 3m from the water's edge when intensive winter grazing.
- Disposing of chemicals appropriately. Environment Southland's Pollution

Prevention Officer can give advice on the correct disposal method and place for different chemicals.

- Keeping your bore or well free from pathogens and contaminants by following best practice guidelines on placement and wellhead protection. More information is available on the Environment Southland website www.es.govt.nz.
- Avoiding the storage and/or use of agrichemicals in the vicinity of bores and wells, and ensuring suitable backflow prevention devices are installed where groundwater is used to fill spray tanks
- Ensuring your septic tank is well maintained and working properly.
- Being involved in submissions and public consultation and voting during elections. Remember the council acts for the community on behalf of the community – so we need your involvement all the time.
- Connecting with your local waterways. Visit your local stream, lake or river regularly. What really is being put in or taken out of the river?
- Joining your local landcare group. Call Environment Southland for more information.

Think about the changes you have observed in Southland's water over your lifetime. Then think about the changes you could make to help improve this finite resource. What do you want to see? Let us know!

A. Henderson

Glossary

Confined aquifer: An aquifer that is 'closed' to the land surface, ie it has a low permeability upper layer such as clay and silt that prevents it from being directly replenished by rainfall.

Contact recreation: Activities involving frequent and direct contact with water where ingestion of water is likely, such as swimming.

Cultural Health Index: A tool, developed by Ngāi Tahu, that Māori can use to assess and manage waterways in their area.

Cyanobacteria: A group of bacteria sometimes called blue-green algae that obtain their energy through photosynthesis, form large mats, and can produce toxins that are harmful to animals and humans when ingested.

Enteroccoci: Bacteria found in animal wastes and human sewage that are able to survive in salt water. These bacteria can be used to indicate the possible presence of disease-causing bacteria, viruses and protozoans in coastal waters.

Escherichia coli (or ***E. coli*** for short): A bacterium found in animal wastes and human sewage and is used to indicate the possible presence of disease-causing bacteria, viruses and protozoans in freshwaters.

Faecal coliforms: A group of six species of bacteria that are found in animal wastes and human sewage. These bacteria can indicate the presence of disease-causing bacteria, viruses and protozoans in water and shellfish flesh.

Ions: An atom or molecule in which the total number of electrons does not equal the total number of protons giving it a positive (cation) or negative (anion) electrical charge.

Median: A statistic that describes the middle score in a range of samples or measurements (ie half the scores will be higher than the median and half will be lower). This is the main descriptive statistic used when describing water quality.

Micro-organism (or microbe): Any living organism of microscopic size, too small to be seen by the naked human eye.

Pathogen: A micro-organism capable of causing disease symptoms in another organism.

Secondary contact recreation: Activities involving partial contact with water where ingestion of water is unlikely, such as sports fishing, wading and boating.

Unconfined aquifer: Aquifers that are 'open' to the land surface, ie there is no low permeability confining layer between them and the land surface. Typically shallow, they are normally comprised of permeable surface sands and gravels and recharged directly by rainfall seeping through the soil.


Z. Moss

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Our Health: Southland Water 2010: Part 1

For further information, see www.es.govt.nz

For information on:	Contact:
Bathing and shellfish gathering water quality	Coastal Scientist, Environment Southland
Water quality of our rivers and lakes	Surface Water Quality Scientist, Environment Southland
Groundwater quality	Groundwater Scientist, Environment Southland
Fish species present in Southland	Surface Water Resources Scientist, Environment Southland
What you or your school could do to improve water quality	Environmental Education Officer, Environment Southland
Regional council plans and policies	Senior Resource Planners, Environment Southland
Māori environmental health	Māori Resource Management Officer, Te Ao Mārama Incorporated

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