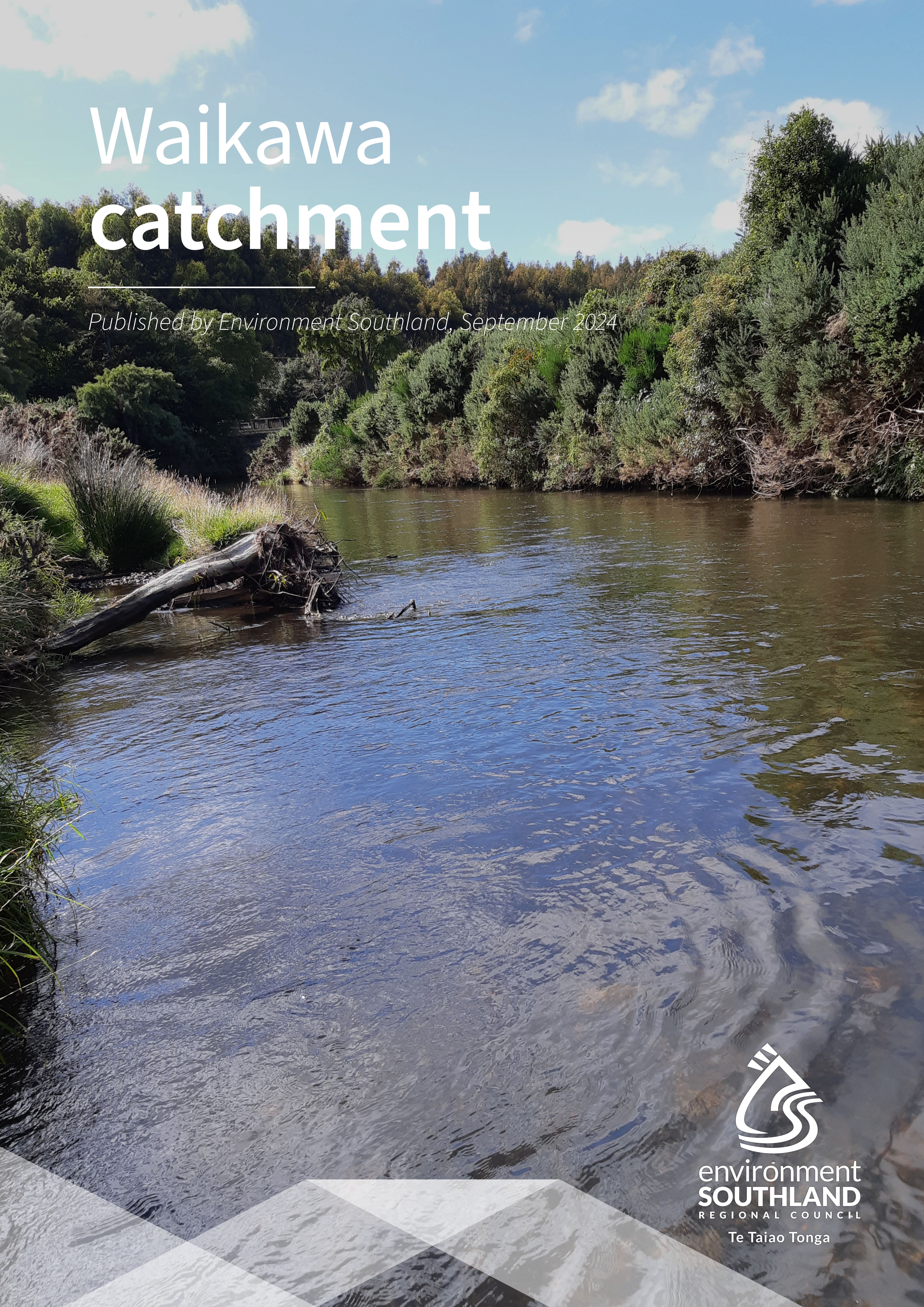

Waikawa catchment

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environment
SOUTHLAND
REGIONAL COUNCIL
Te Taiao Tonga

Waikawa catchment

This document summarises scientific information for freshwater and estuarine areas, opportunities for action and the socioeconomic context for the Waikawa catchment.

It is one of twelve catchment summaries prepared for the Murihiku Southland region.

We have collated and presented scientific data at the catchment scale to provide an understanding of freshwater quality and quantity challenges and their underlying factors. We have included an evaluation of the current state of freshwater within the catchment and highlighted the magnitude of change necessary to meet freshwater aspirations.

The information in this document should be considered alongside other information sources, including mātauranga Māori.

Main features

Land area: 24,700ha

Major rivers and streams:
Waikawa River

Aquifers:
No zones recognised

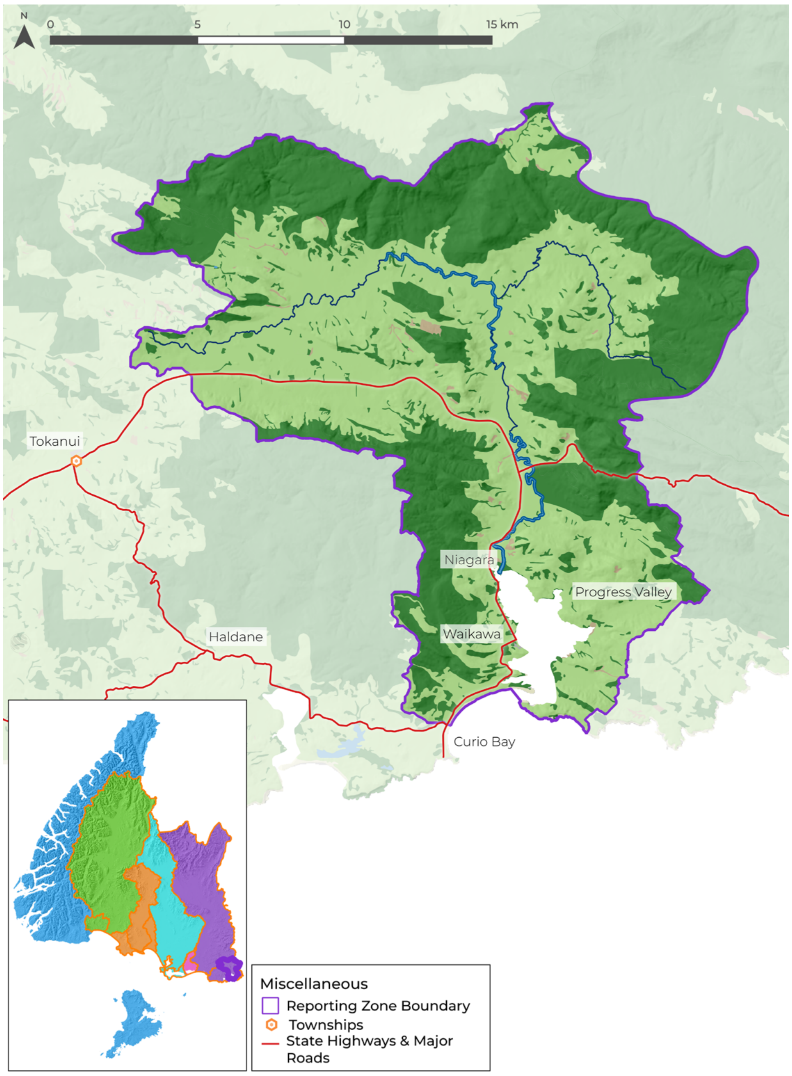
Lakes:
None

Estuaries:
Waikawa

Townships:
Waikawa, Niagara

Population:
Less than 1,000

Catchment outline



For most attributes, current state is assessed using data from the 2018 – 2022 period.

Key messages

Issues

- Monitoring indicates that freshwater ecosystem health is typically good within the Waikawa catchment, with hauora targets met for most monitored river ecosystem health attributes, except for sediment. Of the three human health attributes monitored, only one meets the hauora targets.
- Sedimentation rate and sediment type are the two main drivers of change for the ecosystem health of Waikawa Estuary, with fine sediment deposition increasing the presence of mud and the associated issues this brings.
- Modelling indicates contaminant load reductions are required to achieve desired freshwater and estuary outcomes. Reductions are required for nitrogen (17%), phosphorus (40%), sediment (54%) and *E. coli* (86%).
- Approximately 130ha of wetlands have been lost since 1996 in the Waikawa catchment. Of the remaining wetlands not on conservation land, 60% are at moderately-high risk of being lost.

Opportunities for action

- Implement property-scale mitigations tailored to the land's physiographic characteristics, the sensitivities of the receiving environments and the outcomes sought for the catchment.
- Target actions to reduce the loss of sediment to the receiving environments and efforts to stem the flow of *E. coli* into rivers and streams.
- Give particular attention to forestry harvest plans and farm-scale actions to reduce sediment loss.
- Enhance marginal vegetation and habitat of the estuary through retirement, protection and restoration of the estuarine margins.

Socioeconomic context for action

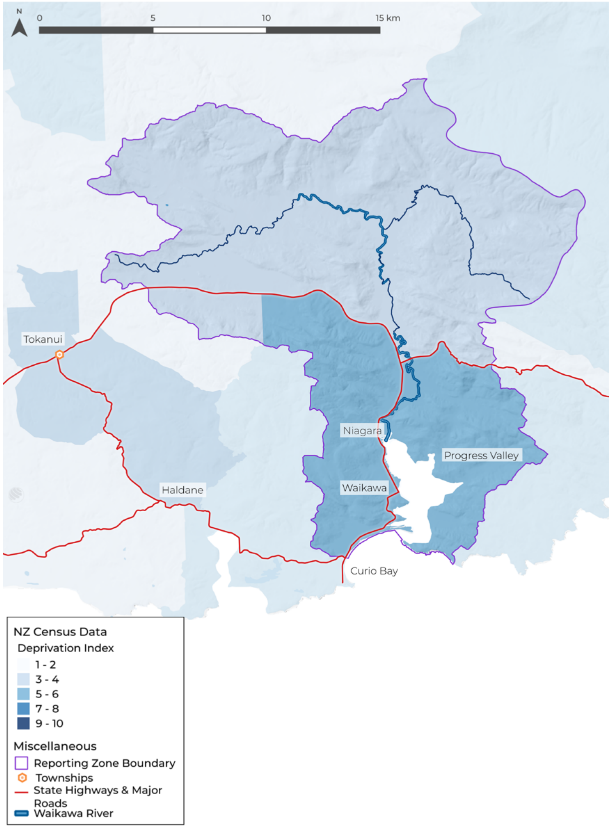
The Waikawa catchment is one of four catchments within the Wyndham-Catlins SA2 (Statistical Area 2). Insights provided in this section, therefore, extend beyond the Waikawa catchment.

Historic socioeconomic shifts later in the 20th century have impacted Wyndham-Catlins and communities within the four catchments. The impacts of neoliberal deregulation from the 1980s removed agricultural subsidies and export assistance, creating a period of austerity for many farming communities. Other industry declines, such as timber, led to a further deterioration of socioeconomic conditions for local dependent townships, driving population decline.

The rise in dairy farming across the region in the 1990s began to reverse economic conditions for the more expansive zone, ushering in land use change and industry and demographic changes. However, populations in the Wyndham-Catlins area remain closely associated with agriculture and forestry (and, to a lesser extent, fishing), with approximately a third of the population directly involved in these industries.

From the 1990s to the mid-2000s, the Wyndham-Catlins catchments experienced a general population decline but had a period of reasonably steady population increases that peaked in 2020, before declining slightly.

Social Deprivation Index



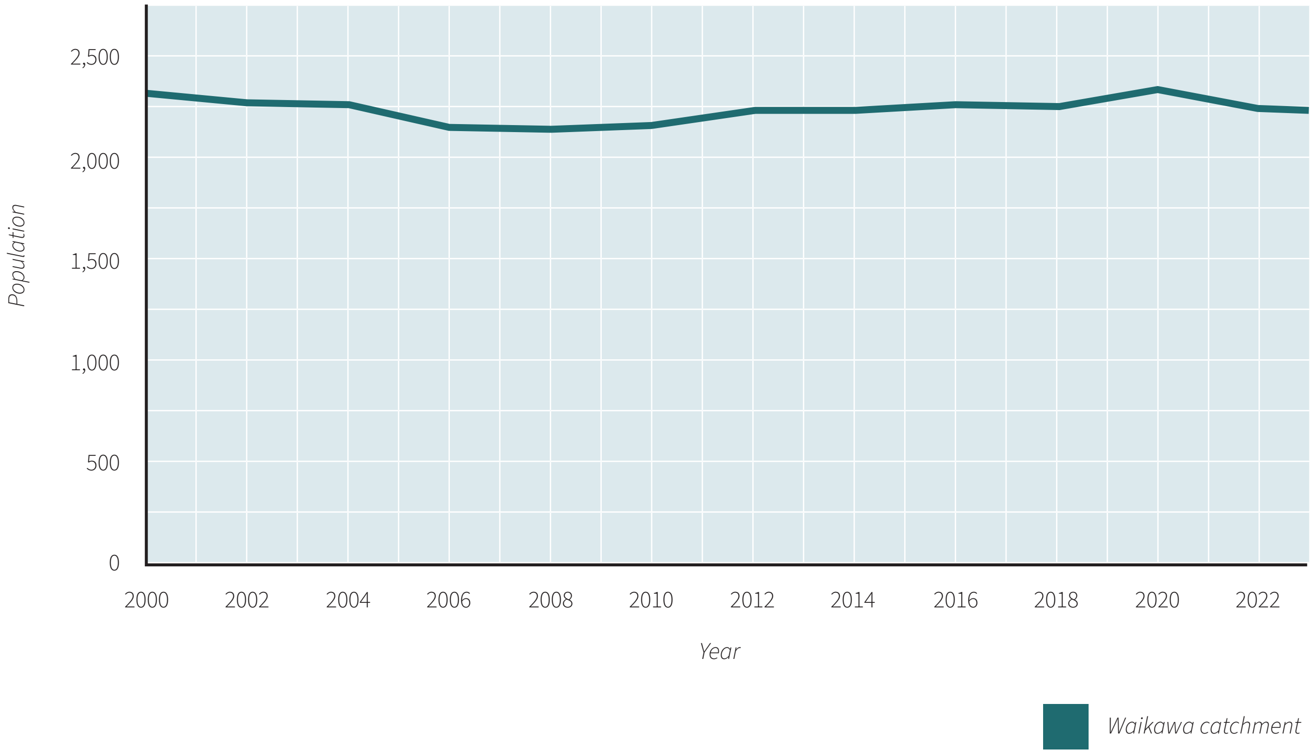
Social Deprivation Index

The Deprivation Index measures socioeconomic deprivation based on census information. It considers income, income benefits, communication access, employment, educational qualifications, home ownership, care support, living space and living conditions.

The population in Wyndham-Catlins broadly follows regional demographic trends. However, there are fewer people aged 30-39 years and slightly more aged 15-19 and 55-64. The regional trend of young adults leaving for tertiary education or employment opportunities outside of Murihiku Southland is present in Wyndham-Catlins, but is not as pronounced as it is for other areas.

Unemployment is very low in Murihiku Southland and even lower than regional average in Wyndham-Catlins. More than nine out of ten residents in the area are New Zealand-born and a similar proportion identify as primarily of European ethnicity. The proportion of people that identify as either Māori, Asian, and MELAA populations is lower in Wyndham-Catlins than the regional averages. However, these populations are steadily growing.

Estimated population trends (Dot Loves Data, 2024)



The Waikawa catchment comprises only a portion of the Wyndham-Catlins SA2, so this graph can only indicate general population trends.

Home ownership in the Wyndham-Catlins area has declined from 2006 to 2018. However, housing is comparatively more affordable and there is a greater proportion of home ownership than elsewhere in Murihiku Southland.

Although the Southland district is among the least socioeconomically deprived regions in New Zealand, the Wyndham-Catlins catchment zone has areas of high deprivation, particularly in the smaller settlements.

Trends from 2014-2024 show that Wyndham-Catlins has experienced gradually increasing levels of deprivation, partly due to increases in crime victimisations (though this is more applicable to Wyndham Township than the rural areas). Higher levels of deprivation tend to correlate with less capacity, fewer resources, and higher vulnerability, along with poorer wellbeing outcomes for communities.

Summary

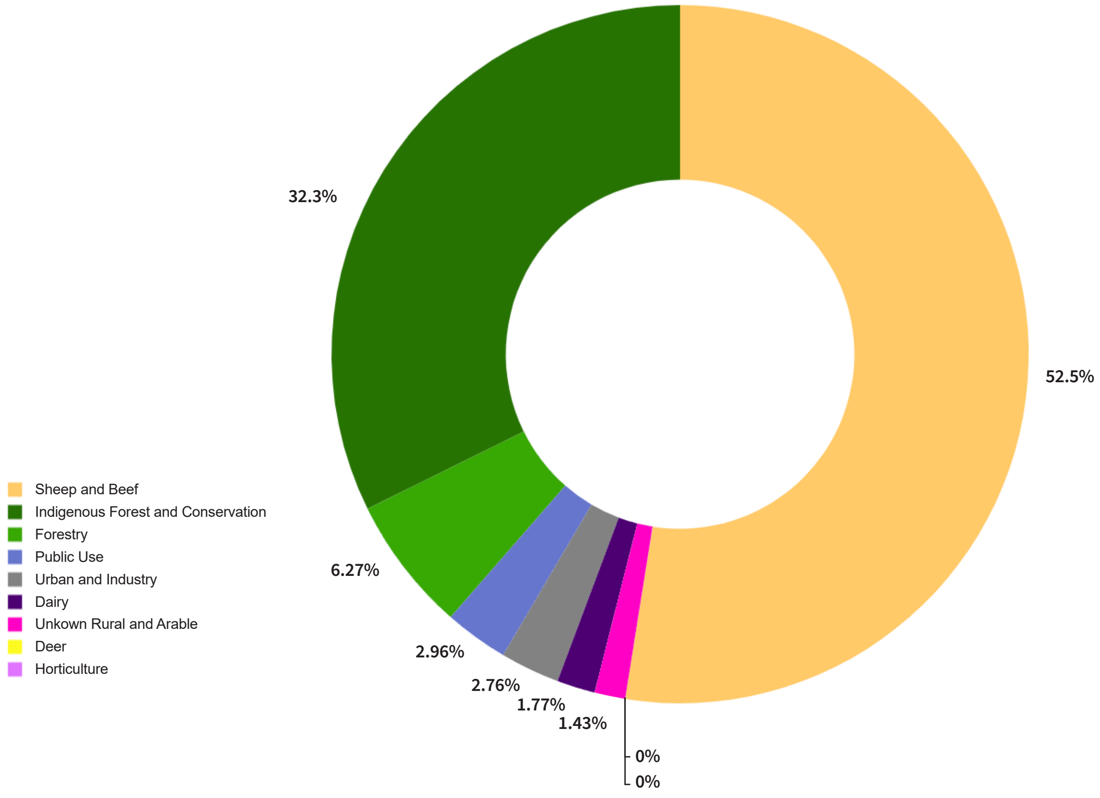
- The small local economy relies heavily on agriculture, forestry and fishing, increasing risks from industry or regulatory changes.
- Higher deprivation levels in some areas could result in less resilience and poorer wellbeing outcomes.
- Lower education attainment levels in parts of the community may reduce the capacity to adapt to economic, technological and environmental changes.
- Established catchment groups, like the Waikawa Catchment Group, provide support systems for members and community projects and may facilitate adaptation to external pressures and challenges.

Catchment overview

The Waikawa catchment is in the southeast corner of Murihiku Southland. The Waikawa River drains the native forest-covered Maclennan and Forest Ranges and discharges into the Waikawa Estuary on the south coast.

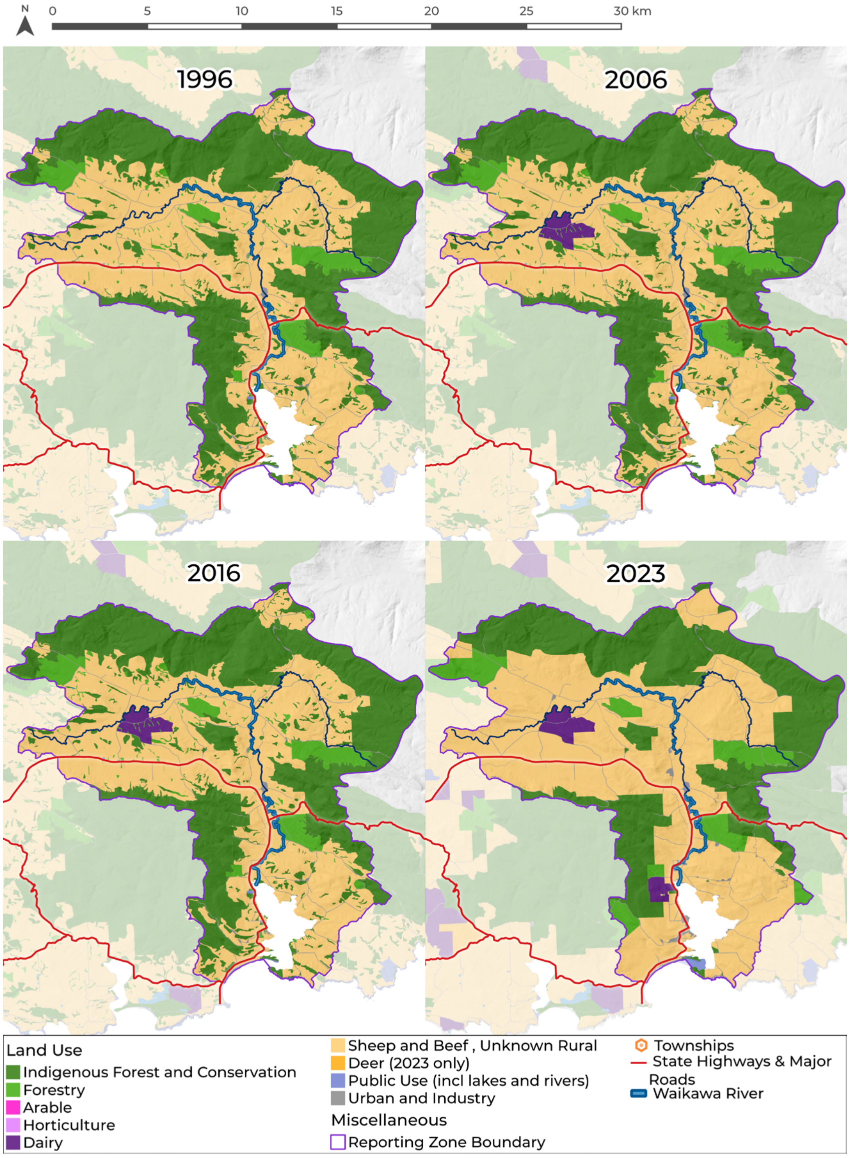
Land use

The Waikawa catchment cover 24,700 hectares. About 13,832 ha (53%) is farmed. The next largest land use is indigenous forest and conservation estate, covering 7,900ha (32%). Forestry covers 1,482 ha (6%), with urban and industry alongside public land making up the rest (3% each or 1,500ha).



There have been certain changes in land use in the last 25 years. Land development has continued with intensification in some places.

Historic land use



Please note that these maps and figures are indicative only due to land use class aggregation and differences in mapping methods.

Historic land use

	1996 to 2006	2006 to 2016	2016 to 2023	Overall 1996 to 2023
Pastoral land	↓ 1%	↑ 1%	↑ 15%	↑ 15%
Dairy	↑ 290Ha	No change	↑ 51%	↑ 440Ha
Drystock	↓ 3%	↑ 1%	↑ 14%	↑ 11%

Climate

Understanding climate at a catchment scale helps to explain spatial and temporal variation in land use, water quality and quantity.

Current climate

Waikawa is in one of the wettest parts of the region, experiencing an average of greater than 183 wet days (>1mm precipitation) per year, with less common heavier rainfalls of around 43 days >10mm and seven days of >25mm per year. The weather is typically cooler, with less than 25 frosty nights per year, summer temperatures infrequently rising above 25°C, and an annual average temperature between 9-12°C.

Hydrological statistics for the Waikawa River are available from Environment Southland's monitoring site at Biggar Road, located approximately a third up the main stem of the river from the estuary. Here, the median annual flow is around 2.6 cumecs, with a seven-day mean annual low flow of 0.807 cumecs, and Q95 (the value above which the river flows 95% of the time) of 0.819 cumecs. The lowest recorded flow for the Waikawa River occurred at the end of March 2022, with a flow of 0.327 cumecs, while the highest flows recorded on the river were 121 cumecs in February 2011.

Future climate

Potential changes to the future climate of the Waikawa catchment have been examined in a regional study exploring scenarios for two Representative Concentration Pathways (RCPs): 4.5 and 8.5, representing lower and higher carbon emissions, respectively. These potential changes are summarised in the following table.

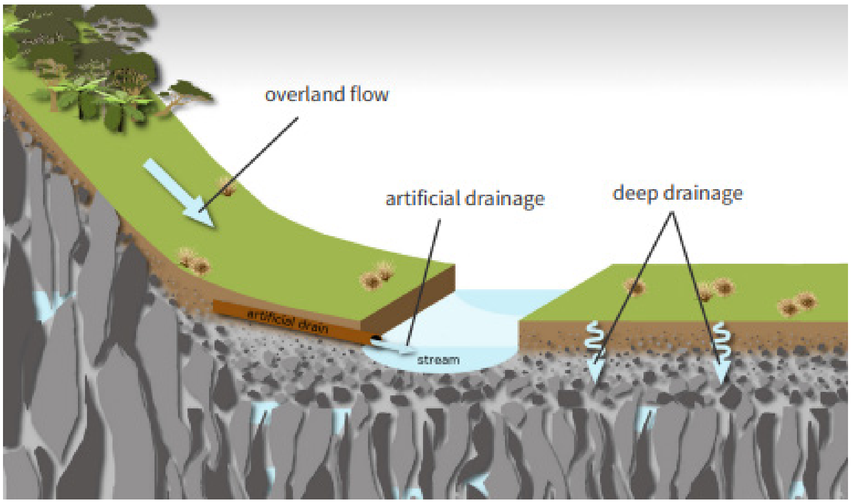
Precipitation

		RCP 4.5		RCP 8.5	
		Mid 21st century	End of 21st century	Mid 21st century	End of 21st century
Temperature	Daily mean (°C)	↑ 0.5-0.75	↑ 0.75-1.25	↑ 0.5-0.75	↑ 1.75-2
	Mean minimum (°C)	↑ 0-0.5	↑ 0.5-0.75	↑ 0.25-0.5	↑ 1.25-1.5
	Number of hot days	↑ 0-5	↑ 0-10	↑ 0-5	↑ 10-25
	Number of frosty nights	↓ 0-10	↓ 5-10	↓ 5-10	↓ 10-20
Rainfall	Annual rainfall change (%)	↑ 0-5%	↑5-10%	↑ 0-5%	↑ 15-20%
	Number of wet days	184	186	184	185
	5-Day maximum rainfall (mm)	↑ 0-15mm	↑ 0-15mm	↑ 0-15mm	↑ 15-30mm
	Heavy rainfall days	46	47	45	52
	Seasonal changes	Wetter springs	Concentrated to winter/spring	Concentrated to winter/spring	Concentrated in Winter and Spring

Catchment landscapes and hydrology

Biogeochemical and physical processes influence water quality variations within a catchment. Understanding hydrology, geology and soil types within a catchment helps to explain variations in catchment yields, water chemistry and water quality outcomes independent of land use.

Headwaters



▲ *Conceptual illustration of the typical landscape setting and contaminant loss/flow pathways in the upper catchment hill country areas..*

Rain falling in the headwaters of the Waikawa catchment makes its way down through the slopes of the Maclennan and Forest ranges as well as the surrounding hills of the lower catchment. These hills have large areas of native vegetation, exotic forestry and hill country farmland. The hills are formed by the distinctive northeast striking volcaniclastic strata of the Murihiku Terrane.

Waterways in the headwaters are generally well distributed across the drainage area, small (< order 4), and with median flows less than 0.5 cumecs. Flow lag times in the upper catchment are relatively short (hours/days), with limited subsurface flow pathways and steeper topography.

Relatively pristine water from the vegetated areas flows to the bottom of the headwater valleys through thin alluvial deposits. As water flows through these deposits, it mixes with localised recharge water from the surrounding land.

Agriculture in the hills and valleys contributes nutrients, sediment and *E. coli* to the water flowing through them.

Mid and lower catchment

Further downgradient, the Waikawa valley becomes more defined, with rolling and flat land. Alluvial deposits are thin and limited to the proximity of the main Waikawa River channel, with bedrock close to the surface in most locations.

Recharge remains a mix of hill country and lowland-derived water.

In the mid and lower reaches of the catchment, an increased proportion of water is derived from localised recharge, natural and artificial drains and temporary overland flow pathways.

Water on the flatter, intensively farmed area interacts with the agricultural landscape's soils and carries nutrients, sediment, *E. coli* and other contaminants.

Lower catchment

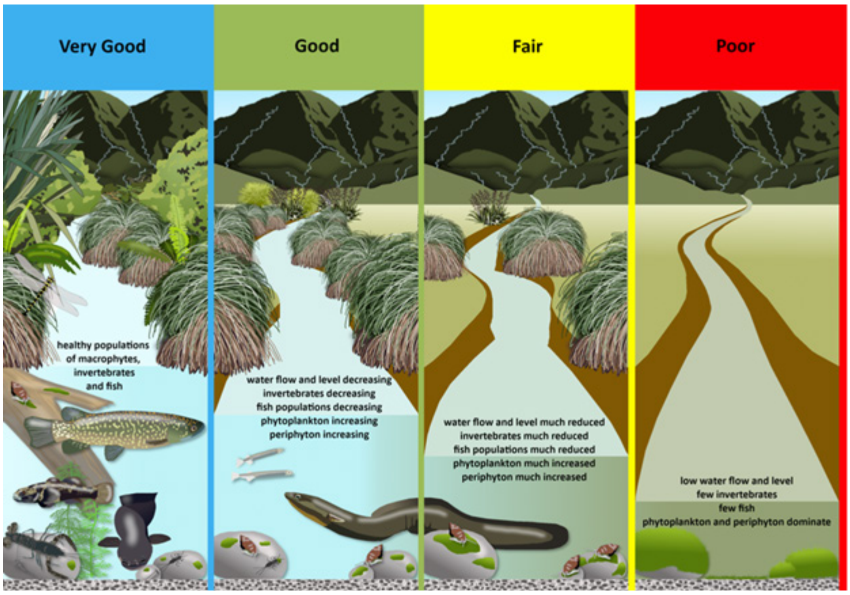
At the bottom of the catchment, the Waikawa River discharges into the Waikawa Estuary. Here, the hydraulic conditions and tidal movement cause the deposition and accumulation of contaminants within certain parts of the estuary.

What are the water issues for this catchment?

Freshwater outcomes and how we measure them

Freshwater outcomes can be described on a spectrum from ‘very good’ to ‘poor’. Using this spectrum helps us to understand the current freshwater environment state and what we might be trying to achieve in the future. This concept is depicted for rivers and streams in the image below.

Although many factors contribute to freshwater outcomes, we can only measure some of these to get an understanding of ecosystem health. We measure the aspects of the freshwater environment that can help us define and determine freshwater outcomes. The aspects that we measure are called ‘attributes’.



Attributes (the things we measure)

Attributes can relate to the ecosystem's physical or chemical environment or biological communities, such as periphyton, macroinvertebrates, and fish. The measured state of an attribute tells us about some aspects of the environmental state, and together, they build a picture of the ecosystem's overall health. The more attributes we monitor, the more precise the picture can become.

Attributes may relate to ecosystem health or human health outcomes (e.g. *E. coli* or cyanobacteria concentrations). Some attributes are graded using ‘ABCD’ categories: A (very good), B (good), C (fair) and D (poor). In some cases, *E. coli* has an additional E (very poor) grade. Other attributes have simple ‘pass’ or ‘fail’ grades.

The more attributes with a higher grade, the better the overall ecosystem health. Conversely, when many attributes have poorer grades, the overall ecosystem health is poorer.

Hauora target attribute states

In 2020, Environment Southland and Te Ao Mārama Inc (TAMI) approved in principle the use of hauora as a freshwater target to be achieved within a generation. These targets provided the basis for the Regional Forum recommendations on how freshwater aspirations may be achieved.

The concept of hauora encompasses far more than the numeric attributes and targets described here. For simplicity, a reduced number of attribute states are presented in this document as they relate to ecosystem and human health. Hauora is a state of healthy resilience and is generally associated with the A ‘very good’ and B ‘good’ attribute states. However, attribute states that support hauora can be anywhere on the scale from A ‘very good’ to C ‘fair’, depending on the natural characteristics of that freshwater environment.

The natural characteristics have been differentiated through the use of classes.

We use monitoring results to compare the current attribute state with the hauora target state for different classes in the Waikawa catchment.

Streams and rivers

River classes

‘River classes’ group rivers (or parts of rivers) with similar characteristics. Similarities can include natural characteristics of the rivers, such as climate, gradient, and flow.

The River classes used in Murihiku Southland are: Mountain, Hill, Lowland, Spring-fed, Lake-fed and Natural State.

About two-thirds of the rivers in the Waikawa catchment are classified as Lowland. The rest are Hill, Natural State and Lake-fed.

Target states can differ between attributes and between different river classes, which may have different target states for the same attribute.

Periphyton is an example of an attribute with different target states for different river classes.

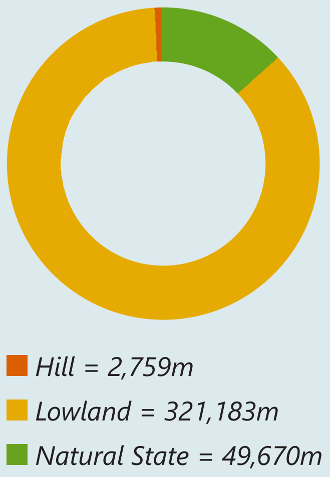
The different target states reflect the differences in natural characteristics for each river class.

- C target state: Lowland class
- B target state: Hill class
- A target state: Mountain, Spring-fed and Lake-fed classes.

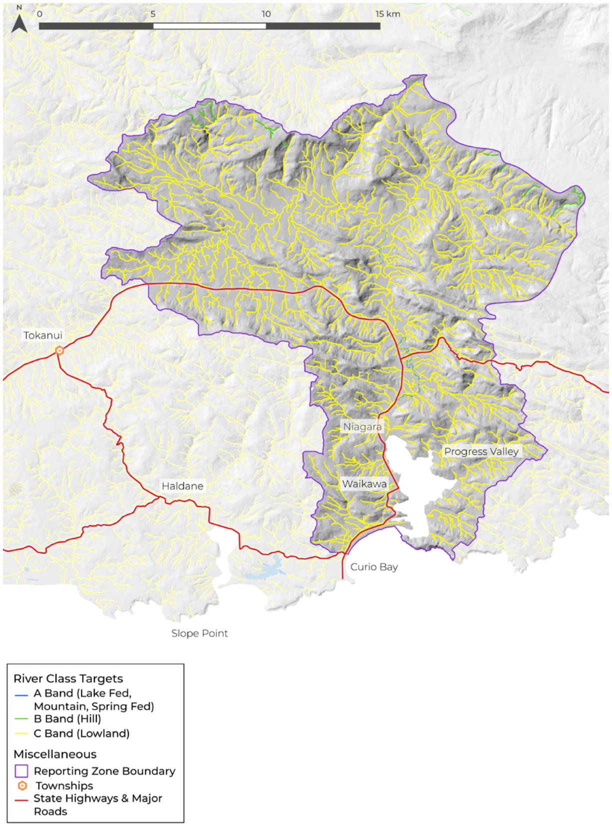
Natural State waterbodies can be identified for management purposes but are assigned attribute targets according to their underlying river classification (displayed here).

▸ *The map shows the distribution of periphyton targets for each river class within the Waiakwa catchment.*

Length of river network in each class



River class hauora targets



Results for the river classes

Hauora targets and current states for ecosystem and human health attributes are summarised in the table below for the catchment's Lowland and Hill river classes. Table colours correspond to the 'ABCDE' grading for attributes described above. Results show that Lowland rivers in the catchment have the most water quality issues.

Current state is assessed using data from the 2018-2022 period.

	Lowland		Hill	
Ecosystem health attributes	Hauora target	Current state	Hauora target	Current state
Periphyton	C	A	B	-
Nitrate toxicity	A	A	A	-
Ammonia toxicity	A	A	A	-
Suspended fine sediment	C	D	C	-
Macroinvertebrates (MCI, QMCI)	C	C	B	-
Deposited fine sediment	A	A	A	-
Dissolved reactive phosphorus	B	B	B	-
Water temperature (summer)	C	C	C	-
Human contact attributes				
Benthic cyanobacteria	A	A	A	-
E. coli	A	E	A	-
Visual clarity	B	D	B	-

"-" no data available.

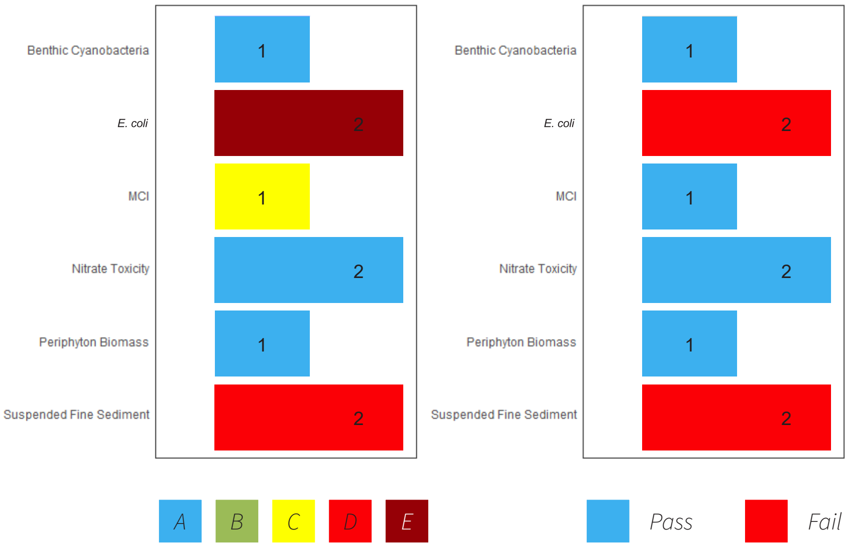
There are no long-term monitoring sites in the spring-fed, lake-fed or mountain classes.

Periphyton is the algae and 'slime' that grows on the streambed and forms the base of the food web in rivers. In some rivers, periphyton is essential for a healthy ecosystem. However, elevated nutrients and light levels can promote excessive periphyton growth. This 'nuisance' periphyton has detrimental effects, such as smothering fish and invertebrate habitat, and can cause greater variation in dissolved oxygen concentrations. The class scale assessment indicates that periphyton in the Lowland rivers and streams is in a 'fair – C band' state and meets the hauora target.

Results for the monitored streams and rivers

Ecosystem health

Results for the Waikawa River are given below for nitrate toxicity, suspended fine sediment, macroinvertebrate community index and periphyton biomass, and the human contact attributes *E. coli* and benthic cyanobacteria. The number of sites that meet hauora targets is also provided (see graphs to the right). Results show that hauora targets are achieved for most attributes except for suspended fine sediment.



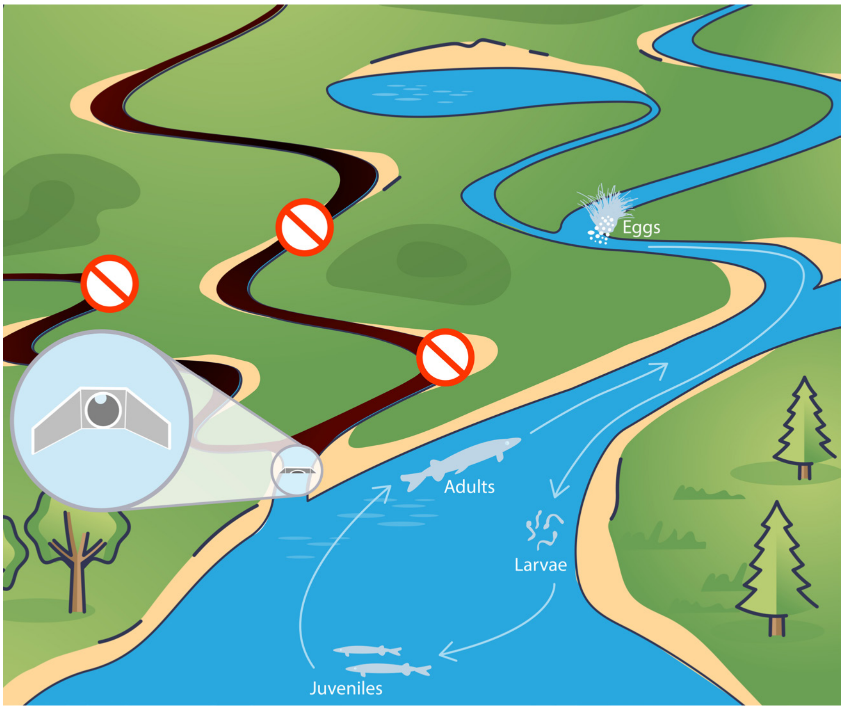
Human health/contact

Both monitored sites have a grade of very poor for *E. coli*. Considerable improvement would be required to achieve the hauora target of very good. Benthic cyanobacteria is monitored at one site which achieves the hauora target of very good.

Fish passage

Fish passage barriers obstruct the passage of fish species. This particularly impacts migratory fish species that complete their lifecycles in both freshwater and the ocean, such as tuna/eels, kanakana/pouched lamprey and migratory galaxiids/whitebait. Generally, the closer a barrier is to the coast, the larger the area of habitat that becomes inaccessible to migratory fish, making it a higher priority for restoring passage. Common examples of fish passage barriers include structures like culverts, weirs and dams, while natural features such as waterfalls can also form barriers. Different fish species and life stages have varying climbing and swimming abilities, so a barrier for one species or life stage may not be a barrier for another.

Whitebait lifecycle



In some cases, fish barriers may be desirable to protect populations of non-migratory galaxiids that struggle to co-exist with trout. In these cases, a barrier could be installed or maintained in a specific location to prevent trout from reaching the population of non-migratory fish.

Culverts are the most common fish passage barrier in the Waikawa catchment. When culverts are designed and installed, consideration of fish passage and regular maintenance of structures will help improve fish passage.

Groundwater

Human consumption – is it safe to drink?

Groundwater use in the Waikawa catchment is limited. There are only a small number of wells. Well depths range between 15m and 55m, with a median depth of 30m.

The main contaminants affecting the suitability of potable groundwater for drinking are pathogens (*E. coli*) and nitrate.

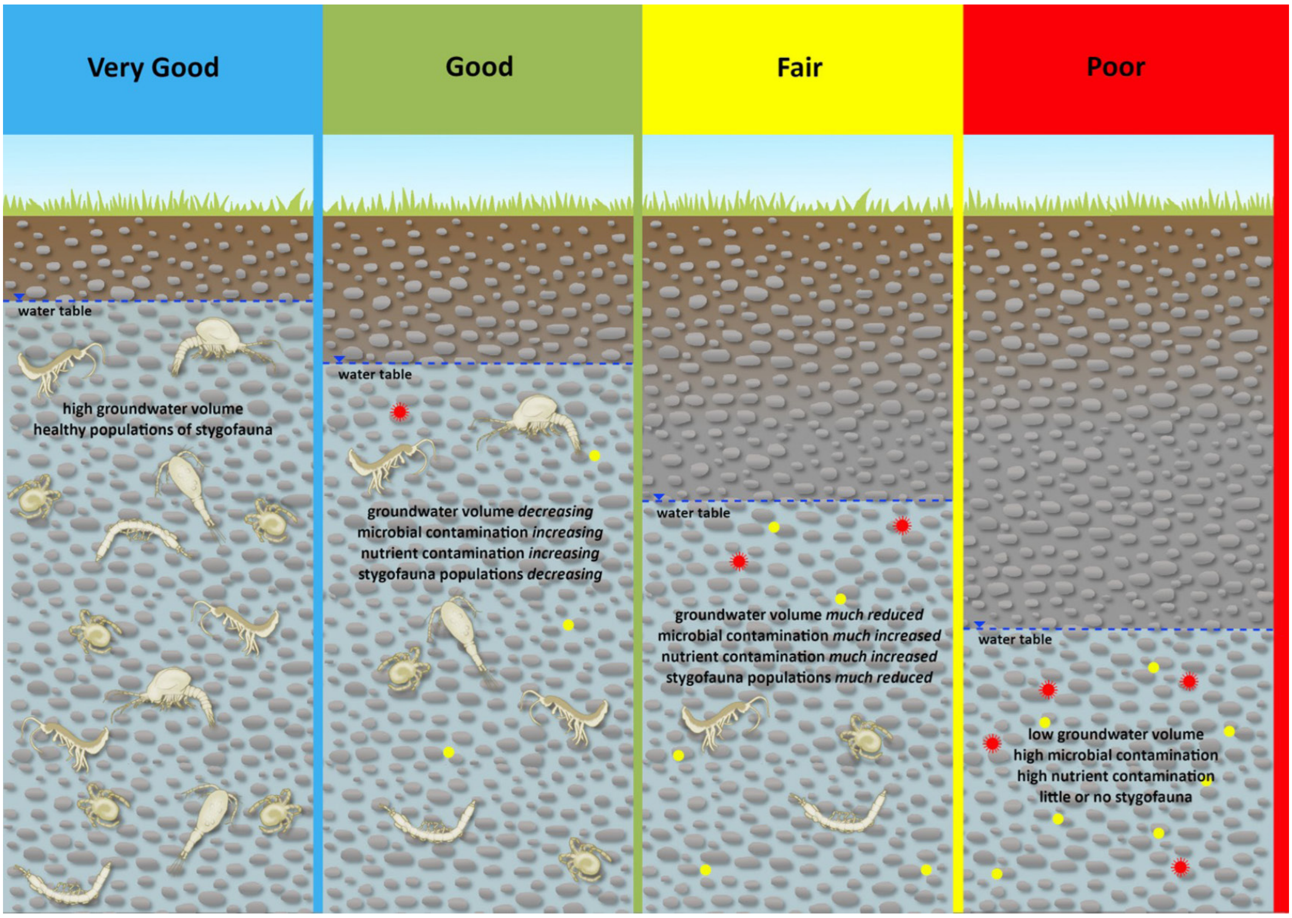
Target states for groundwater are based on the New Zealand drinking water standards and use a pass/fail assessment system.

There are no groundwater monitoring sites in the Waikawa catchment. The catchment is dominated by the bedrock/hill physiographic zone. There are limited areas where groundwater resources are utilised and quality contamination issues and impacts are expected to be minor.

Ecosystem health

Nitrate concentrations are also used to monitor ecosystem health – for both groundwater ecosystems and connected surface waterways. Groundwater ecosystem health outcomes are represented conceptually in the figure below. Nitrate concentrations are one factor that contributes to overall ecosystem health. Nitrate concentrations that relate to surface water and groundwater ecosystem health outcomes are different to those used in relation to drinking water mentioned above.

We have insufficient monitoring data and no model estimates for nitrate in the Waikawa zone. Physiographic information suggests that the risk of severe nitrate contamination in the Waikawa catchment is relatively low.



Wetlands – how many do we have left?

Wetlands and water quality

Wetlands are increasingly being recognised for their functional values within the landscape. For example, their ability to intercept and attenuate agricultural runoff is now recognised as an important contribution to farm nutrient management.

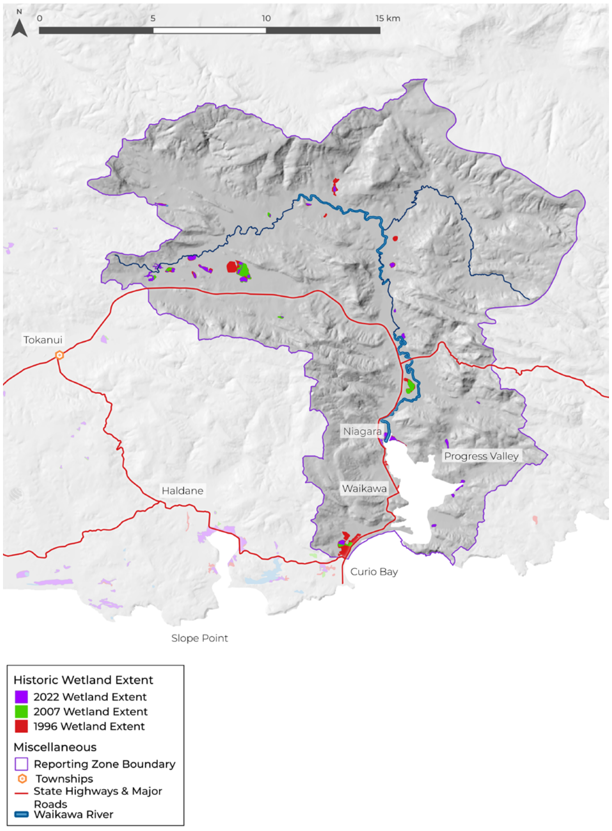
Wetlands purify water through sediment capture and storing nutrients in their soils and vegetation. This is particularly important for the agricultural nutrients nitrogen and phosphorus, which contribute to the eutrophication of receiving environments such as rivers, lakes and estuaries.

For the purposes of this document wetlands are generally defined as per the Southland Water and Land Plan definition.

The following areas were not included as wetlands in this classification:

- Wet pasture or where water ponds after rain
- Pasture containing patches of rushes less than 50% total cover
- Ponds of any kind unless associated with 0.5 or more hectares of terrestrial wetland.
- Areas of forest unless previoulsy identified as wetland.
- Areas associated with the main active flood channels of rivers.

Historic wetland extent



▲ *This shows the extent of the wetland over three time periods. Wetland areas lost since 1996 and 2007 are shaded red and green, respectively.*

Current state

The current wetland extent for the Waikawa catchment is 75 ha. Most wetlands lost are bogs, fens and marshes, mainly converted to pasture farmland.

	1996 to 2007	2007 to 2022	Overall 1996 to 2022
Change in wetland area	↓ 41% 86 ha	↓ 38% 46 ha	↓ 64% 132 ha

Remaining wetlands

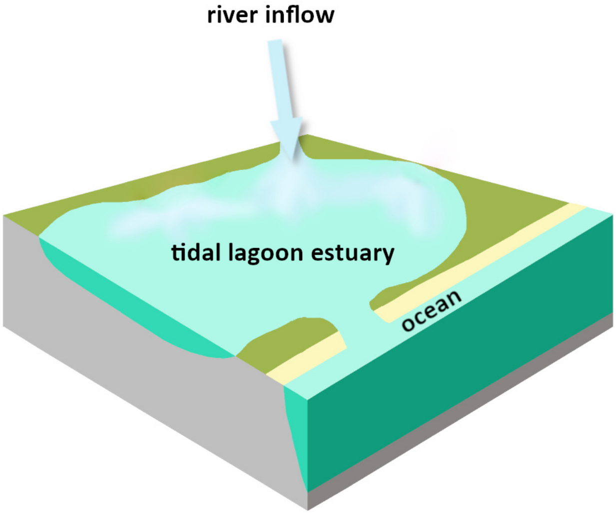
There are few wetlands in the Waikawa catchment, and those that remain tend to be small. Inland wetlands primarily occur on the river flats adjacent to the Waikawa River. The wetlands are typically fen, dominated by red tussock and swamp with rushes and flax. Some low-quality remnant bog also exists north of Quarry Hills. Several large estuarine salt marshes comprised of oioi in the tidal zone and shrubland further inland are located around Waikawa Harbour. Slightly further inland from the Harbour, areas of fen and swamp exist. The Waikawa Harbour itself is a large estuary designated as a regionally significant wetland.

Of the remaining wetlands not on conservation land, there is a moderate risk of losing more wetlands in the near future.

	1	2	3	4	5
Risk of loss (1 = low, 5 = high)	0%	17%	74%	9%	0%

Waikawa Estuary

The Waikawa river discharges into the Waikawa Estuary, a shallow intertidally-dominated (SIDE) tidal lagoon-type estuary that interfaces with the open coast at Porpoise Bay in the Catlins. The estuary is relatively shallow and drains almost entirely at low tide, except for some deeper channels near the estuary mouth. Due to their location at the bottom of river catchments, estuaries are at risk from the associated rivers' adverse impacts of nutrients, contaminants, and sediment. Some estuaries are more at risk than others. They are grouped into categories according to these risks.

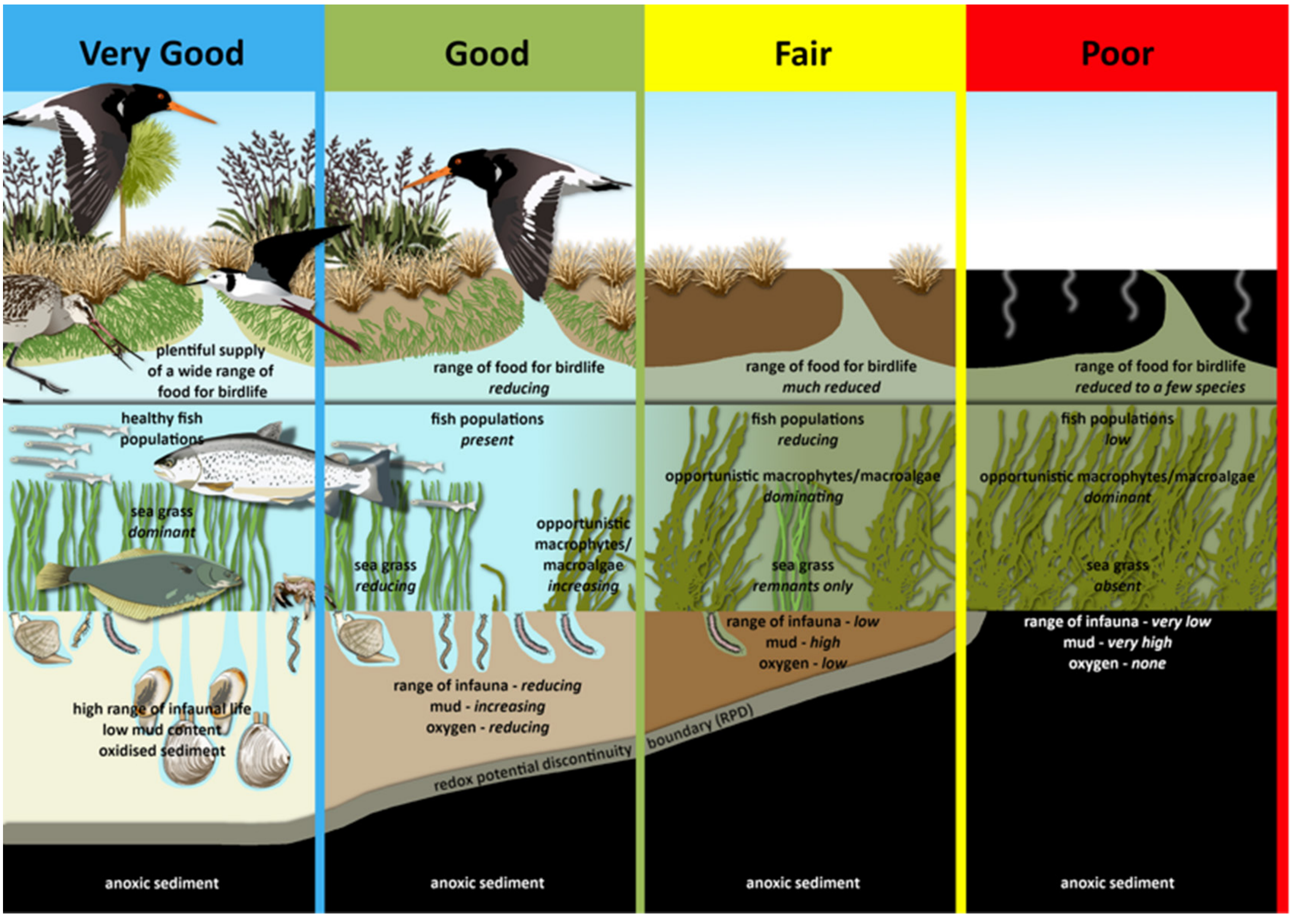


Tidal lagoon estuaries, like Waikawa, have a high risk of eutrophication, as they are typically shallow, fed by rivers, have large intertidal areas of sand or mud, and are moderately influenced by tidal flow.

Sediment and nutrients

Sediment and, to a lesser extent, nutrients are the primary ecosystem health issues for the Waikawa River Estuary – carried down and entering the estuary via the Waikawa River and the smaller waterways peppered around its perimeter. The sediment and nutrients that enter the estuary contribute to the expanding muddy zones and increase the risk of nuisance macroalgae growth alongside the reduced life-supporting capacity of the sediments

Estuary health outcomes can be described on a scale from ‘very good’ to ‘poor’. Using an outcome scale can help us understand the state of the freshwater environment and what we might be trying to achieve in the future. This concept is depicted for estuaries in the image below. We measure various aspects of the estuarine environment that can help us define and determine estuary outcomes. Monitoring results show that the main issue for Waikawa Estuary is high sedimentation (mud) levels. Heavy metals are not an issue for this estuary.



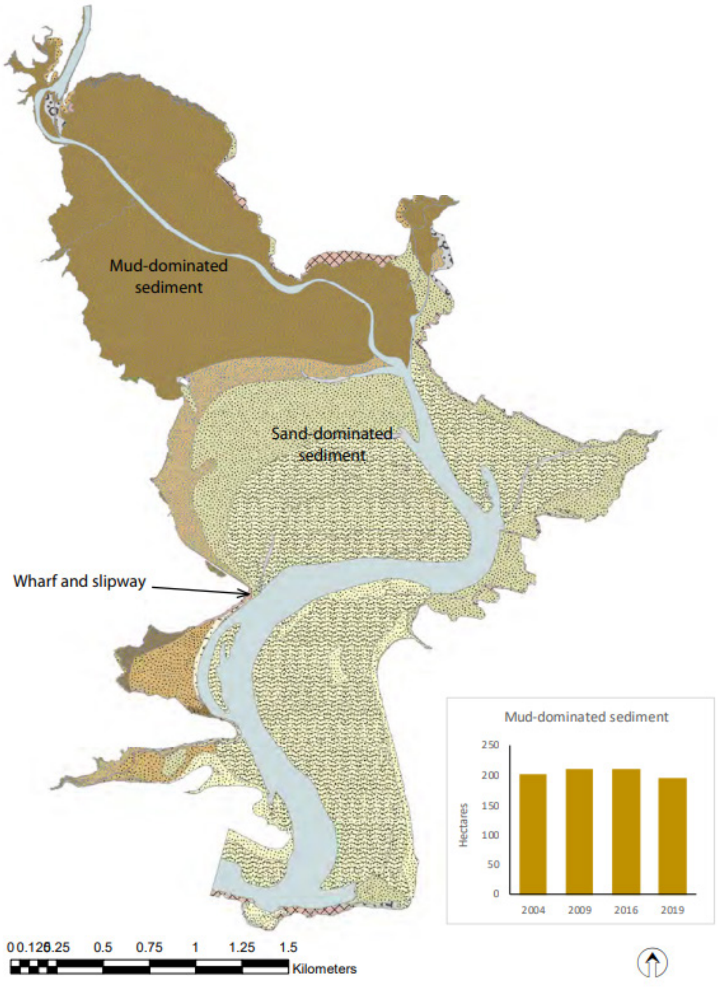
Increased muddy zones create areas that are less conducive to healthy estuarine ecosystems. The increased mud content of the sediment, alongside nutrients, decreases the depth oxygen can penetrate. This means that sensitive sediment-based organisms such as crabs and shellfish struggle to survive. Seagrass also struggles to grow in areas where sediment has a high mud content.

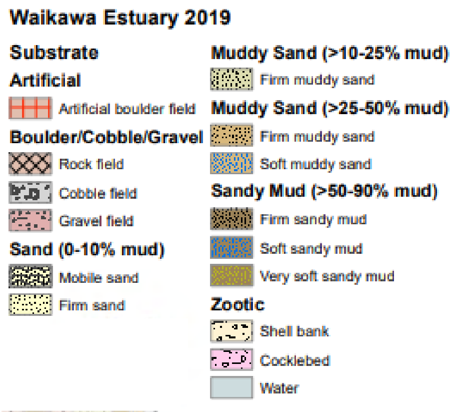
Increases in sediment and nutrient levels also contribute to conditions favouring macroalgae growth, which supports further sediment deposition and can increase the speed at which an estuary degrades.

As with most estuaries, results for measured attributes vary spatially across Waikawa, primarily due to the influence of the ocean and the estuary's hydrology. For example, the upper tidal flats are more at risk of mud build-up, nutrient accumulation, macroalgae growth and seagrass loss.

Regional attributes	Hauora target	Current state
Phytoplankton	C	No data
Sediment oxygen levels	B	C
Gross eutrophic zone	A	B
Mud content	A	D
Mud extent	Pass	Fail
Sedimentation rate	<2 mm/year	Pass
Macroalgae	B	B
Enterococci	A	No data
Enterococci at popular bathing sites	A	No data
Total metals in sediment (Arsenic, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Zinc)	A	A

Broadscale mapping shows high concentrations of soft sediments or mud in the upper reaches of the estuary, where deposition is highest and tidal energy lowest. This area is starting to experience some increases in macroalgal cover, but it has not become dominant yet.





Water quantity – how much do we have, and how much are we using?

Surface water allocation

Surface water takes are managed through two types of allocation blocks. A primary allocation block restricts the amount of water that can be taken during low flows (allocation available is 30% of Q95). A secondary allocation block restricts the amount of water that can be taken when flows are above mean or median levels, depending on the time of year (10% of mean flow from December to March and 10% of median flow from April to November).

Stream depletion occurs when groundwater is abstracted in an area hydraulically connected to nearby surface waterways, reducing stream flow. As a result, it has to be accounted for in surface water and groundwater allocation management. Under the Southland Water and Land Plan, we are required to manage surface water allocation at any point of a surface water network, so allocation totals change along rivers to reflect the balance between the natural addition of water and the abstraction of water.

Most surface water abstractions are subject to minimum flow requirements, meaning they must cease abstraction when flow thresholds are reached. The following allocation figures do not include permitted take estimates. Only the Waikawa River has continuous flow monitoring in this zone and has no surface water abstraction consented. There is one consented surface water abstraction of 1 l/s for municipal supply at Curio Bay.

Monitoring data provided by consent holders show that surface water use was less than 5% of the total volume allocated during the 2022/2023 season.

Site	Primary allocation (l/s)		Secondary allocation – Summer - 1 Dec - 31 Mar (l/s)			Secondary allocation – remainder of year - 1 Apr - 31 Nov (l/s)		
	Minimum flow (Q95, l/s)	Most consecutive days below Q95	Mean (l/s)	Average days below mean (Summer period)	Most consecutive days below mean (Summer period)	Median (l/s)	Average days below median (remainder of year period)	Most consecutive days below median (remainder of year period)
Waikawa River at Biggar Road	818	45 (2022)	3,815	109	121 (2022	2,573	87	47 (2020)

Groundwater allocation

Most groundwater allocation thresholds are set using a proportion of annual rainfall recharge to aquifers, varying depending on the aquifer type. In the Waikawa catchment, there are no defined GMZs. As per the Southland Water and Land Plan, primary allocations for groundwater abstractions outside of GMZs are calculated as 35% of the estimated rainfall recharge occurring over the relevant land area where the water is to be taken.

There are four groundwater abstraction consents in the Waikawa catchment.

Waikawa allocation/use summary 2022/2023

Most of the allocated groundwater is consented for municipal use (64%), with the remaining volume consented for dairy (36%). Monitoring data provided by consent holders indicate overall groundwater use was less than 50% of the total volume allocated for the 2022/2023 season.

How much do we need to reduce contaminants to achieve a state of hauora?

Regional contaminant modelling

We have undertaken contaminant modelling to help us better understand water quality across Murihiku Southland. This modelling utilises monitoring data to estimate water quality in all waterbodies (excluding Fiordland and islands). This expanded view of water quality allows us to estimate the reductions in contaminant load and concentrations required to achieve the identified target attribute states and can test the impact of different land use scenarios.

For this work, we focused on four main contaminants of concern: nitrogen, phosphorus, sediment, and *E. coli*. Actions taken to reduce the impact of these contaminants on our freshwater systems will have benefits for ecological and human health outcomes.

How much do contaminant loads need to be reduced?

Load is a measure of the total mass of a contaminant (in kg or tonnes) coming from a given area past a given point over time. For example, the total amount of nitrogen delivered to the sea by a river in one year.

We use loads to quantify contaminants here because they describe the amount of contaminants lost over a whole catchment area. It is the land that consequently needs to be managed to reduce those loads. It is important to remember that concentrations (e.g., the mass of the contaminant per litre of water in the waterbody in kg/L) must also be considered. Concentrations in waterbodies are affected by the size of the contaminant load lost from land and the amount of water available to dilute that load. Hence, water takes and climate can affect concentrations too.

Concentrations are the relative amount of contaminant present in a given volume of water at that time. Concentrations are important because they have direct relevance to toxicity attributes as well as ecological processes.

This modelling considers draft targets for the following attributes:

Rivers
Periphyton biomass, nitrate toxicity, dissolved reactive phosphorus, visual clarity, suspended sediment, *E. coli*.

Lakes
Total nitrogen, total phosphorus, phytoplankton.

Estuaries
Macroalgae.

This modelling accounts for loads and concentrations required to achieve target states everywhere for all the above attributes.

Estimated load reductions for the Waikawa catchment are in the table below. Load estimates were calculated using sites with ten years of data and relates to 2017.

Contaminant	Total Load (2017 - Best estimate*)	Percentage load reduction required to achieve hauora (Best estimate*)
Total Nitrogen	251 Tonnes/Year	↓ 17% (0-52)
Total Phosphorus	40 Tonnes/Year	↓ 40% (6-70)
Sediment	9,000 Tonnes/Year	↓ 54%
E. coli	10 peta *E.coli*/Year	↓ 86% (72-95)

These values represent our best estimate. Levels of uncertainty are indicated by the 90% confidence interval shown in brackets where available. For estimates of uncertainty, see full reports.

What options do we have to reduce nutrient and sediment loads?

We have modelled different scenarios to indicate how far each may go toward achieving the estimated load reductions required. We have also bundled multiple scenarios to test the effect of combining multiple strategies.

This work is not intended to assess individual properties or activities. Rather, it generalises land use so that we can make some broad catchment scale assessments of the impact of different actions. This can also help give information about the differences between possible allocation approaches.

The results for each of the scenarios modelled are presented on page 26. Explanations of each scenario can be found in our published reports. The coloured table cells indicate how far each scenario achieves the required load reductions.

Several of the tested scenarios would likely achieve the nitrogen reductions required. In the case of the Waikawa, phosphorus and sediment and *E. coli* require larger load reductions, and actions to achieve these would need to be considered.

We have also modelled phosphorus and suspended sediment load reductions under different mitigation options. These results are not presented here but broadly show:

- Implementation of scenarios 4 and 14 (detailed on next page) was estimated to achieve the phosphorus reductions required. Furthermore, scenarios 5, 11, and 15 are estimated to achieve reductions within the uncertainty of the required estimate. The range of reductions across all scenarios was 0-42%.
- Implementing existing rules and regulations relating to sediment is estimated to achieve a 10% reduction in suspended sediment load delivered to the estuary. This is less than the required 54% reduction to support hauora.

ID	Scenario	Reduction in nitrogen load (%)	Remaining deficit from target (%)
Individual methods			
1	100% adoption of established farm Good Management Practice (GMP) mitigations	3	14
2	Adoption of all established and developing farm mitigations	13	4
3	Wetlands returned to the same area as existed in 1996	3	14
4	Establishment of wetlands in a way that treats all surface runoff from agricultural land	35	0
5	Establishment of large community wetlands in inherently suitable areas	9	8
6	All wastewater point sources are discharged to land rather than directly to water	0	17
7	Reducing land use intensity on flood prone land	0	17
8	Reducing land use intensity on public land	0	17
9	Destocking (10% reduction drystock, 20% reduction dairy)	7	10
10	Riparian planting (full shading of streams <7m wide)	1 (indirect effect on periphyton)	16
Bundled methods			
11	1996 wetlands returned, wastewater discharged to land (3 + 6)	28	0
12	Established and developing farm mitigations, 1996 wetlands, wastewater to land (2 + 3 + 6)	16	1
13	Established and developing farm mitigations, 1996 wetlands, wastewater to land, repurposing public land (2 + 3 + 6 + 8)	16	1
14	Established and developing farm mitigations, 5% wetlands, wastewater to land, repurposing public land (2 + 4 + 6 + 8)	43	0
15	Established and developing farm mitigations, community wetlands, wastewater to land (2 + 5 + 6)	21	0
16	Established farm mitigations, wastewater to land, plantain on dairy farms, 1996 wetlands, repurposing of ES land, forestry expansion (1 + 6 + 3 + new individual methods)	31	0

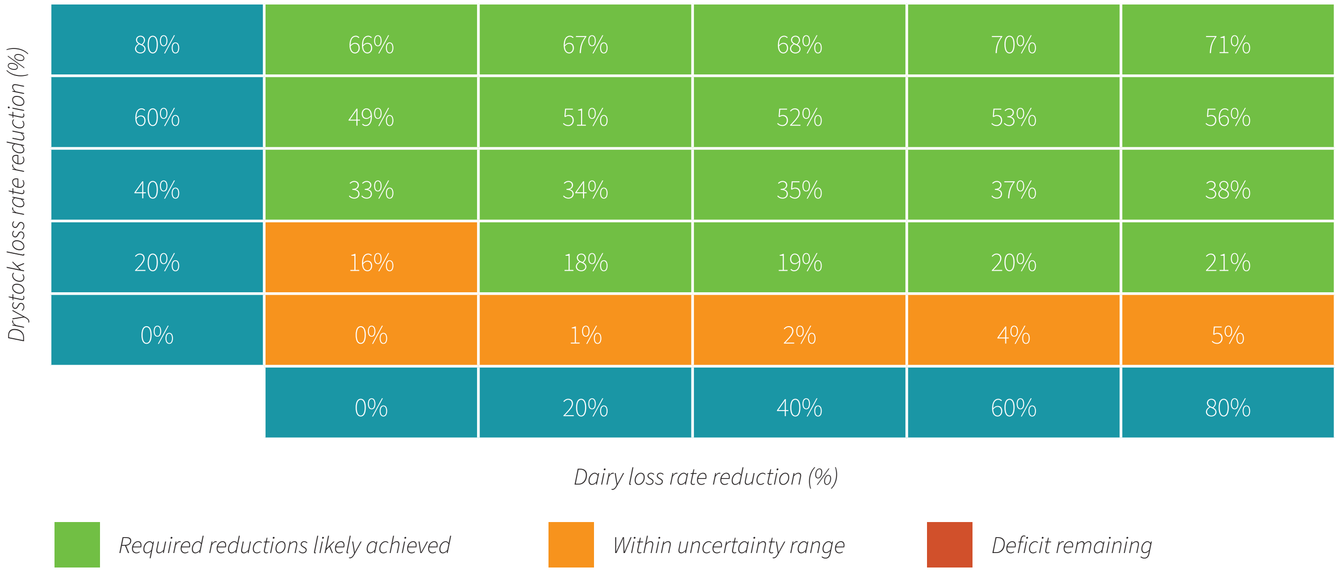
🟩 *Required reductions likely achieved* 🟧 *Within uncertainty range* 🟥 *Deficit remaining*

Reducing load from pastoral land across the catchment

In addition to the above, we looked at different nitrogen load reduction scenarios for dairy and drystock farms. The purpose of this work was to help show the reductions that could be achieved via reductions in loss from drystock and dairy land. Nitrogen losses vary depending on land use and multiple environmental factors. We used land use, climate, soil type and slope to estimate losses from the land. The percent reductions modelled apply across these estimated losses.

The table shows the load reduction achieved for each combination of simulated reductions. The coloured table cells indicate how far each combination achieves the required load reductions. For example, a 40% reduction in loss from dairy farms combined with a 20% reduction from drystock farms will result in approximately a 19% reduction in the instream TN load across the catchment.

Basin-wide mean % TN reduction, relative to baseline



Drystock loss rate reduction (%)					
80%	66%	67%	68%	70%	71%
60%	49%	51%	52%	53%	56%
40%	33%	34%	35%	37%	38%
20%	16%	18%	19%	20%	21%
0%	0%	1%	2%	4%	5%
	0%	20%	40%	60%	80%

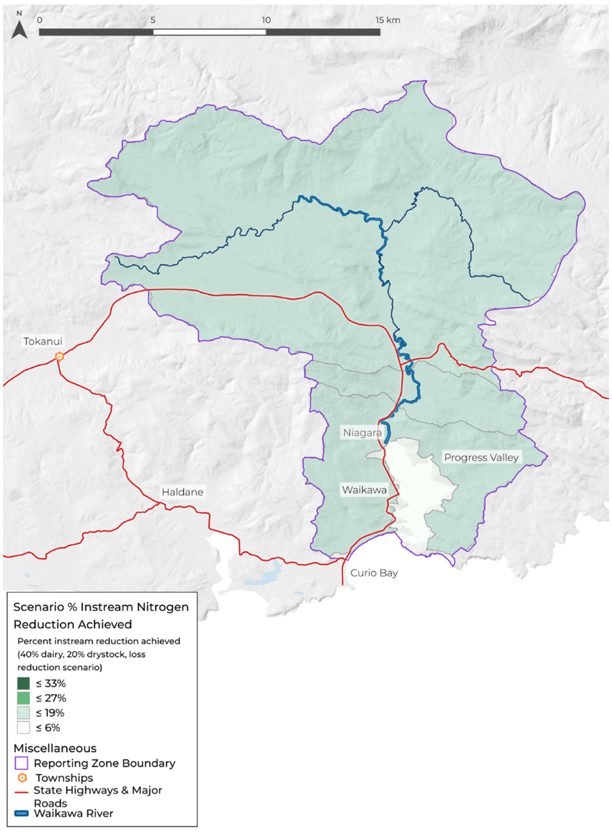
Dairy loss rate reduction (%)

🟩 *Required reductions likely achieved*

🟧 *Within uncertainty range*

🟥 *Deficit remaining*

Instream nitrogen reduction achieved (%)



The map shows how the modelled nitrogen reductions achieved vary spatially across the sub-catchments. In the Waikawa, if all dairy land reduced nitrogen losses by 40% and drystock by 20%, we would expect instream reductions to be similar across the catchment.

Opportunities for action

We've put together opportunities for action for the Waikawa catchment to reduce the load and impact of contaminants on freshwater.

The catchment Scale of the problem

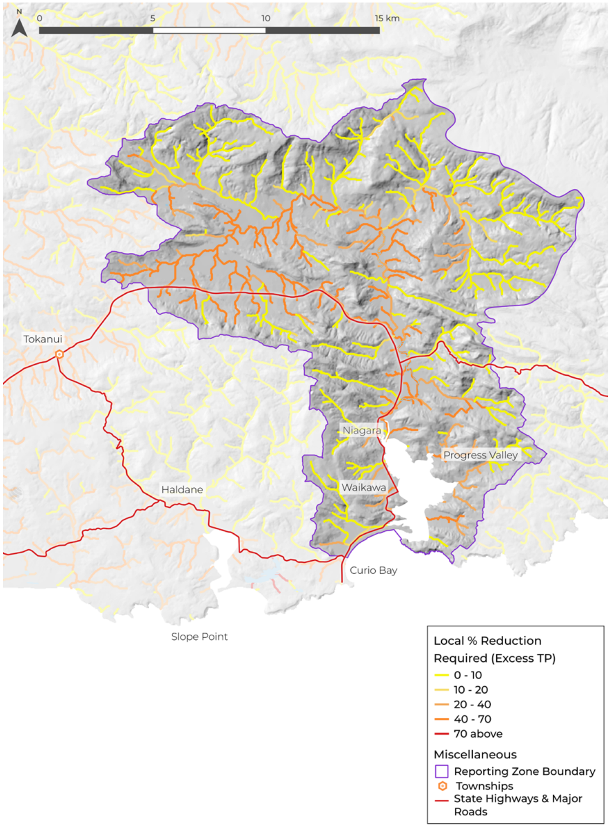
The Waikawa catchment currently has better freshwater quality outcomes than many other catchments in Murihiku Southland. However, some environments in the catchment are sensitive to contaminant loads, and modelling indicates that reductions in sediment, phosphorus and *E. coli* loads would be required to meet targets.

The map below shows modelled excess phosphorus load patterns and helps to demonstrate the spatial scale of the reductions required. Excess loads depend on the modelled concentrations and all the defined targets locally and downstream. The load excess map indicates the magnitude of phosphorus load reductions to achieve river, lake and estuary targets for the entire catchment.

High phosphorus, sediment and *E. coli* loads may be difficult to mitigate, and implementing improved management practices alone may not achieve the desired outcomes for freshwater and the estuary. Consideration should be given to the potential for large-scale catchment mitigations and changes to land use.

In addition, efforts to implement nature-based solutions and slow water flow will likely benefit water quality, biodiversity, flood mitigation and catchment resilience.

Critical excess TP load (%)



Farm scale opportunities for action

Farm-scale actions should be tailored to physiographic settings as well as catchment priorities. In the Waikawa catchment, load reductions are required for all major contaminants (nitrogen, phosphorus, sediment and *E. coli*).

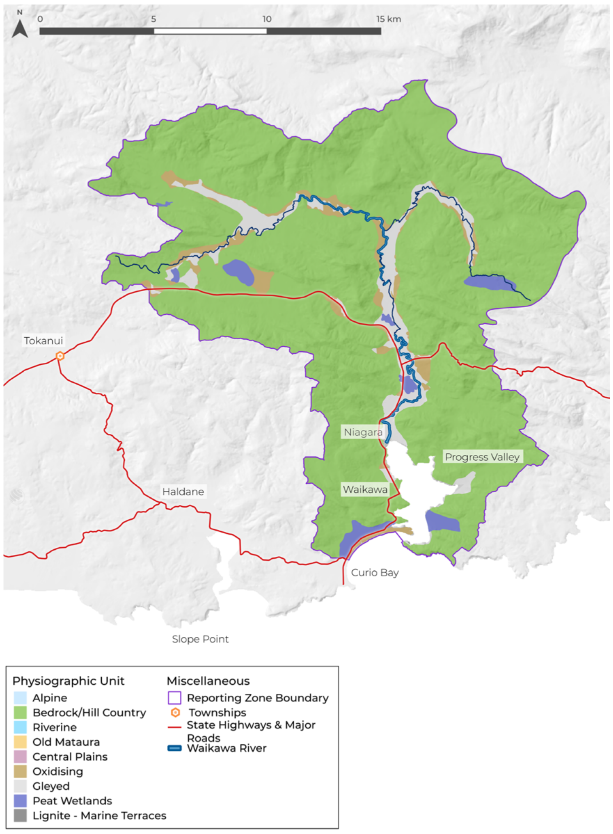
We can use farm scale observations, physiographic information, and our understanding of water quality to help refine the most relevant actions for a given location or landscape.

Physiographic zones help us better understand how contaminants move through the landscape. Each zone has common attributes that influence water quality, such as climate, topography, geology and soil type.

Contaminants can move from the land to waterways via:

- overland flow (or surface runoff)
- artificial drainage - e.g. tile drains and mole pipe drainage
- deep drainage (or leaching) - of either nitrogen or phosphorus to groundwater
- lateral drainage (or horizontal movement through the soil) - of phosphorus and microbes

Physiographic zones



These key transport pathways for contaminants differ for each physiographic zone. Understanding differences between zones allows for targeted land use and management strategies to be developed to reduce impacts on water quality.

Widespread implementation of property actions to improve water quality can have significant co-benefits for catchment hydrology (flood risk and climate change resilience) and biodiversity outcomes.

The Waikawa catchment comprises four main physiographic zones: bedrock/hill country, gleyed, oxidising and peat wetlands.

Farm-scale, or more resolute physiographic information may be available in some locations. We promote using the best information available to identify farm-specific risks and solutions.

The following maps help to identify the most important actions to focus on in different parts of the catchment.

Nitrogen

Over time, reductions are required across the catchment area to achieve hauora targets.

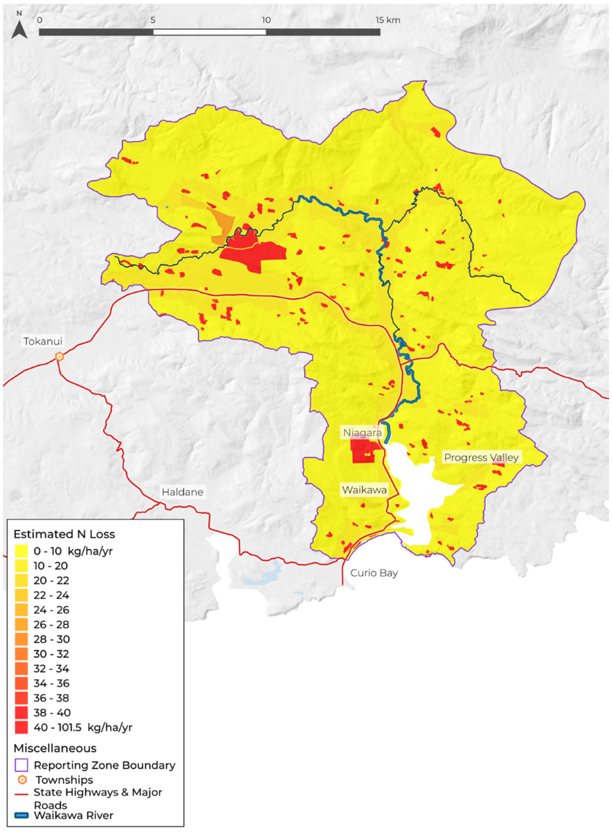
Reducing nitrogen loss should be a priority in all farm-scale mitigation planning.

Physiographic zones can help to identify what contaminant loss pathways likely need attention in different locations. Nitrogen reductions will be required across the catchment to meet a state of hauora. The map of estimated nitrogen loss indicates where losses are expected to be higher due to the presence of dairy farms or winter grazing. The specific locations of winter feed crops change from year to year.

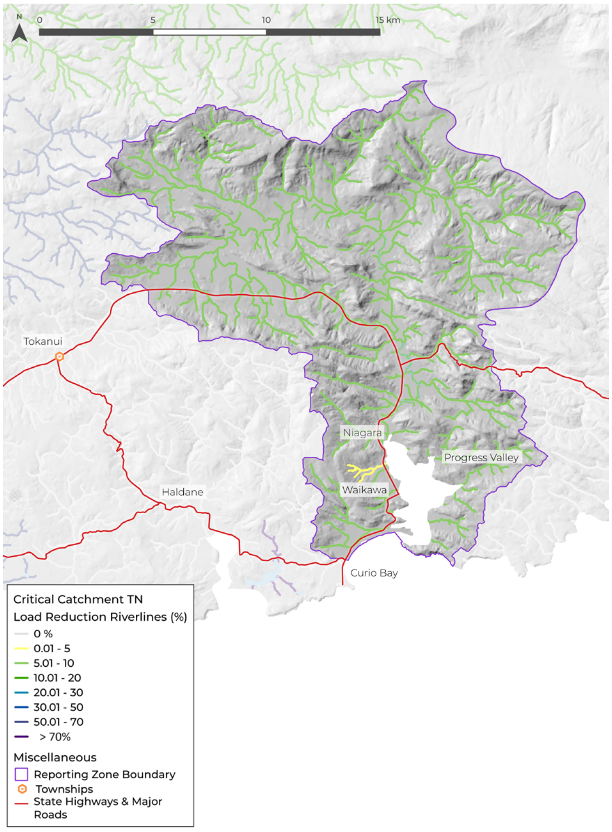
This excess load map shows parts of the catchment where nitrogen loss mitigation should be a particular focus in farm planning to reduce excess nitrogen loads. This map indicates the magnitude of nitrogen load reductions needed to achieve all river and estuary targets for the entire catchment area.

▸ *Nitrogen loss in this graphic is an approximation and is only differentiated by land use, soil drainage, rainfall/irrigation, and slope.*

Estimated nitrogen loss



Critical catchment TN Load reduction (%)



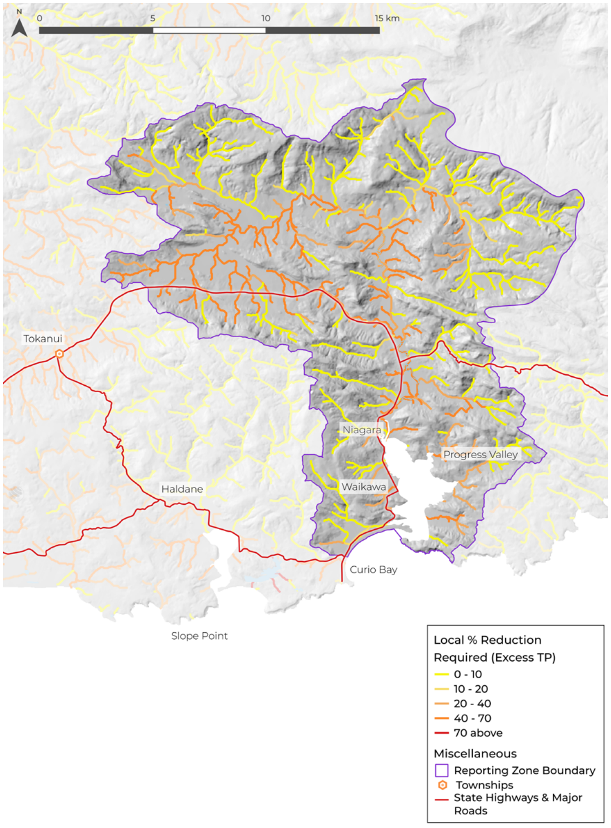
Phosphorus

Over time, reductions are required across the catchment area to achieve hauora targets.

Reducing phosphorus loss should be a priority in all farm-scale mitigation planning.

Physiographic zones can help identify which contaminant loss pathways likely need attention in different locations. As shown above, the excess load map indicates areas where phosphorus loss mitigation should be a particular focus in farm planning.

Critical excess TP load (%)



Sediment

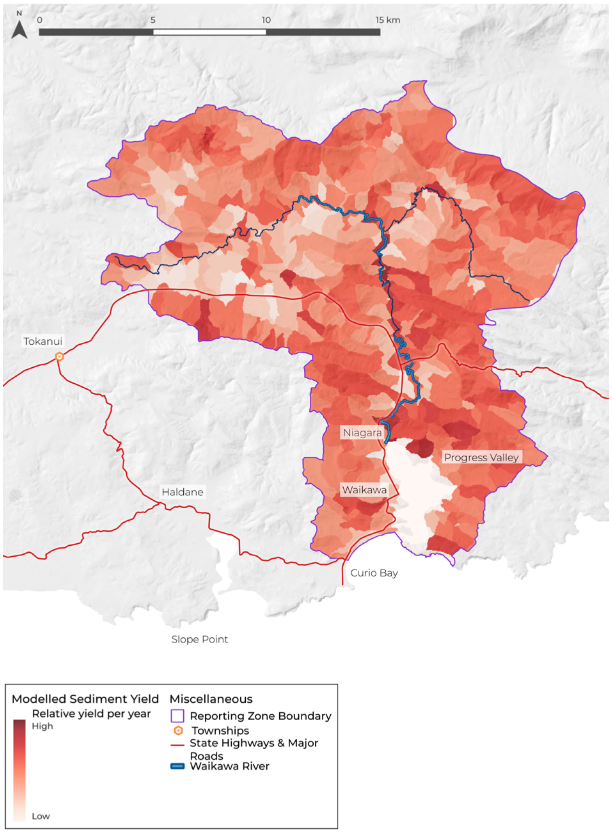
The map (right) shows how we expect sediment loss to vary throughout the catchment. Areas of higher sediment loss rates are shaded darker red. These are generally areas with more sloping land, soils susceptible to erosion, and where stream bank erosion is likely an issue.

While some areas are predicted to have higher erosion, the map indicates that sediment loss can be an issue right across the catchment.

Sediment from natural erosion in native vegetation generally has less impact on waterways than sediment from agricultural land. Agricultural sediments are usually finer and carry higher concentrations of nutrients.

Large reductions in sediment load are required, so reducing sediment loss should be a priority in farm-scale mitigation planning for all properties.

Modelled Sediment Yield



E. coli

The risk of *E. coli* loss to water depends on landscape type, slope, stock and vegetation. Property scale assessments should be used to mitigate the highest risk loss pathways on farms.

Urban and industrial opportunities for action

- Ensure wastewater and stormwater are not cross-connected in municipal systems.
- Improve on-site wastewater disposal systems to reduce the risk of human faecal contamination of freshwater.
- Incorporate best-practice stormwater management methods for urban development incorporates.

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