Waimatuku and Taunamau **catchment**

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Te Taiao Tonga

Waimatuku and Taunamau catchment

This document summarises scientific information, opportunities for action, and the socioeconomic context for the Waimatuku and Taunamau catchment.

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

The scientific data presented in this summary has been collated at the catchment scale to provide an understanding of freshwater quality and quantity challenges and their underlying factors. The summary provides an evaluation of the current state of freshwater within the zone and highlights 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: 25,400ha

Major rivers and streams: Waimatuku Creek, Middle Creek, Taunamau Creek

Aquifers: Waimatuku groundwater zone

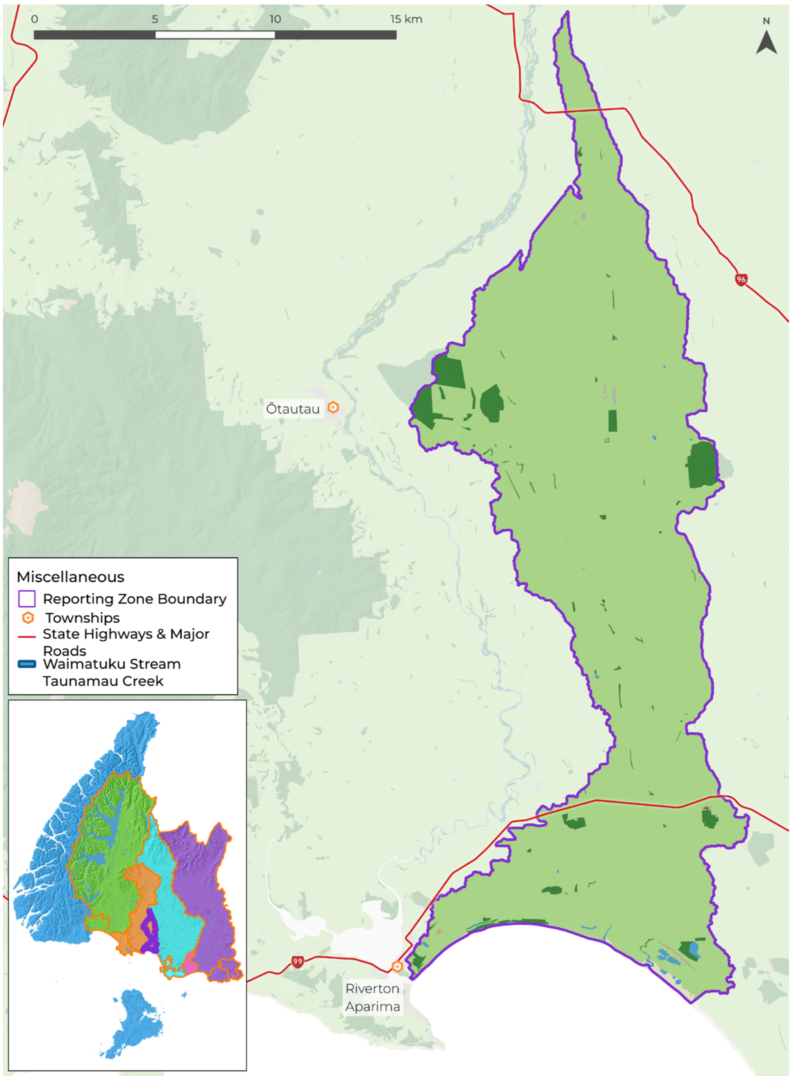
Lakes: Long White Lagoon, Big Lagoon

Estuaries: Waimatuku Estuary, Taunamau Estuary

Townships: Drummond

Population: Approximately 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 poor in many parts of the Waimatuku and Taunamau catchment. Six of the 12 (50%) attributes presented here do not meet hauora targets. Four of the 12 (33%) attributes are graded as currently 'poor' or 'very poor'.
- Monitoring results show that the main issues for Waimatuku Estuary are sediment (mud) and associated sediment oxygen levels.
- Modelling indicates that large contaminant load reductions are required for nitrogen (86%), phosphorus (56%), sediment (55%) and *E. coli* (86%) to achieve hauora targets.
- Approximately 436 ha of wetland have been lost since 1996 in the Waimatuku and Taunamau catchment. Of the remaining wetlands on non-conservation land, 67% are at a moderately high risk of being lost.

Opportunities for action

- Implement property scale mitigations tailored to the land's physiographic characteristics and the sensitivities of the receiving environments.
- Consider opportunities to facilitate land use change and deintensification within the Waimatuku and Taunamau catchment. This may be through developing long-term catchment plans, promoting alternative land use options and diversification, or implementing regulation that provides clear mechanisms and outcomes concerning contaminant loss reductions.

Socioeconomic context for action

The Waimatuku and Taunamau catchment is a small, lightly populated, predominantly rural area, making it difficult to gather accurate social insights due to the alignment of census statistical areas (SA2). While most of the Waimatuku catchment falls within the Ōtautau SA2, it also includes small portions of the Riverton, Wallacetown, Waianiwa, Ohai-Nightcaps, and Oreti River statistical areas. These areas are sparsely populated, and their statistics are not included in this social analysis.

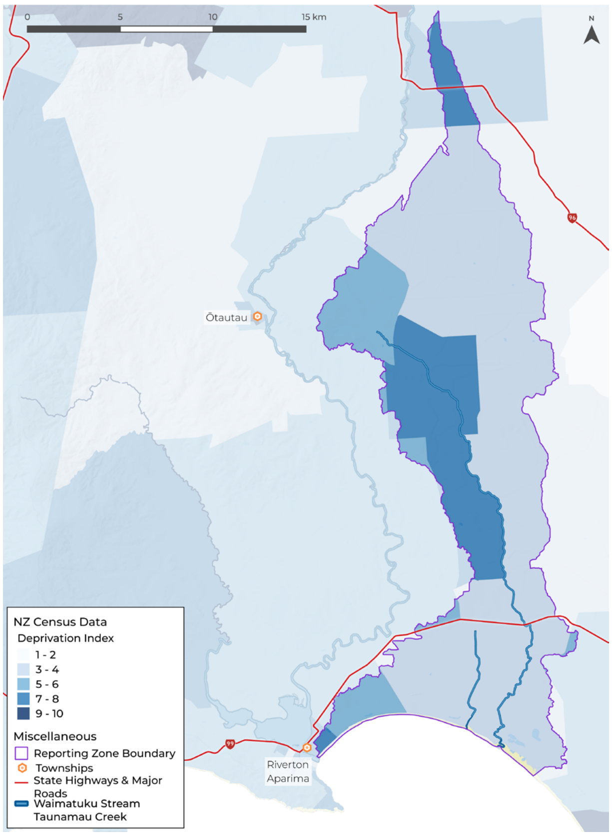
However, by combining data from other sources, we can infer some high-level insights about the Waimatuku and Tauananau catchment based on information from the Ōtautau statistical area.

Historic socioeconomic shifts in the late 20th century have shaped the Waimatuku area. The impacts of neoliberal deregulation from the 1980s removed agricultural subsidies and export assistance, creating a period of austerity for many farming communities in the area.

This led to a 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.

Although there have been some demographic fluctuations since 2000, the population of the Waimatuku and Taunamau catchment has remained relatively stable. Due to the catchment's location, it is difficult to determine whether these fluctuations are tied to changes in the Ōtautau township population or the transient nature of agricultural (dairy farm) workers, with younger families moving in and out of the area. This mobility may partly explain the comparatively higher numbers of working-aged people in their 30s and the larger proportion of younger children in the population.

Social Deprivation Index



The area has relatively affordable housing but, has seen a decline in homeownership over the past two censuses. This may again be attributed to a mobile agricultural workforce, who often prefer to rent on-farm accommodation.

The ethnic distribution in the area aligns with Southland district trends, with the population identifying as predominantly European and Māori. However, there is a growing population that identifies as having Asian ethnicity, many of whom were born overseas.

Social Deprivation Index

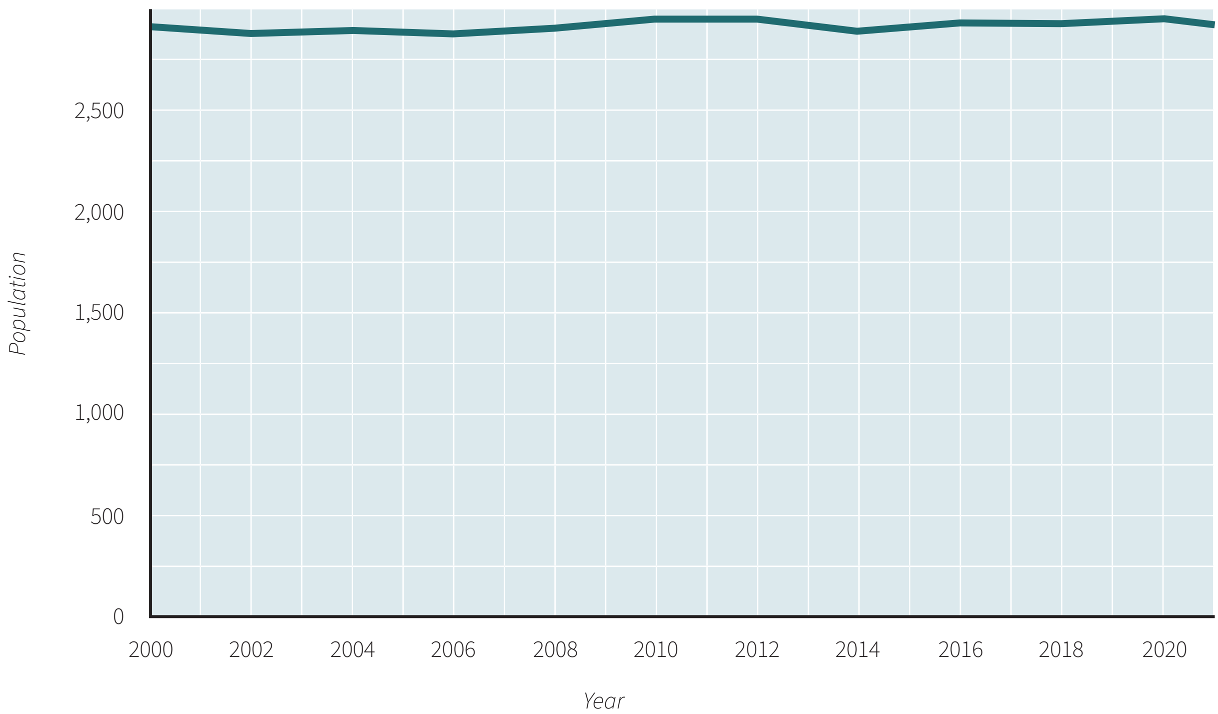
The Deprivation Index measures socioeconomic deprivation based on census information. It considers income, income benefits, communication access, employment, educational qualifications, home ownership, care support, living space and living conditions.

Employment in the Waimatuku area is closely tied to primary industries. In the Ōtautau SA2, 28% of the population is directly employed in agriculture, forestry, or fishing, with many others indirectly connected to these sectors. Given the rural nature of the Waimatuku and Taunamau catchment, this percentage is likely even higher.

Although the Southland district is among the least socioeconomically deprived areas in New Zealand, the Waimatuku and Taunamau catchment has some pockets of higher deprivation, particularly near the borders of the Riverton and Ōtautau townships.

Deprivation trends from 2014 to 2023 show that Ōtautau has experienced some increases in deprivation. Higher levels of deprivation tend to be associated with reduced capacity, fewer resources, and greater vulnerability, which can lead to poorer wellbeing outcomes for communities

Estimated population trends (Dot Loves Data, 2024)



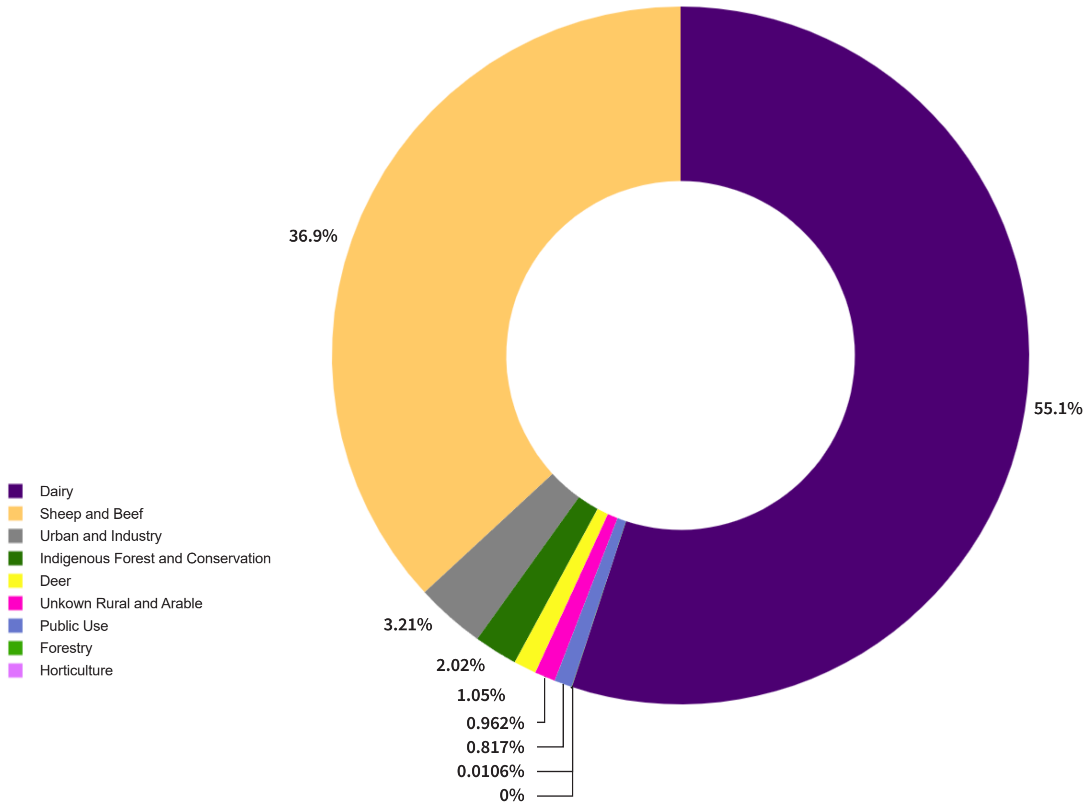
The Waimatuku and Taunamau catchment comprises only a portion of the Ōtautau SA2, so this graph only indicates general population trends.

Catchment overview

The Waimatuku and Taunamau catchment area begins near Heddon Bush, with both creeks originating on the eastern side of the Aparima River. The catchment is predominantly low-lying, with both creeks flowing toward the coast through an area dominated by highly productive exotic grasslands. The Waimatuku discharges into the Waimatuku Estuary, while the Taunamau Creek flows directly into the ocean.

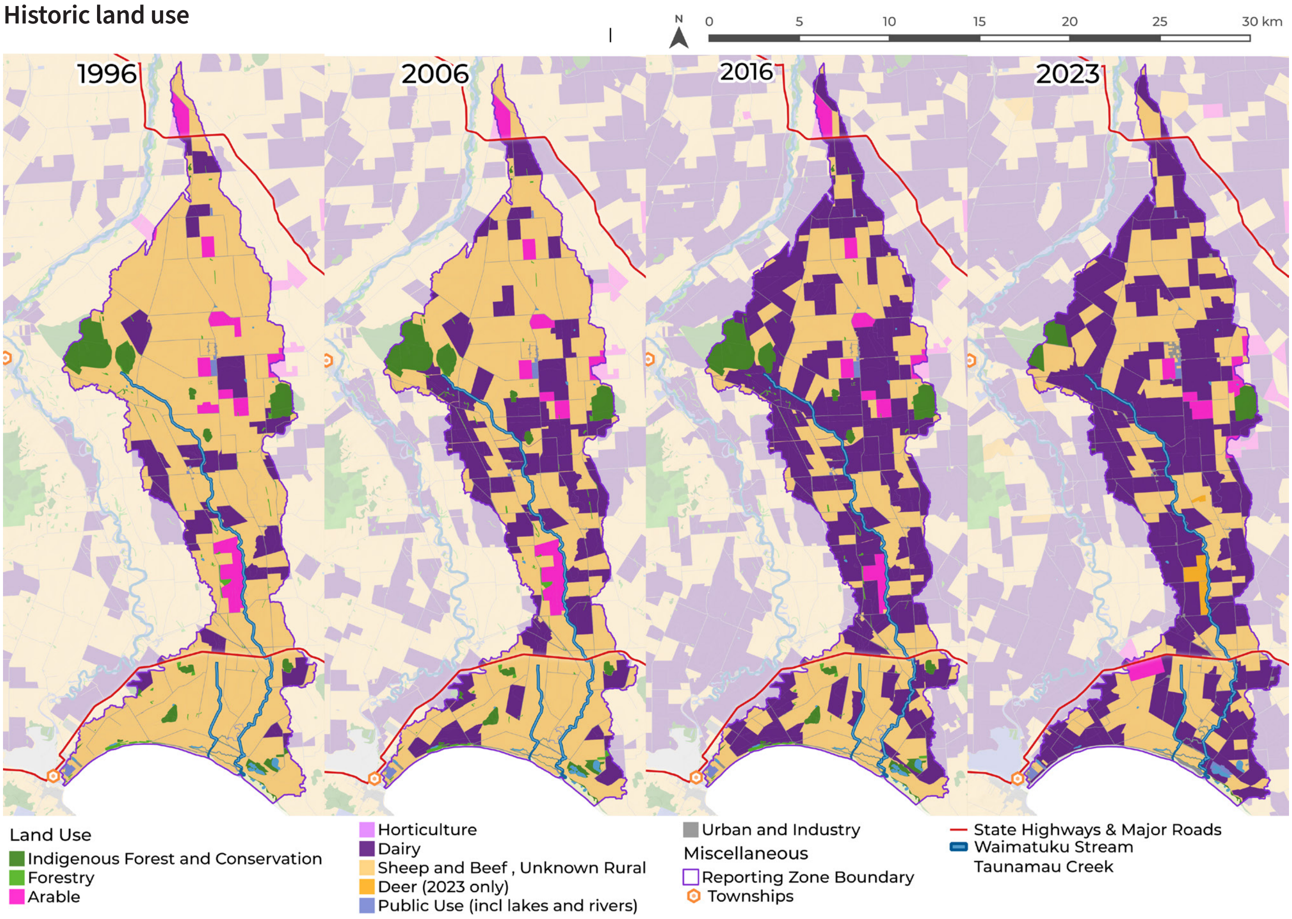
Land use

The Waimatuku and Taunamau catchment cover 25,400 ha of land, with about 23,881 ha (94%) used for farming. Approximately 500 ha (~2%) is Department of Conservation estate or indigenous vegetation and 750 ha (~3%) classed as urban or industry. Farming land use is predominantly beef and dairy (54.3%) and sheep (36.3%).



Over the past 25 years, land use changes have occurred, particularly with the expansion of the dairy sector. This growth in dairy farming has led to an increase in agricultural intensity and associated contaminant loss, resulting in increased pressure on natural resources.

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	No change	No change	No change	No change
Dairy	↑ 128%	↑ 82%	↑ 11%	↑ 360%
Drystock	↓ 19%	↓ 34%	↓ 7%	↓ 50%

Climate

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

Current climate

The Waimatuku and Taunamau catchment can typically be considered to have a cool-wet climate. On average, the mean annual temperatures are 10-11°C, summer in the range of 12-15°C and winter between 3-6°C. Typically, the area sees 25-50 nights below 0°C annually.

Rainfall across the Waimatuku and Taunamau catchment is consistent (800-1,100 mm/yr). The average number of wet days per year (>1mm rainfall) ranges from 150-200 per year. The heaviest rainfall events are typically seen in the coastal/southern part of the catchment area.

Future climate

Possible changes to the future climate of the catchment have been explored through several scenarios based on the representative concentration pathways (RCP) of 4.5 and 8.5. The outputs from these scenarios are summarised in the 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	↑ 1-1.25	↑ 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	↑ 5-10	↑ 0-5	↑ 10-25
	Number of frosty nights	↓ 5-10	↓ 10-20	↓ 5-10	↓ 15-25
Rainfall	Annual rainfall change (%)	↑ 0-5	↑ 5-10	↑ 0-5	↑ 15-20
	Number of wet days	170	170	171	171
	5-Day maximum rainfall (mm)	↑ 0-15	↑ 0-15	↑ 0-15	↑ 15-30
	Heavy rainfall days	32	32	31	35
	Seasonal changes	Much wetter springs	Concentrated to winter/spring	Concentrated to winter/spring	Concentrated to winter and spring

Catchment landscapes and hydrology

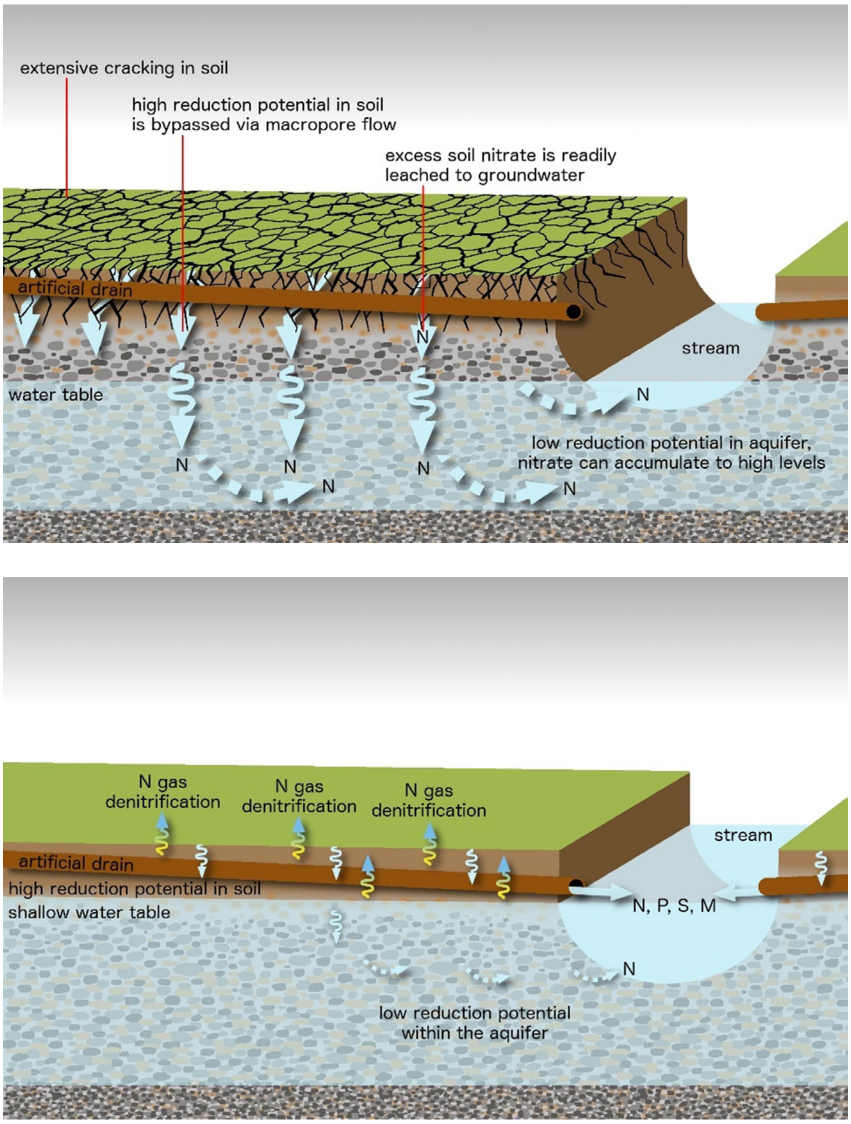
Water quality variations within a catchment are influenced by biogeochemical and physical processes. Understanding hydrology, geology and soil types within a catchment helps explain variations in catchment yields, water chemistry and water quality outcomes independent of land use.

Headwaters and mid-catchment

The Waimatuku and Taunamau streams both originate from the drainage of the Drummond, Heddon Bush, Gladfield, and Bayswater areas, collectively known as the Central Plains. Middle Creek, a significant tributary of the Waimatuku, drains the Drummond and Heddon Bush areas. This Central Plains region features gentle topography and is dominated by intensive agriculture. Consequently, water flowing into these streams interacts extensively with the agricultural landscape and associated contaminants. The Waimatuku Stream also drains the Bayswater Bog, a regionally significant peat wetland.

Soils in the upper and middle parts of the catchment are dominated by poorly drained silts over clays, with some distributed smaller areas of well-drained silts and organic soils. Poorly drained areas are often extensively drained, allowing water and contaminants to be rapidly exported to surface water during drainage periods.

These poorly drained soils also exhibit increased bypass flow characteristics. When dry, the soils shrink, creating macropores and bypass flow conduits through which water can drain directly into artificial drainage networks or underlying groundwater, bypassing the soil's ability to filter and attenuate contaminants.

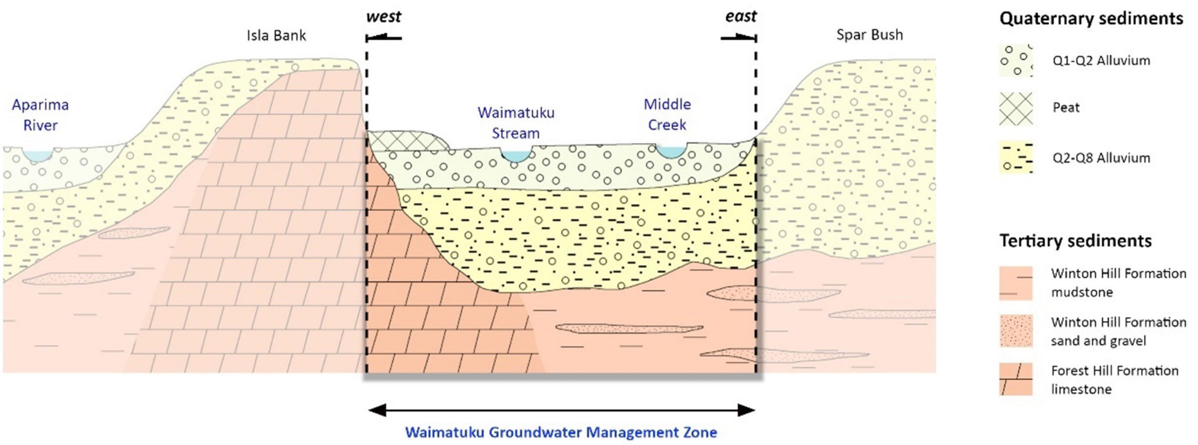


▲ *Conceptual illustration of the typical hydrological and landscape setting in the upper and mid catchment areas. Bypass flow during dry conditions is shown (top) vs wet soil conditions (bottom)*

Groundwater in the area is hosted in young alluvial deposits at shallow depths and older alluvium at greater depths, underlain by the older tertiary rocks of the Winton Hill and Forest Hill formations. These groundwater systems generally have a low capacity to attenuate nitrogen, leading to elevated concentrations. In some areas, nitrogen levels exceed drinking water standards. This high-nitrogen groundwater feeds into the Waimatuku and Taunamau streams via springs and baseflow, resulting in relatively high nitrogen concentrations in the streams.

Flow pathways and lag times vary significantly. Subsurface groundwater flows have relatively long lag times (years), while modified surface hydrology leads to shorter lag times for overland flow and artificial drainage networks.

Hydrological concept diagram



▲ *Conceptual depiction of the typical hydrological and landscape setting in the mid catchment.*

Lower catchment

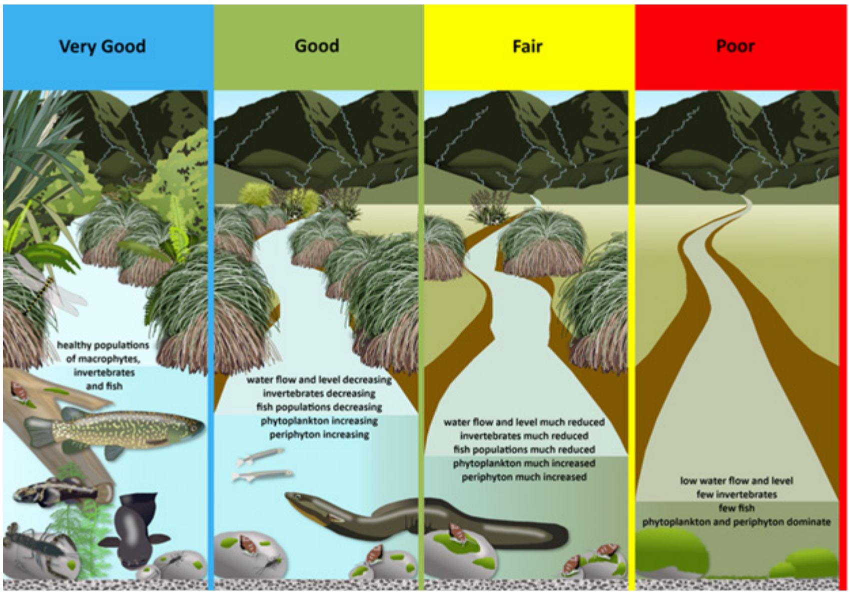
Closer to the coast, the streams drain larger areas of deeper, well-drained silts, gley and organic soils. Water and contaminant transport pathways vary across these different landscapes, but the dominant influence of intensive agriculture results in waterways receiving higher loads of nutrients and *E. coli*. The Waimatuku Stream discharges into an estuary, while the Taunamau Stream flows directly into the sea.

What are the water issues for this catchment?

Freshwater outcomes and how we measure them

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

Although many factors contribute to freshwater outcomes, we can only measure some of them to get an understanding of ecosystem health. We measure the aspects of the freshwater environment that can help us define and determine freshwater outcomes. These aspects 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 Waimatuku and Taunamau 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. River classes can also group environments that are subject to similar pressures, such as land use.

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

About 98% of the rivers in the Waimatuku and Taunamau catchment are classified as Lowland. The remaining 2% are Spring-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.

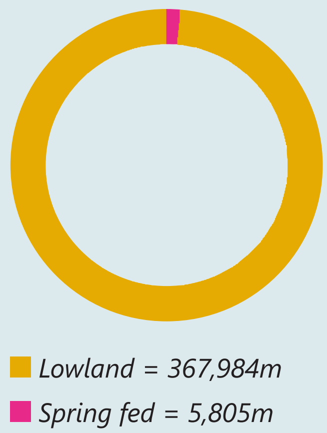
The different target states reflect the differences in natural characteristics for each river class.

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

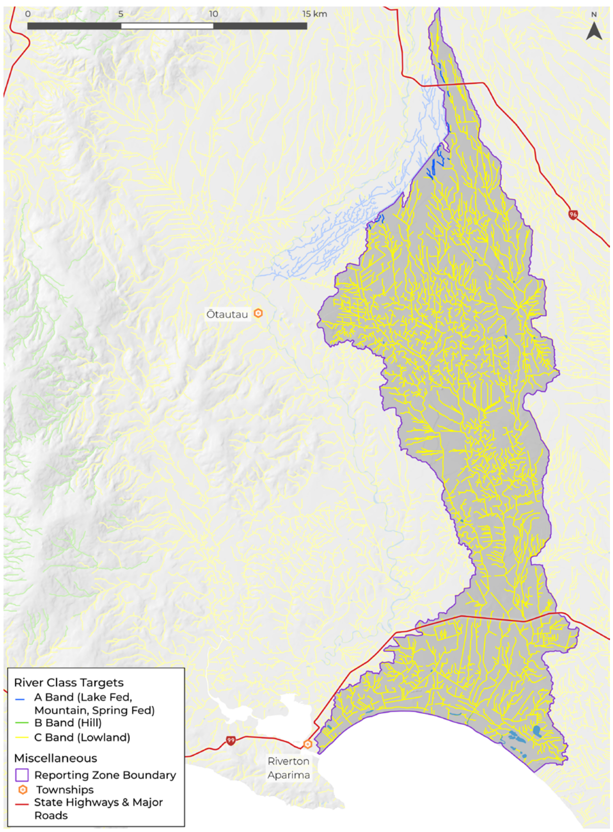
Natural State waterbodies can be identified for management purposes but are assigned attribute targets according to their underlying river classification (displayed here).

The map shows the distribution of periphyton targets for each river class within the Waimatuku and Taunamau 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 Spring-fed river classes. Table colours correspond to the 'ABCDE' grading for attributes described previously. Results show that very few of the monitored attributes meet the hauora targets in the Waimatuku and Taunamau catchment.

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

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

"-" no data available.

Results for the monitored streams and rivers

Ecosystem health

Nitrate toxicity and suspended fine sediment are measures of ecosystem health based on water quality. The current state of the monitored sites in the Waimatuku and Taunamau catchment is 'fair' for nitrate toxicity and 'poor' for suspended fine sediment.

The Macroinvertebrate Community Index (MCI) and periphyton biomass are measures of ecosystem health, based on the aquatic life present in streams and rivers. The MCI current state is 'poor' at all three monitored sites. In contrast, periphyton biomass at the single monitored site is rated 'good' and is the only ecosystem health attribute that meets the hauora target.

Dissolved Inorganic Nitrogen (DIN) is similar to nitrate toxicity, although the bands are set lower to recognise that nitrate has detrimental effects, such as promoting excessive plant growth, before reaching toxic levels that are toxic to aquatic life. Dissolved reactive phosphorus (DRP) is another nutrient that can support excessive plant growth. The Waimatuku Stream has high nutrient levels, with all monitored sites in the D band, or 'poor' state for both attributes.

Human health/contact

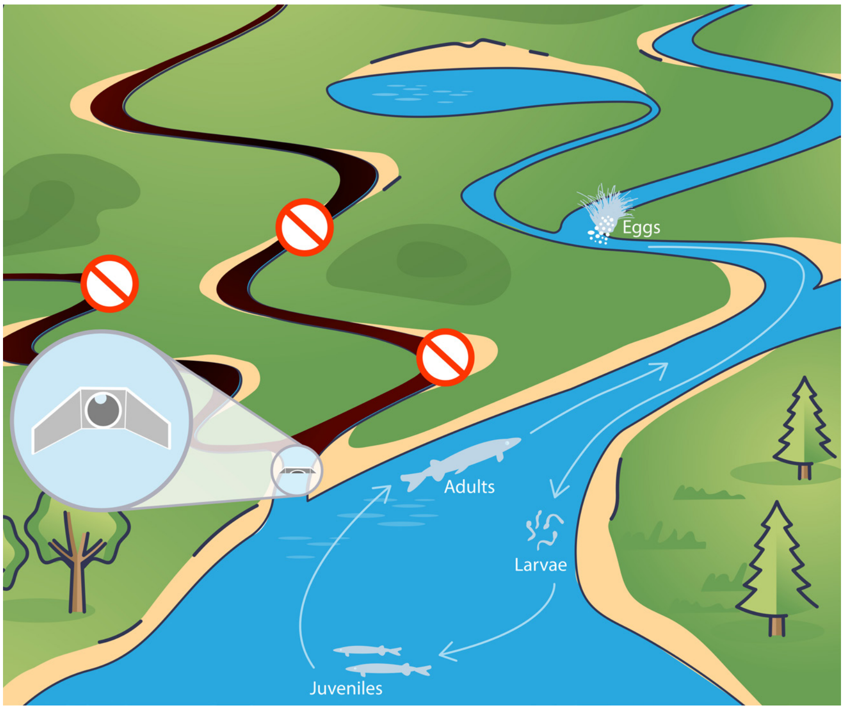
The human contact attributes benthic cyanobacteria and *E. coli* are measures of the suitability of the waterbodies for recreational use. Both monitored sites have a current state of 'very poor' and are significantly below the target state of the A band. Benthic cyanobacteria (also called potentially toxic algae) is monitored at one site in the Waimatuku and Taunamau catchment, which achieves the target state of A band.

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.

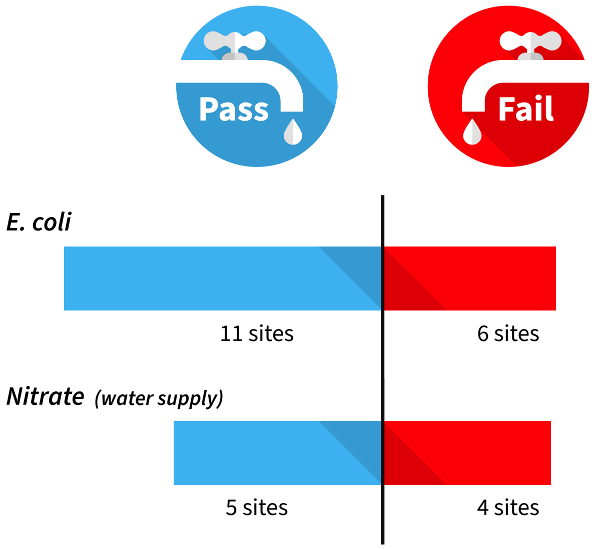
In the Waimatuku and Taunamau catchment, culverts are the most common type of fish passage barrier. Considering fish passage during the design and installation of structures, along with regular maintenance, will help improve fish passage.

Groundwater

Human consumption – is it safe to drink?

Groundwater in the Waimatuku and Taunamau catchment is typically at a depth of 2-4 m with a median bore depth of 12 m. Most utilised groundwater is hosted in Quaternary 1 – Quaternary 8 alluvial deposits.

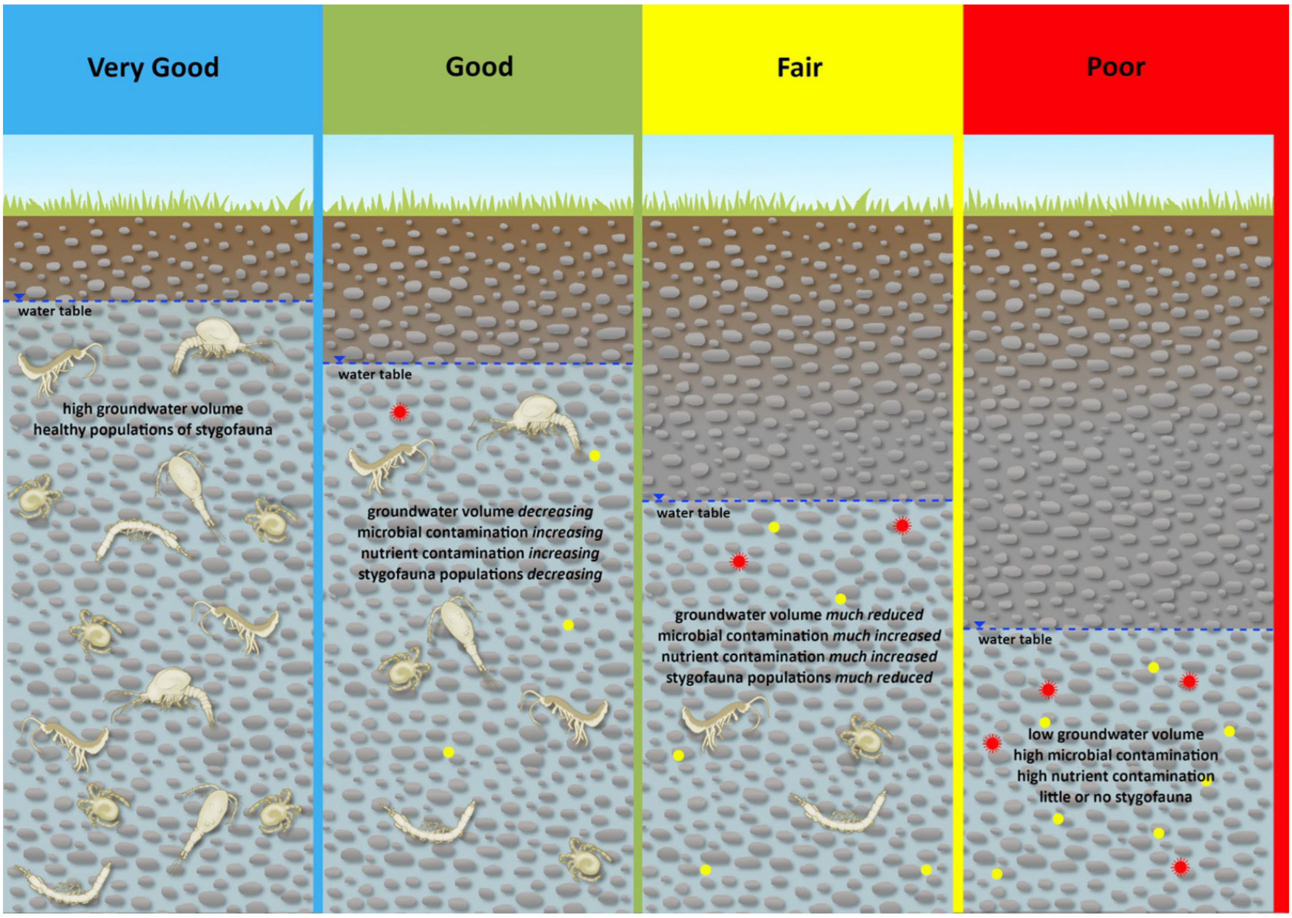
The main issues affecting potable groundwater's suitability for drinking are pathogens (*E. coli*) and nitrate. Target states for groundwater are based on the New Zealand drinking water standards and use a pass/fail assessment system.



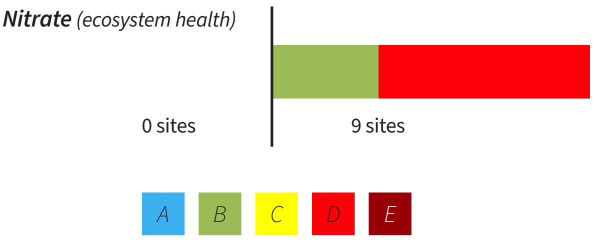
About 60% of the monitored sites meet the target for the *E. coli* (water supply) attribute. The nitrate (water supply) attribute is monitored at fewer sites, and over half of the monitored sites pass the drinking water standard.

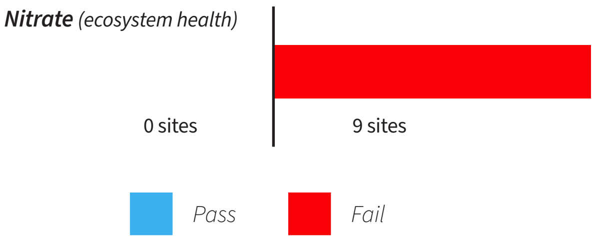
Ecosystem health

Nitrate concentrations are also used to monitor ecosystem health for groundwater ecosystems and connected surface waterways. Groundwater ecosystem health outcomes are represented conceptually in the figure on the following page. Nitrate concentrations are one factor that contributes to overall ecosystem health. Nitrate concentrations related to surface water and groundwater ecosystem health outcomes differ from those used in drinking water mentioned above.



The ecosystem health attribute nitrate toxicity has sites with current states ranging from 'good' to 'poor', with most monitored sites in 'poor' condition. All sites fail to achieve the hauora target of A band.





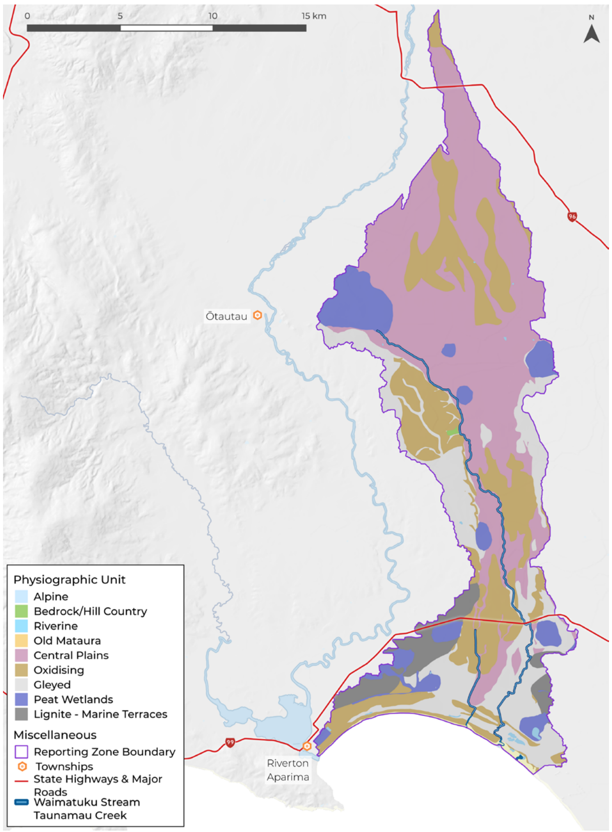
Groundwater contamination 'hotspots'

There are several areas within the Waimatuku and Taunamau catchment where the groundwater is highly contaminated with nitrogen. We call these 'hotspots'. Hotspots have been identified through sampling and modelling and are shown in red in the map below (right). As well as the hotspot areas, the Waimatuku and Taunamau catchment exhibit elevated nitrate concentrations across much of the catchment (areas coloured yellow). These elevated nitrogen concentrations impact groundwater ecosystem health and contribute to contamination and eutrophication in surface water environments.

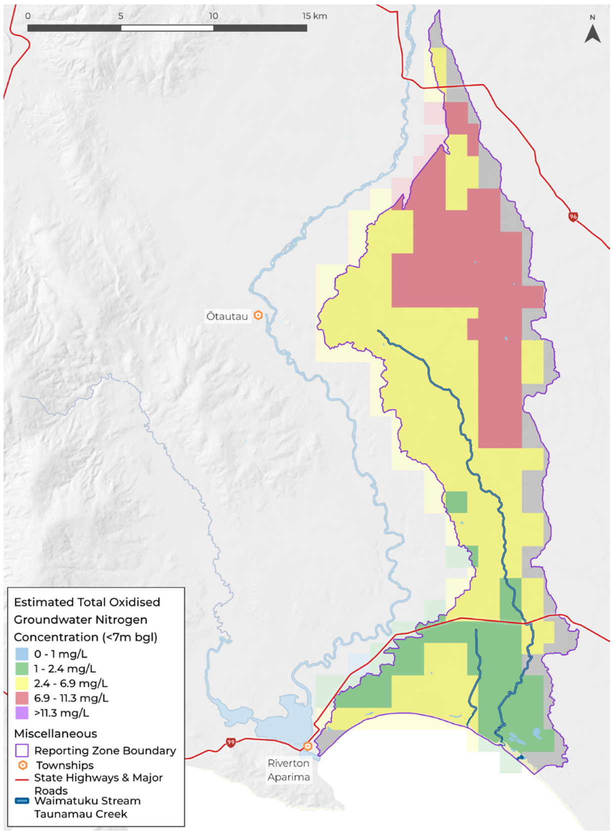
The maps highlight areas susceptible to groundwater contamination due to the overlying land use and the natural characteristics of the soils and geology.

Areas of highly contaminated groundwater will likely require targeted nitrogen action via management and changes in farm systems. Areas within the Oxidising and Riverine physiographic zones, which are also shaded yellow and red on the map, are likely high-risk areas. In these locations, landowners should implement management plans focusing on key pathways and stockpile property-scale actions targeting nitrogen loss via deep drainage.

Physiographic zones



Groundwater nitrogen concentrations



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:

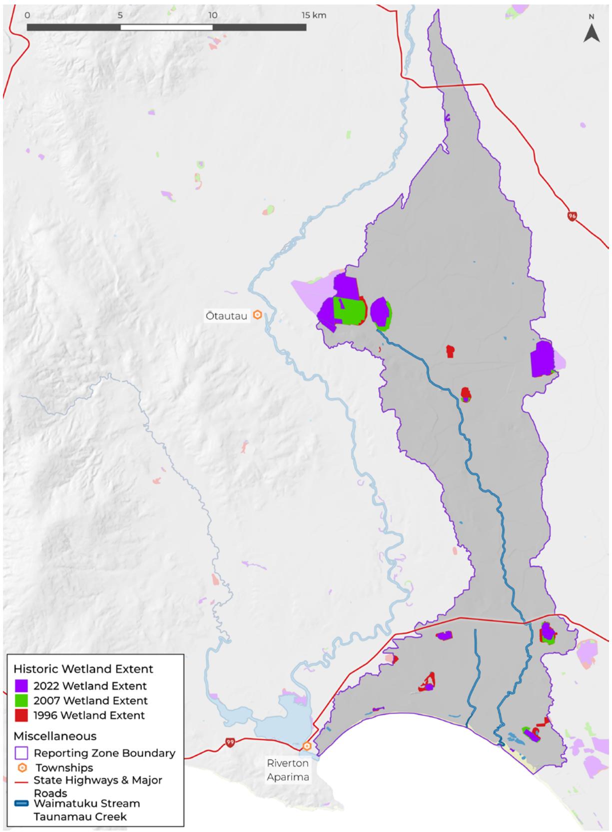
- Wet pasture or where water ponds after rain
- Pasture containing patches of rushes less than 50% total cover
- Ponds of any kind unless associated with 0.5 or more hectares of terrestrial wetland.
- Areas of forest unless previoulsy identified as wetland.
- Areas associated with the main active flood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

Current state

The current wetland extent in the Waimatuku and Taunamau catchment is 702 hectares. Most of the wetlands lost were bogs, the most common wetland type in Murihiku Southland, with the majority having been converted to pasture farmland.

This map shows the wetland extent over three time periods. Wetland areas lost since 1996 and 2007 are shown in red and green, respectively.

Historic wetland extent



	1996 to 2007	2007 to 2022	Overall 1996 to 2022
Change in wetland area	↓ 14% 160 ha	↓ 28% 277 ha	↓ 38% 436 ha

Remaining wetlands

The Waimatuku and Taunamau catchment is relatively small, with few wetlands, but they contain three regionally significant wetlands and ten others greater than 0.5 hectares.

The Waimatuku Wetland is a large, regionally significant bog located just southwest of Wrights Bush, covering approximately 41 hectares and dominated by extensive wire rush vegetation.

The Drummond Peat Swamp, another large regionally significant wetland, spans approximately 256 hectares entirely on Department of Conservation (DOC) land. Despite its name, it is a bog rather than a swamp.

Lastly, the Bayswater Wetland, west of Drummond, is another large bog. It is fragmented, with part on DOC land (some of which extends outside the catchment) and part inside, along with three smaller sections not mapped as regionally significant wetlands adjacent to the DOC land. One large portion remains on private land to the east of the DOC land, and a blueberry farm now occupies a significant portion of the former wetland.

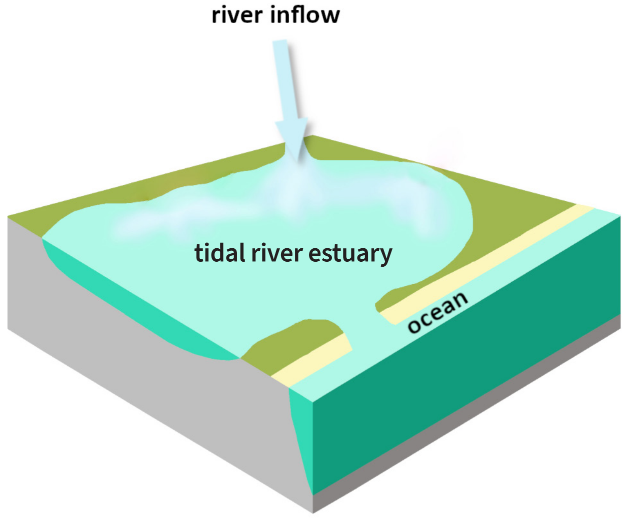
Among the other wetlands, there is another large bog in moderate condition southeast of Thornbury, while a moderately sized marsh exists south of the Thornbury bog near the coast. Near the coast, Long White Lagoon and Big Lagoon are large shallow-water wetlands with adjacent terrestrial wetland vegetation. The Waimatuku Stream forms a saltmarsh parallel to Ōreti Beach, featuring turf plants such as sea primrose (Samolus repens).

Of the remaining wetlands, there is a moderately high risk of further loss in the near future, with 64% classified in the moderately high-risk category.

	1	2	3	4	5
Risk of Loss (1 = low, 5 = high)	0%	0%	27%	64%	4%

Waimatuku Estuary

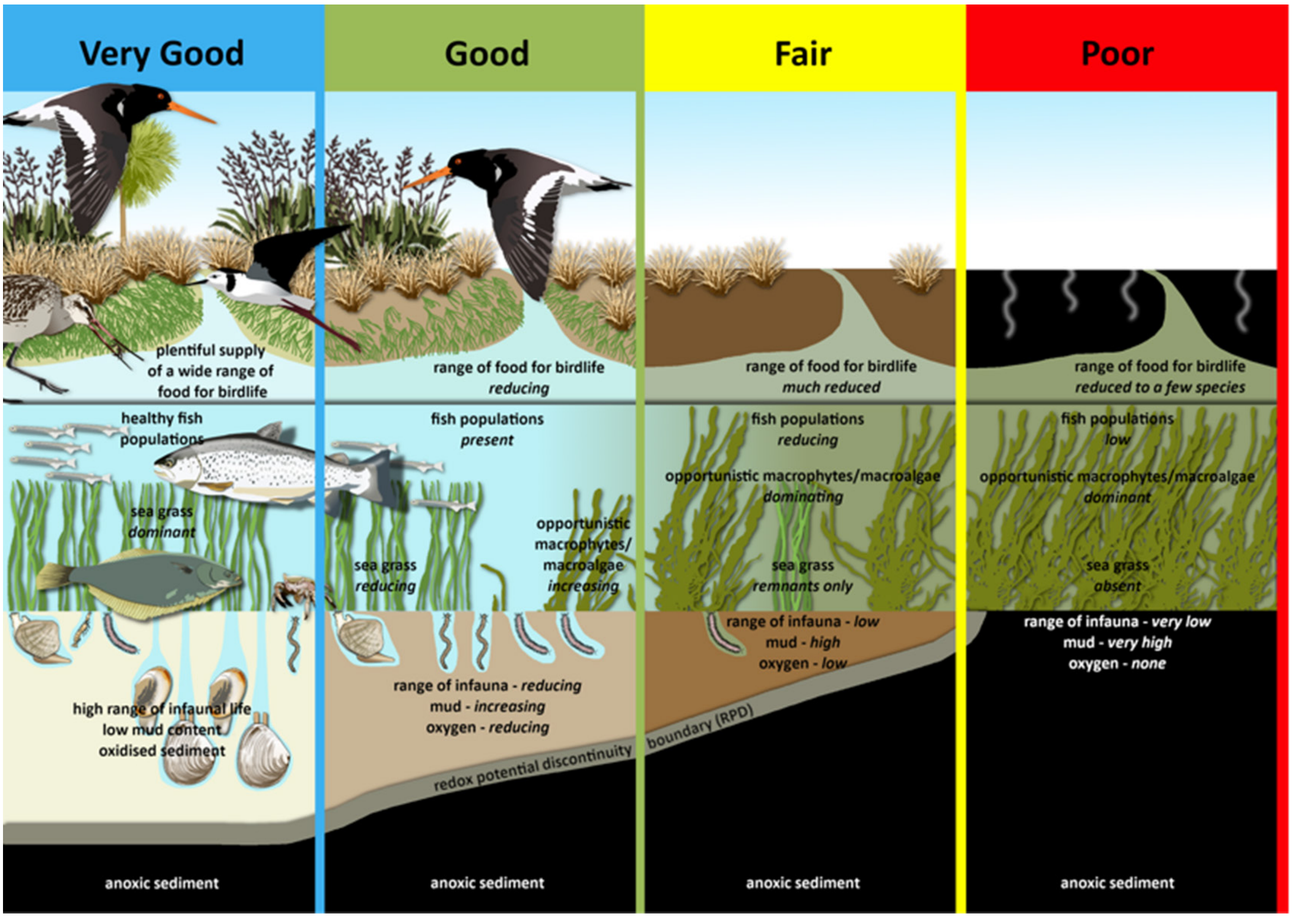
Waimatuku Estuary is a tidal river estuary. This type of estuary is characterised as shallow, with short residence times (less than three days) and a high river flushing potential. These properties usually mean that fine sediment and nutrients are rapidly transported to the sea, and they have a low susceptibility to eutrophication. Eutrophication is generally expressed as excessive macroalgae growth.



Sediment and nutrients

Fine, muddy sediments and sediment oxygenation are the main issues for the Waimatuku Estuary. Fine sediments lost from land in the catchment travel through the river system, depositing in the estuary. Sediment oxygenation is hampered by the deposition of finer sediments and the nutrients they typically contain.

Estuary health outcomes can range from 'very good' to 'poor'. Using an outcome spectrum can help us understand the state of the freshwater environment and what we might be trying to achieve in the future. The 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 indicate that the primary issues for the Waimatuku Estuary are sediment (mud) and low sediment oxygen levels. However, due to limited data, these findings are considered indicative. Heavy metals are likely not a concern for this estuary.

Ecosystem health attributes	Hauora target	Current state
Phytoplankton	A	No data
Sediment oxygen levels	B	D
Gross eutrophic zone	A	No data
Mud content	A	B
Sedimentation rate	<2 mm/year	No data
Macroalgae	B	No data
Metals in sediment (arsenic, cadmium, chromium, copper, lead, mercury, nickel, zinc)	A	A

Human health attributes		
Enterococci	A	No data

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': the primary allocation block, which limits the amount of water that can be taken during low flows (with allocation available up to 30% of Q95), and the secondary allocation, which restricts water takes when flows are above median or mean 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 areas hydraulically connected to surface waterways, reducing stream flow. This needs to be accounted for in both surface water and groundwater allocation management. Under the Southland Water and Land Plan, surface water allocation must be managed at any point within a surface water network, so allocation totals vary along rivers to reflect the balance between natural water input and abstraction.

The following allocation figures do not include permitted take estimates.

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)
Waimatuku Stream at Waimatuku Township Road	555	29 (2022)	2,347	118	122 (2016)	1,509	74	56 (2013)

In the Waimatuku and Taunamau catchment, only the Waimatuku Stream has continuous flow monitoring, and, like the other surface waterways in this zone, there are no consents for surface water abstraction.

Groundwater allocation

Most groundwater allocation thresholds are set using a proportion of annual rainfall recharge to aquifers, varying depending on the aquifer type.

The Waimatuku and Taunamau catchments contain one Groundwater Management Zone, the Waimatuku, which is 10.1% allocated. This groundwater is consented for dairy (65.3%) and irrigation (34.7%).

	Groundwater use efficiency (%)
Dairy	55.5-71.2
Irrigation	26.5

Monitoring data provided by consent holders for the 2022/2023 season indicates that groundwater use for irrigation is 26.5% of the total volume allocated and between 55.5-71.2% for dairy.

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 Muruhiku 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 to test the impact of different land use scenarios.

For this work, we focus 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 Waimatuku and Taunamau catchment are given in the table. Load estimates were calculated using sites with ten years of data and relates to the 2017 year.

Contaminant	Total load (2017 - best estimate*)	Percentage load reduction required to achieve hauora (best estimate*)
Total Nitrogen	1,291 Tonnes/Year	↓ 46% (24-67)
Total Phosphorus	43 Tonnes/Year	↓ 43% (11-75)
Sediment	67,300 Tonnes/Year	↓ 22%
E. coli	62 peta ***E.coli***/Year	↓ 74% (38-93)

These values represent our best estimate. Levels of uncertainty are indicated by the 90% confidence interval shown in brackets where available.

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 required estimated nitrogen load reductions. 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 below. The coloured table cells indicate how far each scenario goes toward achieving the required load reductions. Explanations of each scenario can be found in our published reports.

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

- Implementation of scenario 14 (over page) is estimated to achieve the phosphorus reduction required. Furthermore, scenarios 1, 2, 3, 5, 9, 11, 12, 13, 15, and 16 were estimated to achieve reductions within the uncertainty of the required estimate. The range of reductions across all scenarios was between 0-61%.
- Implementation of the existing rules and regulations relating to sediment was estimated to achieve a 34% reduction in suspended sediment load. This is less than the 55% reduction required 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	10	76
2	Adoption of all established and developing farm mitigations	28	58
3	Wetlands returned to the same area as existed in 1996	11	75
4	Establishment of wetlands in a way that treats all surface runoff from agricultural land	35	51
5	Establishment of large community wetlands in inherently suitable areas	21	65
6	All wastewater point sources are discharged to land rather than directly to water	0	86
7	Reducing land use intensity on flood prone land	0	86
8	Reducing land use intensity on public land	0	86
9	Destocking (10% reduction drystock, 20% reduction dairy)	25	61
10	Riparian planting (full shading of streams <7m wide)	2 (indirect effect on periphyton)	84
Bundled methods			
11	1996 wetlands returned, wastewater discharged to land (3 + 6)	10	76
12	Established and developing farm mitigations, 1996 wetlands, wastewater to land (2 + 3 + 6)	35	51
13	Established and developing farm mitigations, 1996 wetlands, wastewater to land, repurposing public land (2 + 3 + 6 + 8)	35	51
14	Established and developing farm mitigations, 5% wetlands, wastewater to land, repurposing public land (2 + 4 + 6 + 8)	53	33
15	Established and developing farm mitigations, community wetlands, wastewater to land (2 + 5 + 6)	42	44
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)	18	68

Required reductions likely achieved *Within uncertainty range* *Deficit remaining*

The results in the table above indicate that none of the mitigation scenarios we tested achieve the reductions required to support a state of hauora. This is because the necessary reduction in contaminant loss is very large and will likely require more widespread changes to how land is used rather than maintaining the status quo and relying on implementing mitigations.

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. This work aimed to help show 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 goes toward achieving the required load reductions. For example, we can see that a 40% reduction in loss from dairy farms combined with a 20% reduction from drystock farms will result in approximately 33% reduction in the instream TN load across the catchment.

Basin-wide mean % TN reduction, relative to baseline

Drystock loss rate reduction (%)					
80%	15%	30%	44%	59%	74%
60%	11%	26%	41%	55%	70%
40%	8%	22%	37%	51%	66%
20%	4%	18%	33%	48%	62%
0%	0%	15%	29%	44%	58%
	0%	20%	40%	60%	80%

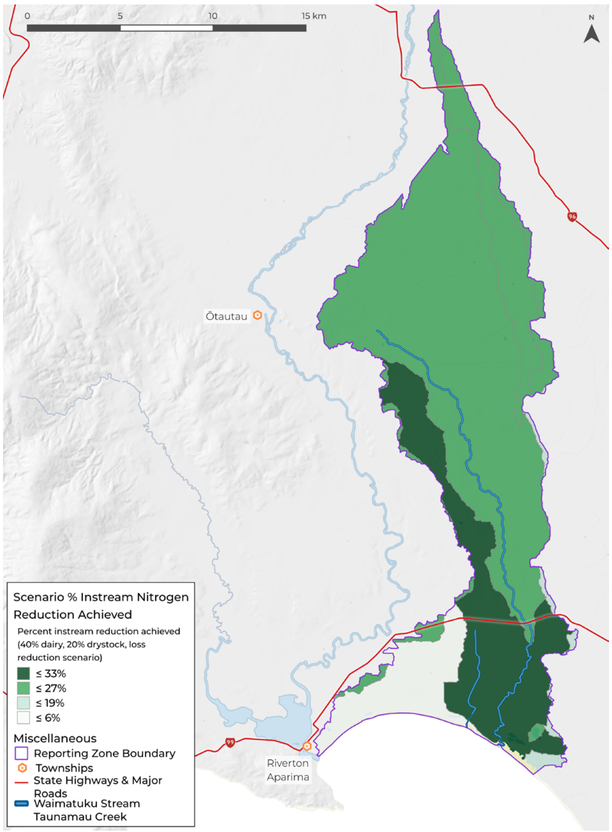
Dairy loss rate reduction (%)

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. For example, if all dairy land reduced nitrogen losses by 40% and drystock by 20%, the largest instream reductions would be achieved in the darker green sub-catchments.

Opportunities for action

We've put together opportunities for action for the Waimatuku and Taunamau catchment to reduce contaminant loads and improve the state of freshwater.

The catchment

Scale of the problem

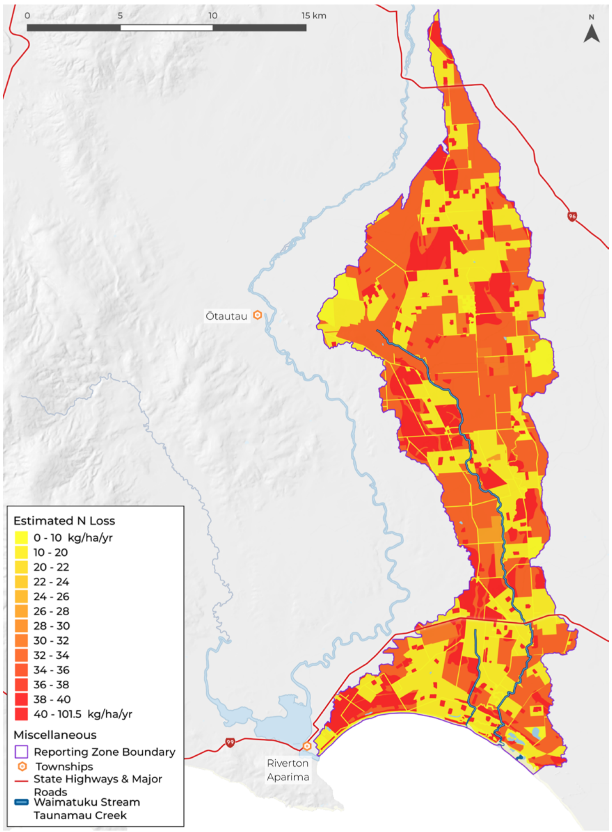
There are extensive areas of land contributing high contaminant loads in this catchment.

The following map set shows the spatial distribution of intensive land use and the associated estimated nitrogen loss, the modelled in-stream nitrogen concentrations (using monitoring data), and the modelled excess nitrogen load patterns across the catchment. These maps help to demonstrate the spatial scale of the reductions required. Excess loads depend on the modelled concentrations and all the defined targets locally and downstream. This load excess map indicates the magnitude of nitrogen load reductions to achieve all river and estuary targets for the entire catchment area.

High nitrogen loads may be difficult to mitigate, and implementing improved management practices alone is unlikely to achieve the desired outcomes for freshwater and the estuary. Consideration should be given to the potential for large-scale catchment mitigations and changes to how land is used.

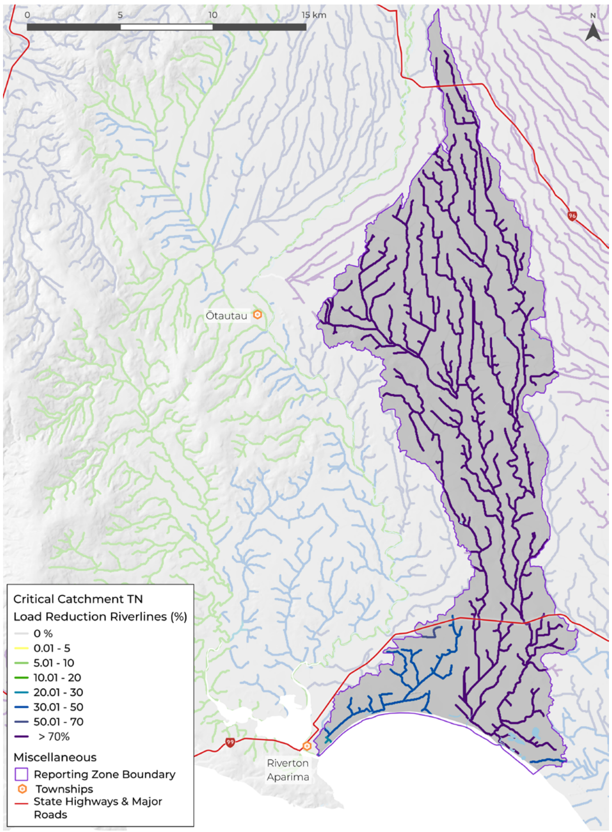
Large nitrogen reductions over large spatial areas will likely require changes to land use over a long period. It might be through exploring and adopting different land uses or technological advances in farm systems and management. The hydrology of the catchment has been extensively modified through stream channel straightening and artificial drainage. Efforts to implement nature-based solutions and slow water flow are likely to have multiple benefits for water quality,biodiversity, flood mitigation, and catchment resilience.

Estimated nitrogen loss

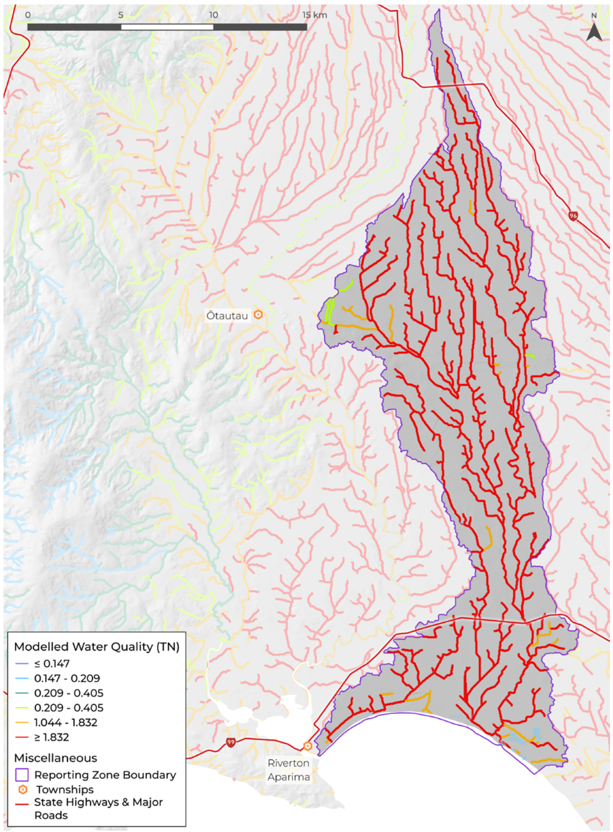


▲ *Nitrogen loss in this graphic is an approximation and is only differentiated by land use, soil drainage, rainfall/irrigation, and slope.*

Critical catchment TN load reduction (%) riverlines



Modelled water quality (Total Nitrogen)



Farm scale opportunities for action

Farm scale actions should be tailored to physiographic settings, catchment priorities and broader context. In the Waimatuku and Taunamau 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.

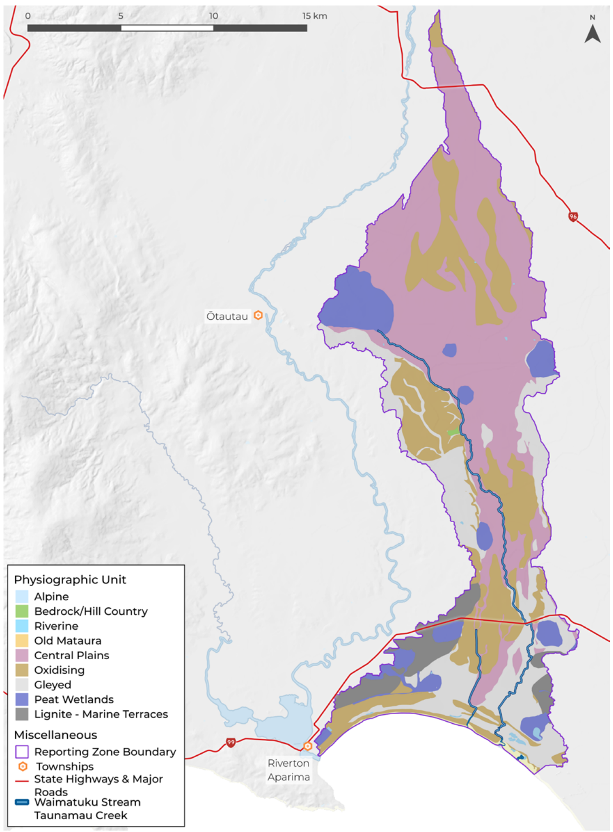
Physiographic information helps us to better understand how contaminants move through the landscape. Each zone has common attributes that influence water quality, such as climate, topography, geology and soil type.

Physiographic zones differ in how contaminants build up and move through the soil, through areas of groundwater and into rivers and streams.

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

The Waimatuku and Taunamau catchment comprise five main physiographic units: central plains, oxidising, gleyed, peat wetlands and lignite/marine terraces.

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

Nitrogen

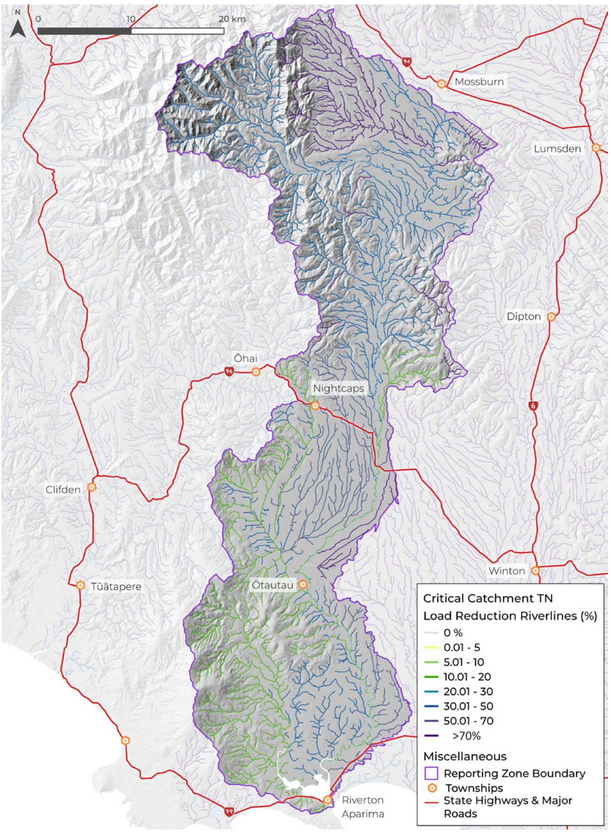
Over time, reductions are required across the Waimatuku and Taunamau catchment to achieve hauora targets.

This means 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. As shown above, the excess load map here indicates areas where nitrogen loss mitigation should be a particular focus in farm planning. In the Waimatuku and Taunamau catchment, this is the entire catchment.

There are very high groundwater nitrate concentrations and instream concentrations that exceed toxicity national bottom lines in some locations. Nitrogen is a priority contaminant everywhere in the catchment.

Critical catchment TN load reduction (%) riverlines



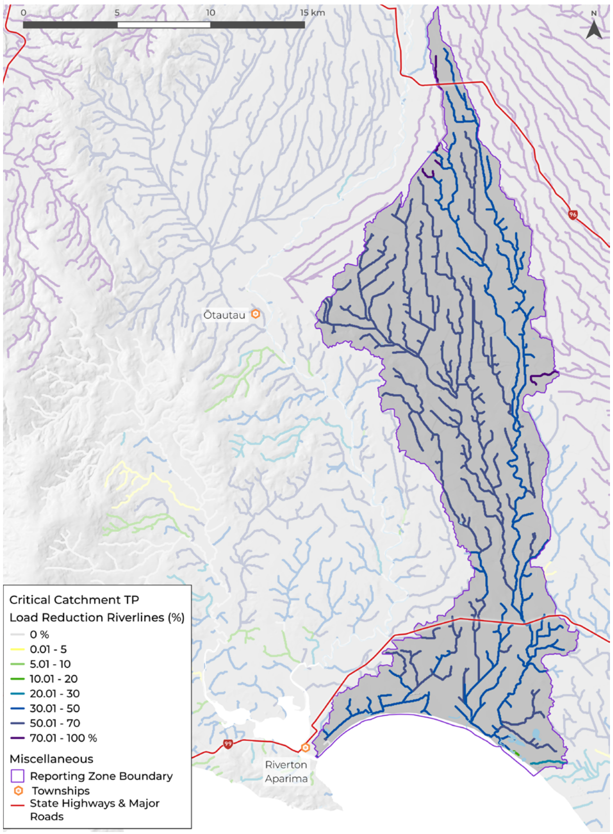
Phosphorus

Over time, widespread load reductions will be required to achieve hauora targets.

This means reducing phosphorus 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. The excess load map here indicates areas where phosphorus loss mitigation should be a particular focus in farm planning. In the Waimatuku, this is the entire catchment.

Critical excess TP load (%)



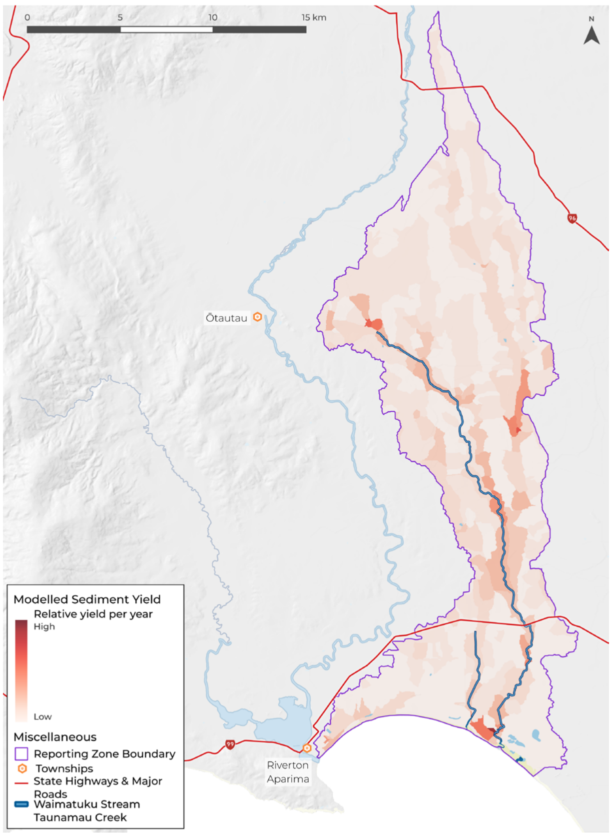
Sediment

The map (right) shows how we expect sediment loss to vary throughout the catchment.

Some places in the agricultural landscape have higher sediment loss rates. These are primarily areas with more sloping land and soils susceptible to erosion, where stream bank erosion is likely an issue.

Sediment from agricultural land generally poses a greater threat to rivers and estuaries, as it is often fine-grained and carries higher concentrations of nutrients. Properties within the shaded, darker red areas should specifically look for opportunities and mitigations to reduce sediment loss. Because of the landscape features in these catchment, actions should focus on minimising stream bank erosion, losses from critical source areas and episodic losses from high-risk activities such as winter grazing and cultivation.

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.

Groundwater – opportunities for action

Areas of highly contaminated groundwater will likely require targeted nitrogen action via management and changes in farm systems. Areas within the Oxidising and Riverine physiographic zones, are likely high-risk areas. In these locations, landowners should implement management plans focusing on key pathways and the stockpile of property scale actions targeting nitrogen loss via deep drainage.

E. coli contamination of groundwater and groundwater drinking supplies is a widespread issue across the Waimatuku zone and Murihiku Southland.

Actions to reduce E.coli to groundwater:

- Ensure good well-head protection is in place for all bores, especially bores used for drinking water.
- Carefully consider the proximity of contamination point sources to bores. These can be things like septic tanks, stock sheds and effluent storage.
- Carefully consider effluent application on freely draining soils or soils with a high likelihood of bypass flow (cracks or conduits that may allow effluent to flow directly to groundwater). This is particularly relevant for this catchment.

Urban and industrial – opportunities for action

- Target improvements to on-site wastewater disposal systems to reduce the risk of human faecal contamination of freshwater.
- Urban development incorporates best practice stormwater management methods.

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