CANTERBURY REGIONAL COUNCIL

Kaunihera Taiao ki Waitaha

Environment Canterbury Regional Council
Kaunihera Taiao ki Waitaha

Risk Maps of Nitrate in Canterbury Groundwater

Authors	Lisa Scott, Senior Scientist: Groundwater Science Marta Scott, Senior Scientist: Groundwater Science Ben Wilkins, Science Analyst: Groundwater Science	March 2020
Reviewed internally	Maureen Whalen, Groundwater Science Team Leader Carl Hanson, Groundwater Science Section Manager	March 2020
Reviewed externally	Denise Tully, Community & Public Health Drinking Water Assessor,	March 2020
Approved for release	Tim Davie, Chief Scientist	March 2020

1 Introduction

What is the aim of this report?

This report is part of a joint communication plan between Community and Public Health/Te Mana Ora and Environment Canterbury to provide information about the risk of nitrate contamination in groundwater used for drinking.

The report presents maps of the risk of nitrate contamination in Canterbury groundwater and explains how we used our data to prepare these maps.

The report is reviewed regularly and updated with any new data, if necessary. The original report was published in June 2013 (Scott and Hanson, 2013) and updated in 2015 and 2018. This version has been updated in April 2020.

What sort of water supplies do these maps cover?

These maps are intended for people drinking water from private wells on individual properties.

The maps are not intended for community drinking water supplies. The Health Act 1956 requires such suppliers to take reasonable steps to provide water that complies with the New Zealand drinking-water standards (MoH, 2018). This includes regular testing and treatment of water if it is necessary.

What terms do we use in this report?

Nitrate nitrogen is the nitrogen portion of the nitrate ion. Nitrogen makes up approximately 23% of the nitrate ion. Therefore, if water has a nitrate ion concentration of 50 mg/L, the nitrate nitrogen concentration is 11.3 mg/L.

Denitrification is a process, whereby naturally-occurring bacteria remove nitrate by converting it to nitrogen gas. This requires certain groundwater conditions including low dissolved oxygen.

Maximum Acceptable Value (MAV) is the highest concentration of a parameter in water that, based on present knowledge, is considered not to cause a significant risk to human health. Ministry of Health has set a short-term exposure MAV for nitrate to protect against methaemoglobinaemia in bottle-fed infants (MoH, 2018).

Water table is the upper surface of the groundwater. Below the water table all the spaces between soil and rock are full of water. Above the water table, the spaces are filled with a mixture of water and air.

Aquifer is underground porous rock or sediment saturated with water that can be readily extracted using a well.

River recharge refers to water that seeps into the ground through the beds of rivers. Because rivers usually have low nitrate concentrations, river water tends to dilute the concentration of nitrate in groundwater.

Land surface recharge refers to rainwater or irrigation water that moves down through the soil and reaches groundwater. This is the main process that leaches contaminants from the soil into groundwater.

Screen this is a part of a well casing which has slots that allow water to enter the well.

CWMS refers to the Canterbury Water Management Strategy. The Canterbury region was divided into 10 water management zones when the strategy was introduced in 2009 (Canterbury Mayoral Forum, 2009).

LWRP is the operative Canterbury Land and Water Regional Plan. (Canterbury Regional Council, 2012).

What is nitrate and where does it come from?

Nitrate is a water-soluble compound that contains nitrogen. At typical concentrations in water, it has no detectable colour, smell or taste. Nitrate occurs naturally in groundwater at low concentrations. Microbes in soil and water convert nitrogen-containing compounds in materials such as urine, fertilizer, manure and plants to nitrate.

Natural nitrate nitrogen concentrations vary, but anything greater than 3 mg/L is above the expected concentrations for natural conditions, based on national-scale studies in New Zealand (MfE, 2019). Nitrate contamination is usually caused by human activities such as waste and effluent disposal or leaching from normal farming activities. Nitrate that is not used up by plants can be flushed through the soil into shallow groundwater by rainfall or irrigation.

Why is nitrate important?

Nitrate contains nitrogen, which is an essential nutrient for plant growth. Nitrogen is widely applied as fertiliser and is also fixed by plants like clover, but microbes can convert any excess nitrogen to nitrate which can enter groundwater. Groundwater with too much nitrate may become unsuitable for drinking.

What are acceptable nitrate levels for drinking water?

Babies cannot tolerate high nitrate concentrations, especially if they have gastrointestinal infections. The New Zealand drinking-water standards set a Maximum Acceptable Value (MAV) for nitrate at 50 mg/L (equivalent to nitrate nitrogen of 11.3 mg/L), based on a risk to bottle-fed babies (MoH, 2018). Community and Public Health recommends applying this value to bottle-fed babies less than six months old and to pregnant women. This concentration of nitrate, ingested in food and/or water, is currently not known to harm healthy adults. Other potential health effects from nitrate are under investigation in New Zealand, but this report only considers the MAV in the current drinking-water standards which applies to bottle-fed babies.

What about *E. coli*?

E. coli is a type of bacteria that indicates the presence of faecal material in water. If there is faecal contamination of water then there is a risk of disease. *E. coli* is a very different contaminant to nitrate. All wells used for domestic supply should be tested for *E. coli* even if

nitrate concentrations are below the MAV. Shallow groundwater wells are particularly prone to this type of contamination.

What is shallow groundwater?

In this report, we consider shallow groundwater to be less than around 40 metres below the water table. In some areas, the water table can be as deep as 100 metres below the ground surface, but we still refer to groundwater in these areas as shallow, as long as it is within 40 metres from the water table. We based the maps in this report on data from shallow groundwater. We refer to deep groundwater as being more than 40 metres below the water table and we mostly disregarded wells in this category, as many of the private drinking water wells are shallow.

How do I get my water tested for nitrate?

Councils do not test private wells. It is the responsibility of the well owner to get their water tested to ensure it is safe to drink. Generally, it is a straightforward procedure. A water sample is taken and sent to an accredited laboratory. The laboratory can provide instructions and clean sample containers. The Ministry of Health has a list of recognised water testing laboratories and the tests they offer on this website: https://www.drinkingwater.org.nz/mohlabs/labmain.asp

2 Risk maps

What do the maps show?

The map in Figure 2-1 indicates the risk of nitrate concentrations in groundwater exceeding the MAV. This version of the map is based on our data up to December 2019.

Pink areas on the map are areas where groundwater is likely to exceed the nitrate MAV (high risk). No new high-risk areas were added as part of a review of data from 2017 to 2019, but some existing high-risk areas were refined. In green areas, the groundwater is unlikely to have nitrate that exceeds the MAV (low risk). Note that individual point sources of nitrate very close to a well, such as a poorly treated on-site wastewater discharge, can still pose a risk of drinking-water exceeding MAV, even if the overall risk for the area is low. A low-risk area around Waipara has been removed because of a lack of recent data to confirm the risk is still low. Groundwater in the yellow areas may be above or below the MAV (moderate risk).

We only assessed risk in areas with known aquifers and we excluded mountainous areas (grey) and large lakes (white). We based the risk assessment on reports and data currently available.

What has changed in this version?

New data have allowed us to adjust the extent of high-risk areas near Seadown in South Canterbury and at north-east Ashburton. We have also used findings from a recent investigation to expand the high-risk area around Tinwald in the Ashburton zone. We have merged two previous high risk areas, Ealing-Hinds and Lowcliffe, to form one larger high-risk area in the lower plains between the Hinds and Rangitata Rivers.

We adjusted the boundary of low risk zones along alpine rivers near Southbridge (Rakaia River) and Rangitata Huts (Rangitata River) where nitrate concentrations in wells have shown that the river recharge does not extend as far as we thought in previous reports.

Finally, we have removed a small low-risk zone around Waipara and changed the area to moderate risk, because we lack recent data to confirm the risk is still low.

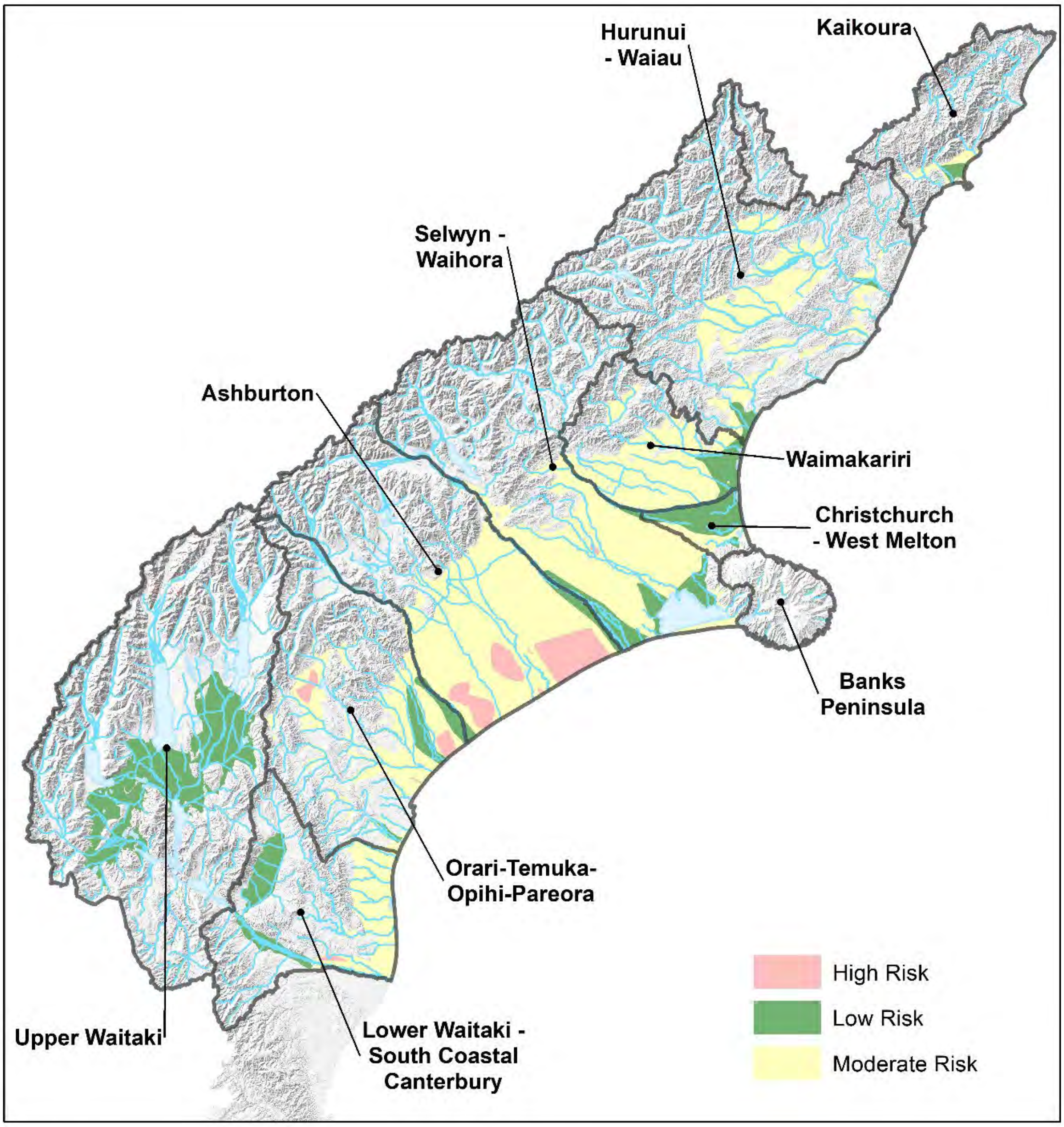

Figure 2-1: Map of the Canterbury region showing areas at low, moderate and high risk of nitrate concentrations exceeding the MAV in shallow groundwater

What data did we use for the maps?

We used the outline of known aquifers in Canterbury as the boundary for our analysis. The aquifer areas are slightly smaller than the previous versions of the maps because we have excluded high-country areas where we have no water quality data and few or no records of domestic wells being in use. Using the data held in Environment Canterbury's water quality database, we plotted the highest nitrate concentrations ever recorded in each well as different coloured dots on a map. This helped us to identify clusters of wells where groundwater is above or below the MAV. We then reviewed all sampling data for each well within these clusters to help us define their boundaries. For some wells, we only have one measurement whereas other wells are part of our regular monitoring programme and we have sampled them numerous times.

Could the maps change in the future?

The maps in this report show risk based on current available data. It is possible that over time some moderate-risk areas will become high risk due to land-use intensification. Low-risk areas will generally remain low where it is alpine river recharge or denitrification that keep the nitrate concentrations low. But where the low-risk is due to low intensity or no farming, this could also change to moderate risk or even high risk over time if the land use is intensified. High-risk areas could be changed to moderate risk if we are confident that concentrations have decreased below the MAV.

The risk area boundaries could also be refined, as some have been in this report, if we have additional data.

Are there any other maps that are similar?

Environment Canterbury commissioned a report on mapping of vulnerability of nitrate leaching (Webb *et al.*, 2010). Those leaching maps were predictions based on certain soil characteristics. They were intended for people preparing farm management plans. The maps in this report are based on collected groundwater data and are quite different to the predicted leaching vulnerability maps.

The Canterbury Land and Water Regional Plan (LWRP) has planning maps showing Nutrient Allocation Zones. The nutrient zones include red zones where surface water quality outcomes are not met, orange at-risk zones and green zones that meet water quality outcomes. There are also nitrate "hot spots" mapped in the Fairlie Basin, Levels Plain and Orton Plain for the Zone Implementation Plan Addendum (ZIPA) in the Orari-Temuka-Opihi-Pareora (OTOP) zone.

Although nitrate was a key indicator in the making of both these sets of maps, they are not for the same purpose as the nitrate risk maps. The nutrient allocation and "hot spot" maps are intended to guide the management of land use and nutrient discharges and they cover a much broader range of effects than health effects on private drinking-water supplies.

2.1 High-risk areas

‘High-risk’ areas are areas where nitrate concentrations in shallow groundwater are above the MAV most or all of the time.

How did we identify high-risk areas?

We looked for areas where nitrate concentrations were at or above the MAV in most groundwater samples. Figure 2-2 shows an example of how we defined the extent of a high-risk area. We coloured these areas pink on the final risk map.

In some of these areas, the concentrations are elevated due to known pollution sources. In other areas, nitrate concentrations have not been linked to specific discharges and are likely to be due to the cumulative effects of diffuse sources such as farming activities.

In general, water obtained from shallow wells in these areas will be above the MAV. About 60% of the wells in these areas have had samples with nitrate concentrations above MAV. However, because groundwater systems are complex, there may be some wells within a high-risk area that have nitrate concentrations below the MAV. Deeper wells are also more likely to have lower nitrate concentrations.

How precise are the boundaries?

These maps give a general location of high-risk areas, but we did not intend to indicate the risk for individual properties. We estimated the location of the high-risk boundaries based on available data but some wells adjacent to these areas may still have high nitrate concentrations.

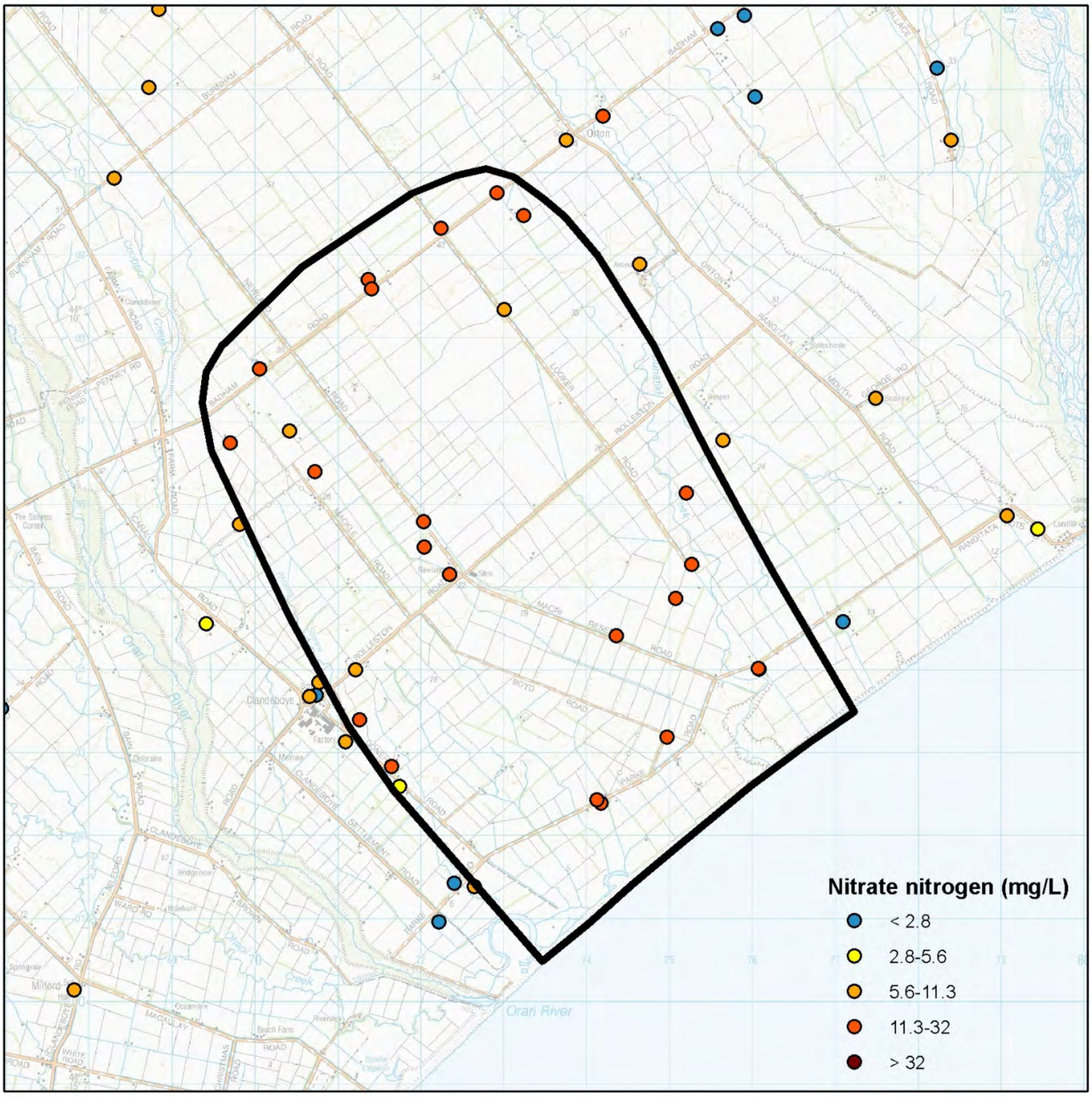

Figure 2-2: Example of identifying a high-risk area

What should people do if they live in a high-risk area?

If someone lives in a high-risk area and their water comes from a shallow well, we recommend that they contact their health practitioner if they intend to use their water for drinking by pregnant women or to make up formula milk for babies.

A common misconception is that boiling water will remove nitrate; it will not. A water treatment system, such as ion exchange or reverse osmosis, may reduce nitrate concentrations in the water. Not all systems are designed to reduce nitrate, so it is best to check with the manufacturer. The treatment system also needs to be serviced regularly to ensure its proper operation. We recommend that the treated water is tested to confirm that the treatment is effective.

An alternative to treating the water is to use bottled water or another water source for drinking by pregnant women and bottle-fed babies.

In deeper wells nitrate could be below the MAV but we recommend that people test their water to confirm this.

2.2 Low-risk areas

In 'low-risk' areas, nitrate concentrations in groundwater are always below the MAV.

How did we identify low-risk areas?

We looked for areas where nitrate concentrations are close to what we expect to see naturally, where the concentrations are not increasing and where we have not seen concentrations above the MAV. As a conservative measure, our analysis did not include wells that only had data more than 20 years old. For such wells, we could not be certain that concentrations are still low today.

There are four main reasons why nitrate concentrations are low in these areas:

- River recharge to groundwater dilutes the nitrate
- There are low-intensity or no farming activities
- Groundwater flow patterns protect the aquifer
- Local conditions are favourable for denitrification

Figure 2-3 shows an example of how we mapped an area that we believe is at low risk of having nitrate concentrations above the MAV. We used the boundaries of known aquifer systems to define boundaries for some low-risk areas. This means that the low-risk areas may have irregular shapes. We coloured these areas in green on the final risk map.

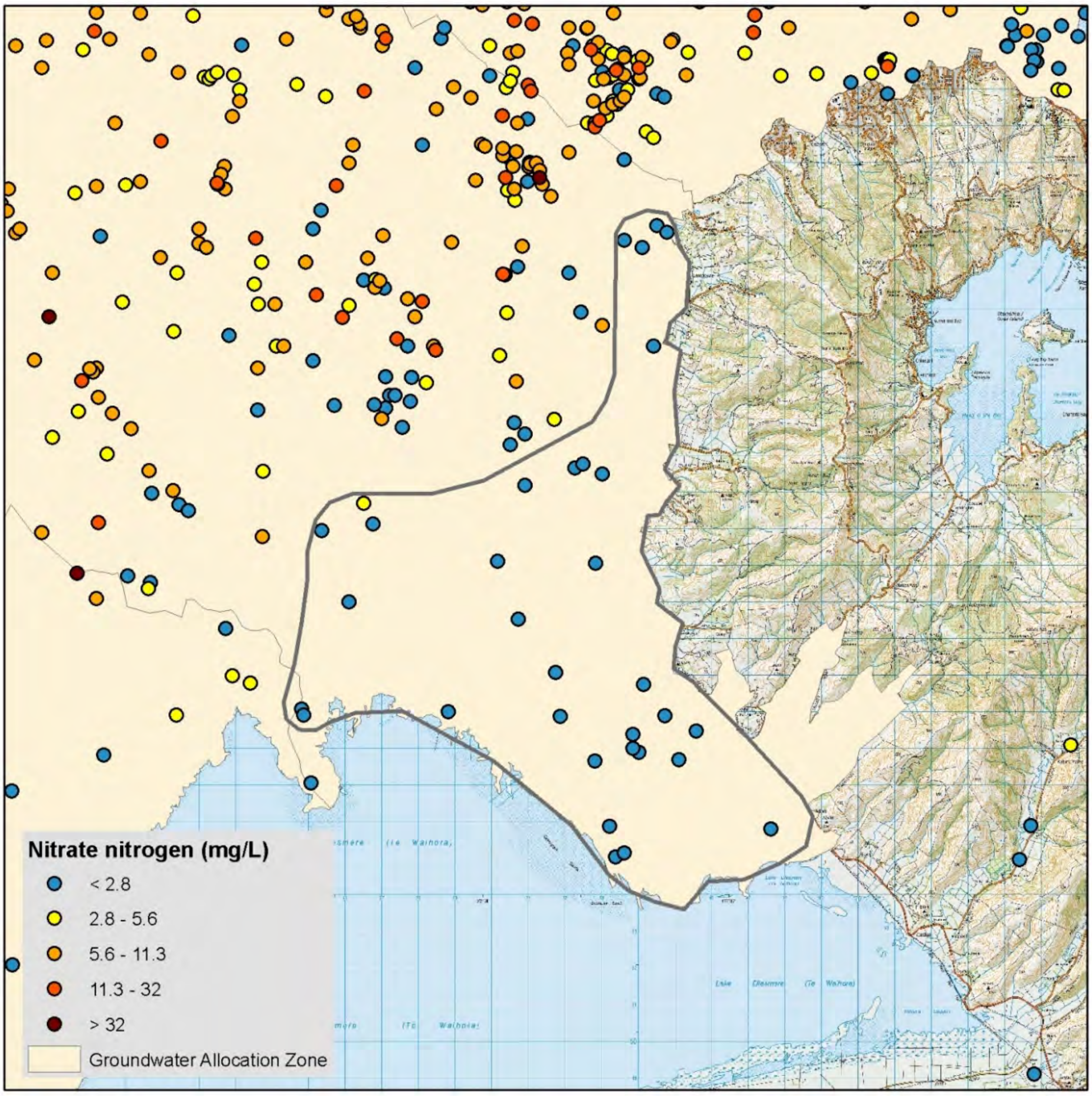

Figure 2-3: Example of identifying a low-risk area

What should people do if they live in a low-risk area?

Water obtained from wells in low-risk areas is unlikely to have nitrate concentrations exceeding the MAV and testing of individual wells is probably not necessary. Less than 1% of the wells in these areas have ever had a sample above the MAV. However, due to the complex nature of groundwater we cannot completely rule out the possibility of localised contamination. If someone is planning to use their well water for bottle-fed babies or pregnant women, they should still have their well tested once to check nitrate concentrations, but regular testing is probably not required. We also recommend testing water for both nitrate and *E.coli* if there is a septic system nearby. The well should be sampled following a wet period when the risk is highest.

Please note that this report is about the nitrate risk only; all wells used for domestic supply should be tested for *E. coli* even if nitrate concentrations are below the MAV.

2.3 Moderate-risk areas

'Moderate-risk' areas are areas where are not sure if a sample collected from a well will have nitrate concentrations exceeding the MAV.

How did we identify moderate-risk areas?

We consider any aquifer areas within Canterbury with groundwater that is not high- or low-risk or that has no recent data to confirm the level of risk, to have a moderate-risk of exceeding the MAV. We coloured these areas in yellow.

In these areas, wells may have nitrate concentrations above or below the MAV, but we cannot see a spatial pattern for those concentrations. In some areas, although we have data that indicates nitrate is below the MAV, the only data available are more than 20 years old and therefore we are not certain of current concentrations. We have made these areas yellow on the map.

We checked the nitrate concentrations for all wells within the moderate-risk areas and found that nitrate exceeds the MAV in about 10% of wells. This means that the risk is generally low, but we cannot predict specific areas of where exceedances will occur.

What should people do if they live in a moderate-risk area?

We recommend that people test their water if they intend to use it for making-up formula for babies or for drinking by pregnant women and particularly if their well is shallow.

If the test result shows nitrate concentrations below the MAV but more than half the MAV, the water may be used but should be tested monthly to ensure that nitrate levels are not increasing. Half the MAV is 25 mg/L nitrate, equivalent to 5.6 mg/L nitrate nitrogen.

3 Risk maps of Canterbury Water Management Strategy (CWMS) zones

In this section, we discuss each of the CWMS zones shown in Figure 2-2 individually.

3.1 Upper Waitaki

Figure 3-1 shows the nitrate risk map for the Upper Waitaki zone based on data currently available.

In the Upper Waitaki zone nitrate concentrations in groundwater are currently low. A likely reason for this is that large parts of the zone are not farmed or for decades have been less intensively farmed than other areas of the region. We have classified all the aquifer areas within the zone as low risk. The boundaries of the low-risk area have changed slightly from previous versions of the risk maps because we have based them on groundwater provinces that were mapped for technical work used to support the proposed Plan Change 5 of the LWRP, but the risk itself has not changed.

Most of the recent data we have collected (2017 - 2019) still support the whole area being classed as low risk. A few wells have shown occasional slightly elevated nitrate concentrations above 3 mg/L nitrate nitrogen or increasing trends in nitrate concentrations, usually in irrigated areas. Only one of the wells we have sampled in the zone has ever had water with a nitrate concentration exceeding the MAV (in 2012), but a second sample in 2014 was below 3 mg/L nitrate nitrogen. The high nitrate probably came from a local source.

There do not appear to be large areas where denitrification or dilution from river recharge could reduce nitrate concentrations. Farming activities in the Upper Waitaki have recently intensifed and large areas are covered by soils with a high risk of nitrate leaching. We also note an increasing density of onsite wastewater discharges in the Twizel area which may pose a localised risk to private drinking water supplies. The number of private wells has also increased around Twizel. Although concentrations are not near the MAV now, over the long-term, we may need to reassess if any of the area needs to be re-classed as moderate risk.

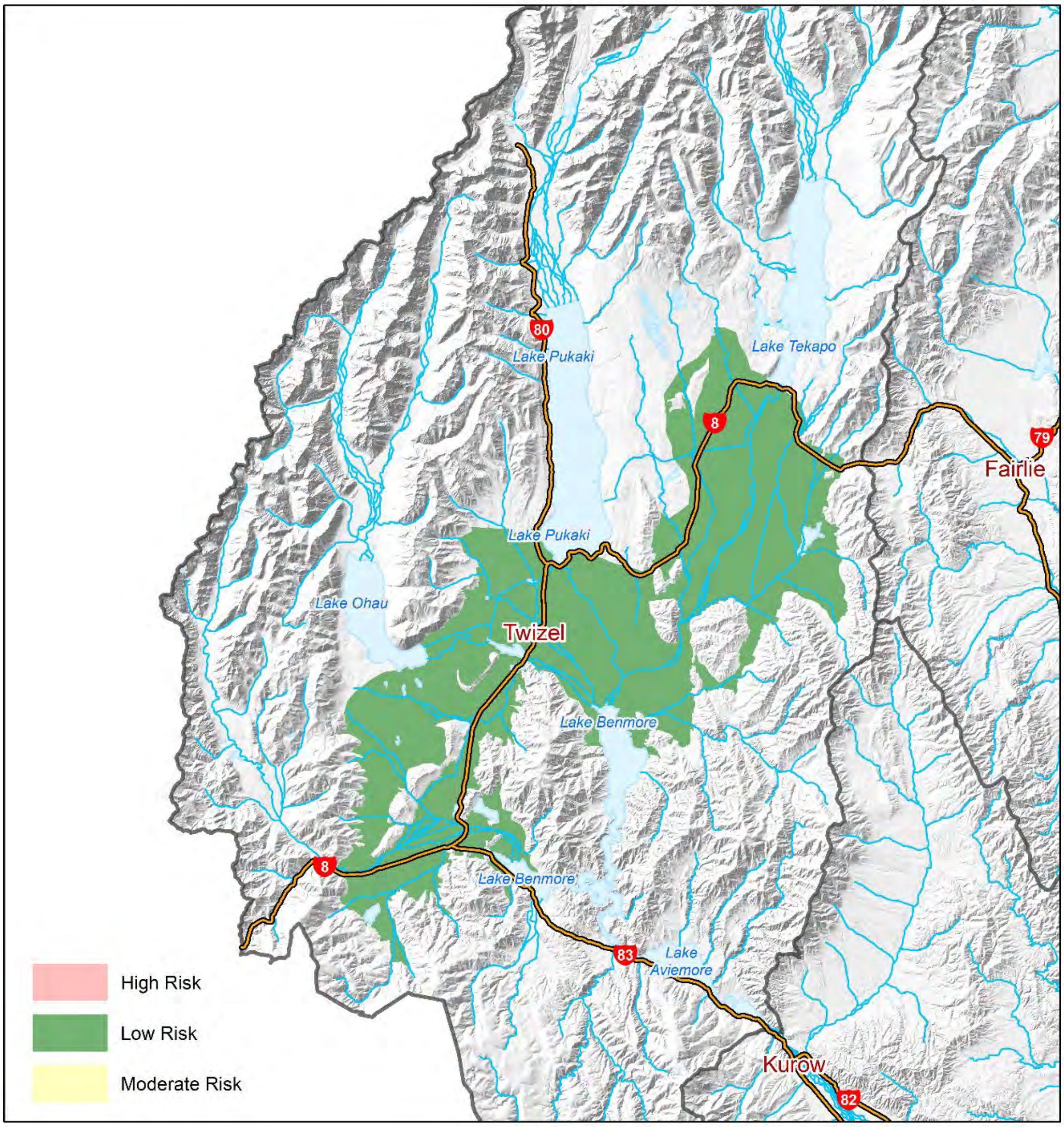

Figure 3-1: Risk map for Upper Waitaki zone

3.2 Lower Waitaki

Figure 3-2 shows the nitrate risk map for the Lower Waitaki zone based on data currently available.

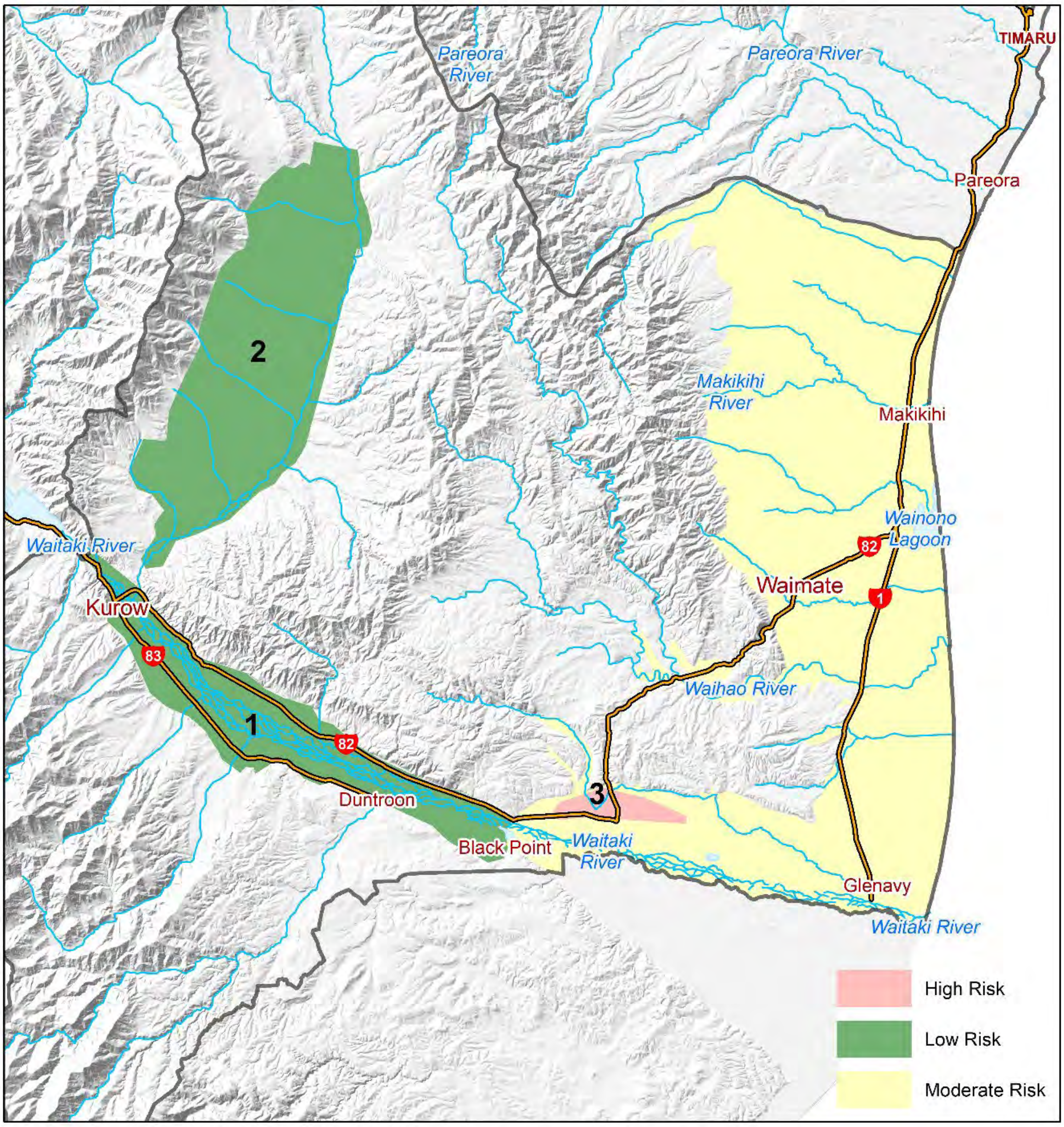

Figure 3-2: Risk map for Lower Waitaki zone. We discuss the numbered areas in the text

We have mapped the groundwater along the Waitaki River (1) as low risk based on where we believe the groundwater is dominated by alpine river recharge and because we continue to observe low nitrate concentrations in two ongoing monitoring wells. However, we note that our data for most of the valley are now more than 10 years old (sampled in 2008), and that there has been significant agricultural development in the area over that period. We are planning a new survey of groundwater quality to confirm that the Waitaki Valley area remains low risk.

Two new monitoring wells near where the groundwater from the Hakataramea valley discharges to the river at the southern end of the valley (2) have low nitrate concentrations. Based on these data and because of the low-intensity land use, we believe this is a low-risk area.

Some wells near Ikawai (3) showed elevated nitrate concentration at the time of an investigation in 2017. Nitrate concentrations in some of the wells are higher than the MAV, so this is classed as a high-risk area.

We have assigned a moderate risk to other areas because human activities have increased nitrate above natural concentrations. There are wells with elevated nitrate concentrations, some over the MAV from time to time, but there is not a clear pattern to their locations. The deeper groundwater in the moderate-risk area is old and pre-dates the impact of human activities and therefore nitrate is below the MAV.

3.3 Orari-Temuka-Opihi-Pareora

Figure 3-3 shows the nitrate risk map for the Orari-Temuka-Opihi-Pareora zone based on data currently available.

The areas around the Pareora (4), Orari (5) and Rangitata (6) Rivers are low risk because of the rivers recharging the groundwater. The boundary of the low-risk area along the Rangitata River (6) was adjusted slightly to exclude a well showing higher nitrate concentrations at Rangitata Huts on the coast.

Away from the main rivers, where there is land surface recharge of the groundwater, nitrate is above natural concentrations due to human activities. These areas are mostly mapped as yellow for moderate risk. Deeper groundwater still has nitrate below the MAV.

There are two areas in the lower plains where we have assigned high risk. Smith (1993) found that a fertilizer store caused the contamination near Seadown (7), while Scott *et al.* (2011) linked the nitrate contamination near Clandeboye (8) to dairy wastewater discharges. These discharges increase nitrate concentrations that are already elevated by farming activities up gradient. The Seadown (7) high-risk area has been refined in this update of the risk maps based on measured and modelled nitrate concentrations related to the discharge.

The high-risk area in Fairlie (9) is not related to a specific discharge but is based on observed nitrate concentrations higher than the MAV in many wells. We think that the intensification in farming activities in areas dominated by land surface recharge is the reason behind the nitrate elevation in groundwater.

We have assigned a moderate risk to the remaining areas as those have a mix of wells with concentrations above and below the MAV.

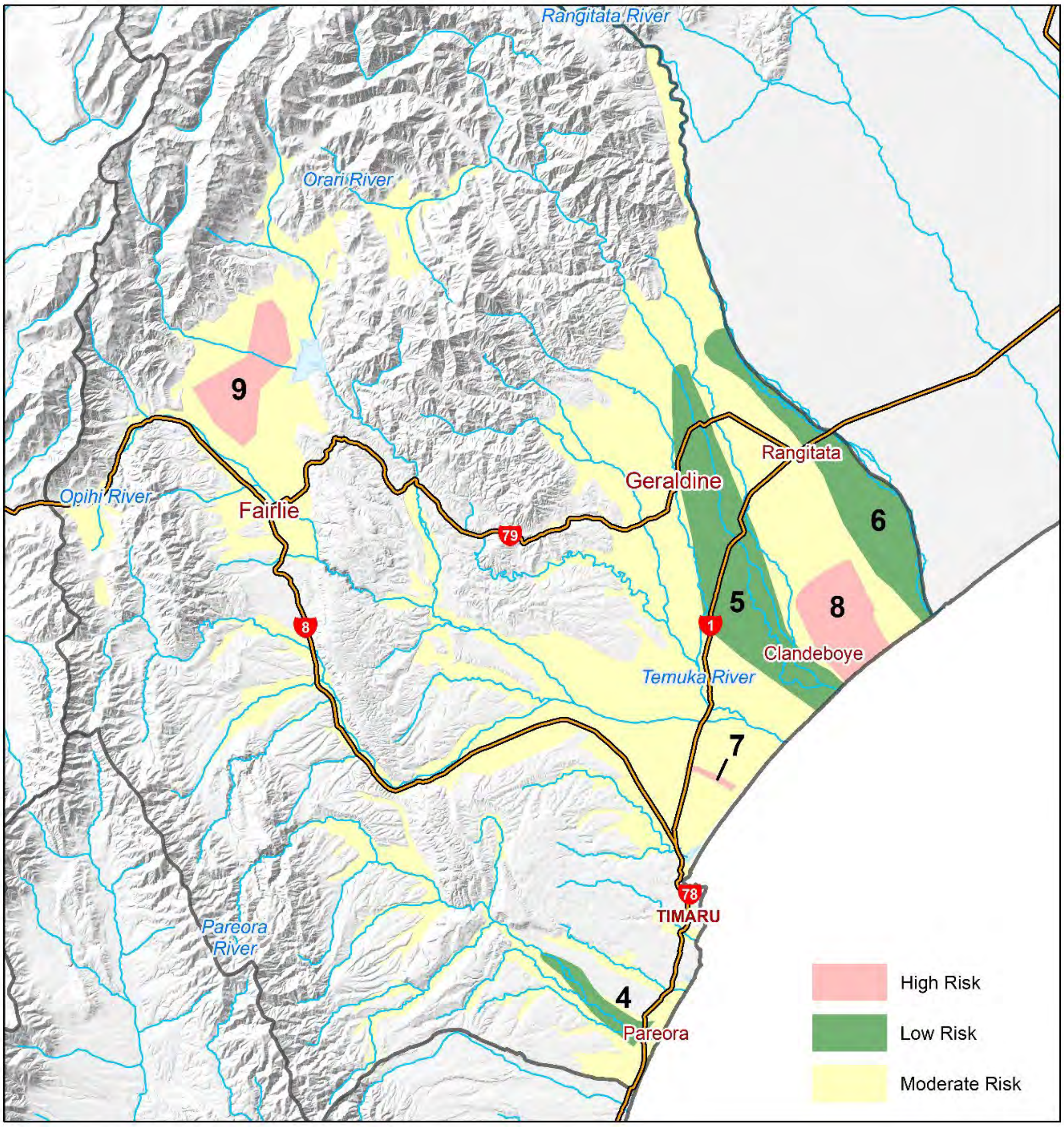

Figure 3-3: Risk map for Orari-Temuka-Opihi-Pareora zone. We discuss the numbered areas in the text

3.4 Ashburton

Figure 3-4 shows the nitrate risk map for the Ashburton zone based on data currently available.

The areas adjacent to the lower Rangitata (6) and Rakaia (10) Rivers are low risk because nitrate concentrations in groundwater indicate river recharge. Areas away from the main rivers have a greater proportion of land surface recharge and nitrate concentrations show the effects of human activities.

In the lower plains, there are five high-risk areas. Hayward and Hanson (2004) reported that the area near northeast Ashburton (11) is impacted by meatworks wastewater discharges.

This high-risk area was modified in this update to encompass the main discharge area and wells with recently observed nitrate concentrations above the MAV.

Hanson and Abraham, (2010) noted that nitrate concentrations near Tinwald (12) are consistently elevated. We have modified the boundaries and extended this high-risk area to reflect the concentrations measured recently by Aitchison-Earl (2019). Nitrogen isotope testing showed that the elevated nitrate is sourced from the application of inorganic fertilisers with localised effects from human and animal effluent discharges.

Hayward and Hanson (2004) reported on two separate investigations carried out in the high-risk area that covers most of the lower plain (13) between the Rakaia River and the Ashburton River/Hakatere. Investigation in the Fairton-Seafield area linked the high nitrate concentrations to wastewater discharges from meatworks discharges, which increase nitrate concentrations already elevated by farming activities. They did not find any large point sources between Dorie-Pendarves, and they concluded that nitrate concentrations there are above the MAV due to overall farming practices. Nitrate concentrations around these two areas have also often exceeded the MAV. Therefore, we have marked out quite a large high-risk area.

In addition, an area near Riverside (14) has nitrate concentrations above the MAV. This is probably associated with discharges of effluent from a feedlot with continued high nitrate concentrations measured in monitoring wells along the coast (unpublished Environment Canterbury data).

Our long-term monitoring programmes identified several wells with nitrate concentrations above the MAV and in past updates we added high-risk areas in the Ealing-Hinds area (15) around State Highway 1 and near Lowcliffe (16). Dench (2017) also found nitrate concentrations above MAV in wells between the two high-risk areas, so we think the areas should be merged into one larger high-risk area in the lower Rangitata-Hinds plains.

Two monitoring wells further up the plains from high-risk areas 15 and 16 also have nitrate concentrations greater than MAV. We do not have enough recent data for the area in between to assign a high-risk area over the whole area, so this remains at a moderate risk for now.

Even deep groundwater seems to be impacted by human activities in the Ashburton zone as some deeper wells have samples with nitrate concentrations above the MAV. We have observed nitrate concentrations above the MAV in a 95-m deep well near Ruapuna and an 86-m deep well near State Highway 1 at Hinds, and we have observed concentrations close to the MAV in an 84-m deep well near the coast.

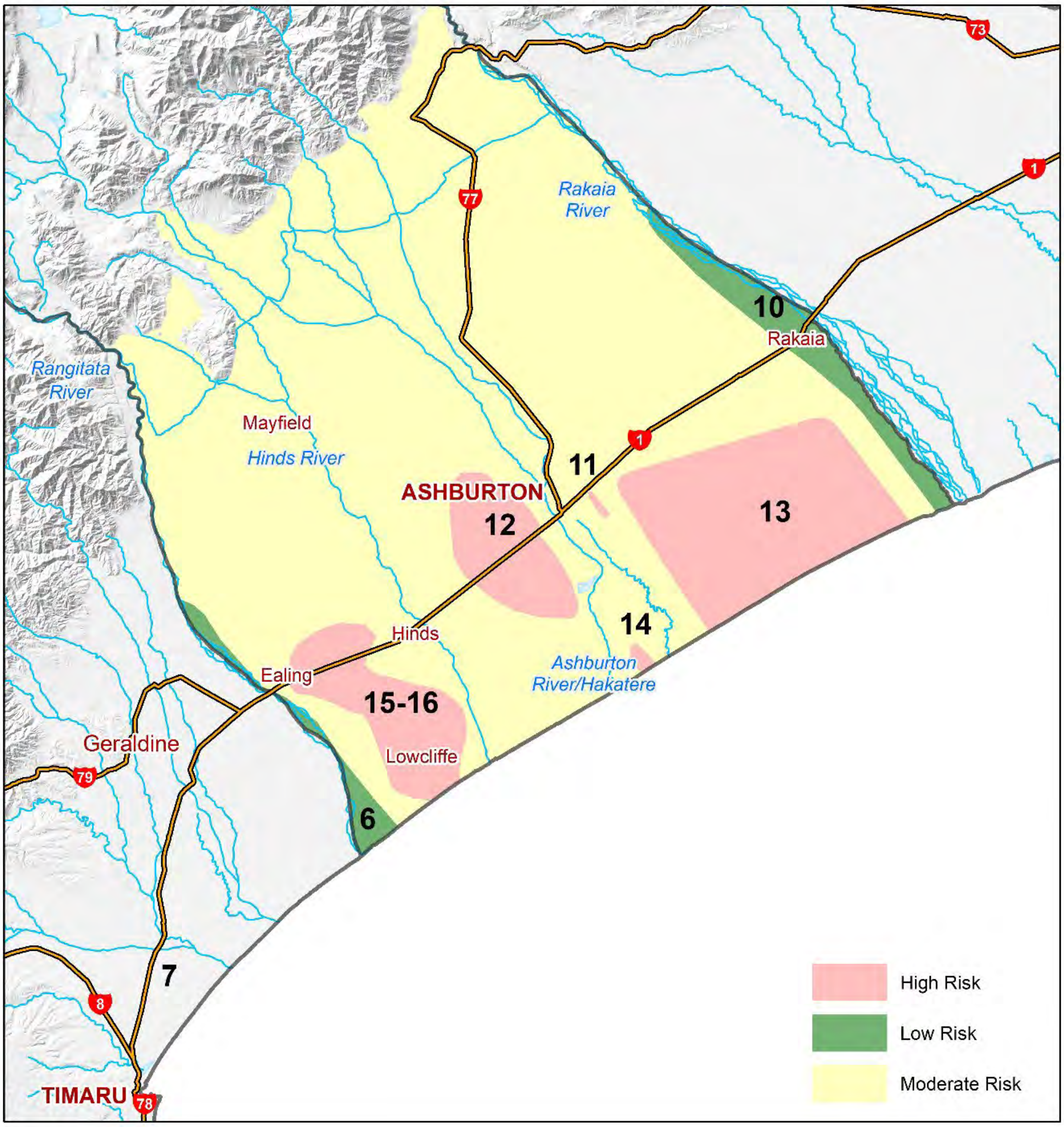

Figure 3-4: Risk map for Ashburton zone. We discuss the numbered areas in the text

3.5 Selwyn-Waihora

Figure 3-5 shows the nitrate risk map for the Selwyn-Waihora zone based on data currently available.

Nitrate concentrations in groundwater adjacent to the Rakaia River (10) indicate river recharge and therefore this area is low risk. In this update we refined the low-risk area boundary to exclude some land near Southbridge where a shallow monitoring well has recently exceeded 50% of MAV. Southbridge township is now included in the moderate risk area where some other nearby wells have measured concentrations above 50% MAV. A high density of onsite wastewater discharges near Southbridge also contribute to a moderate risk that nitrate will exceed MAV from localised sources.

The area around Te Waihora/Lake Ellesmere (17) is low risk, for two reasons. First, this is an area where alpine river recharge rises to the ground surface from the deeper parts of the groundwater system. Second, the groundwater has low dissolved oxygen concentrations due to old swamp deposits and any nitrate entering this environment will tend to be removed via denitrification.

In 2012/13 we investigated the upper Selwyn area to confirm the presence of high nitrate concentrations in groundwater around Greendale. We mapped a high-risk area (18) around wells in this area where nitrate concentrations have exceeded the MAV and continue to monitor one well where nitrate concentrations are still above MAV. This high-risk area remains.

The remaining areas are moderate risk as land surface recharge increases nitrate above natural concentrations. The deeper groundwater has lower nitrate concentrations than the shallow groundwater but even a few of the deeper wells exceed the MAV.

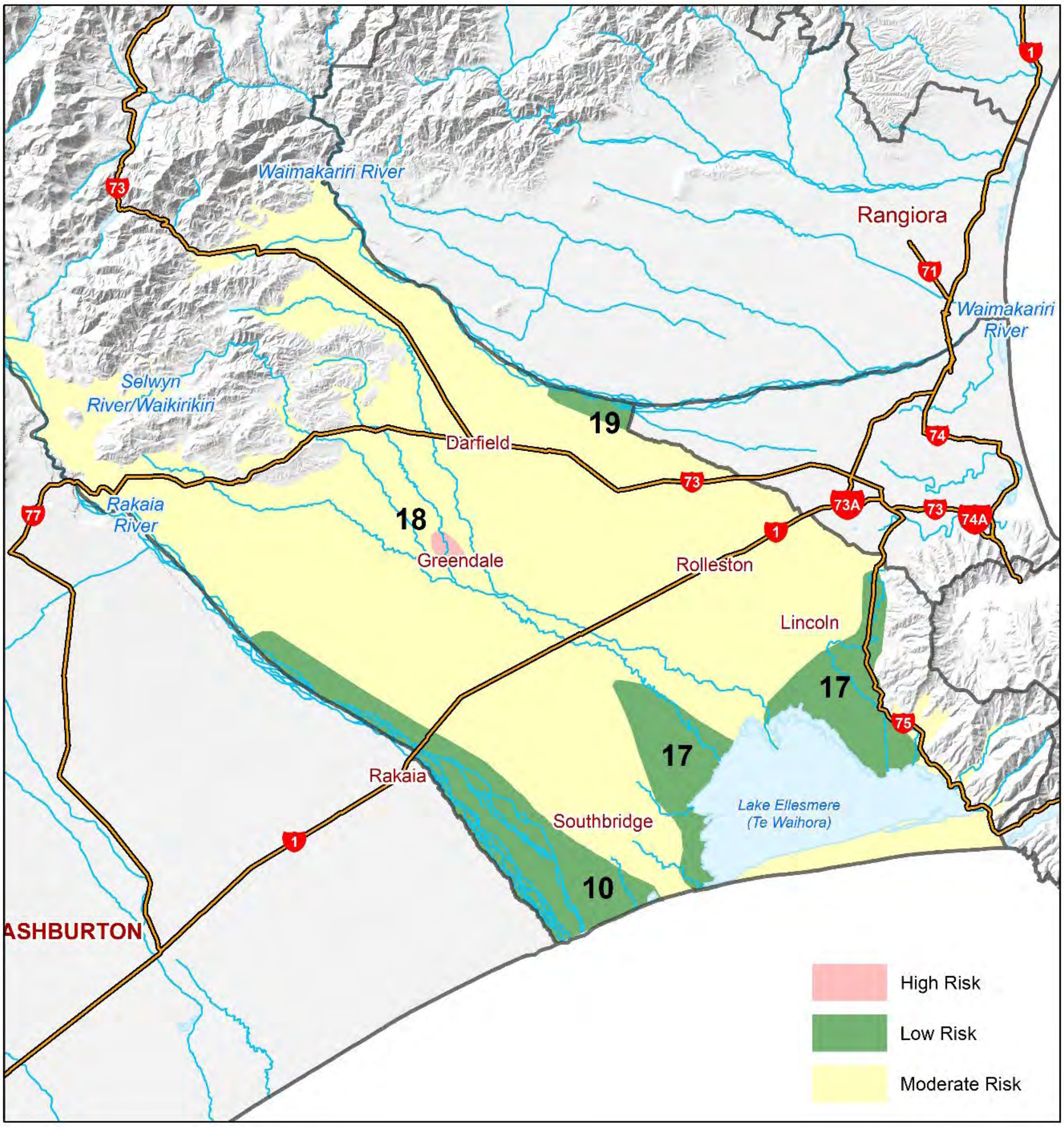

Figure 3-5: Risk map for Selwyn-Waihora zone. We discuss the numbered areas in the text

3.6 Christchurch-West Melton and Banks Peninsula

Figure 3-6 shows the nitrate risk map for the Christchurch-West Melton and Banks Peninsula zones based on data currently available.

A significant part of the Christchurch-West Melton zone (19) is low-risk due to the Waimakariri River recharge that flows towards the Christchurch groundwater system. There are also low dissolved oxygen concentrations in the groundwater in some areas, particularly toward the coast.

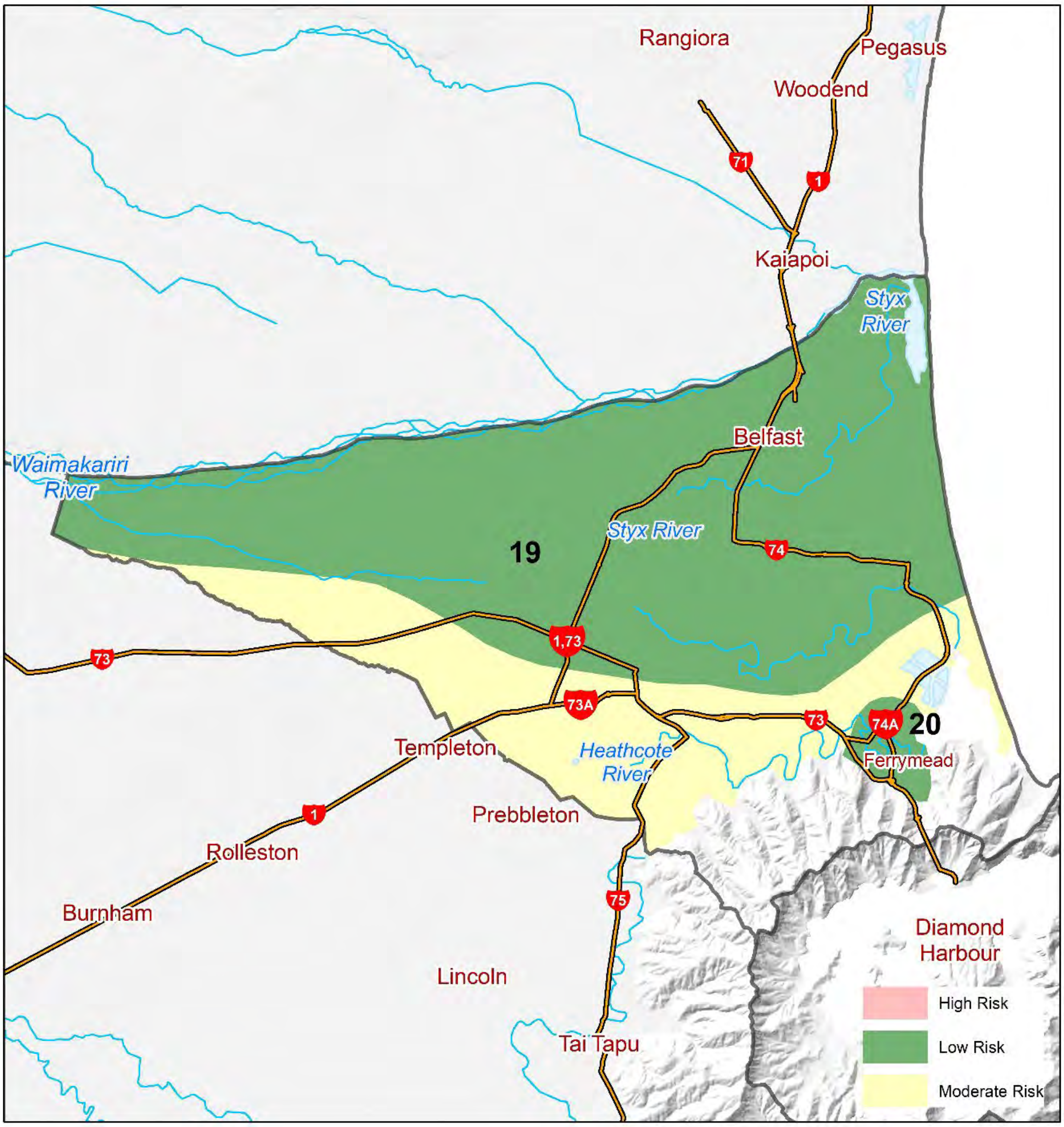

Figure 3-6: Risk map for Christchurch-West Melton and Banks Peninsula zones. We discuss the numbered areas in the text

Land surface recharge enters the groundwater system to the west of Christchurch, but the water stays in a relatively shallow part of the system and then discharges in springs. The southern part of Christchurch zone does have some wells with nitrate above the MAV, but we cannot define any high-risk areas.

The green area near Ferrymead (20) is separate from the rest of the low-risk area because we do not have enough data to be confident that the area in-between is also low-risk. Because we see elevated nitrate in shallow wells to the west, we cannot be confident that the shallow groundwater in this area is low risk. The deeper groundwater in this area generally has nitrate concentrations below the MAV.

Because of low groundwater use, we only monitor surface water quality in the Banks Peninsula zone. We do not have current data available to map the nitrate risk for groundwater.

3.7 Waimakariri

Figure 3-7 shows the nitrate risk map for the Waimakariri zone based on data currently available.

The low-risk area along the coast (21) has nitrate below the MAV due to both river recharge from the Ashley River/Rakahuri and low dissolved oxygen concentrations in the groundwater. There is one well (22) within the green area that has elevated nitrate concentrations. Although we do not know the source of nitrate in this well, we believe that it is due to a point source that does not affect the overall groundwater quality. Nitrate in this well has not exceeded the MAV, but we last tested the well in 2010. As a precaution, we have kept the area around the well a moderate-risk area.

Nitrate concentrations in the yellow area show impacts from human activities. There are some wells where nitrate exceeds the MAV, but these are not in defined areas. From our recent data, we noticed a well in the Eyrewell area where nitrate concentrations are consistently over the MAV around 80 m below the water table. This seems to be an isolated incidence of contamination from an intensive farming operation, so we have kept the moderate-risk classification for this area. However, nitrate concentrations are also rising rapidly in the spring-fed streams sourced from groundwater from the Eyrewell area. Future reviews should look for potential changes in this area as farming intensifies on light free-draining soils.

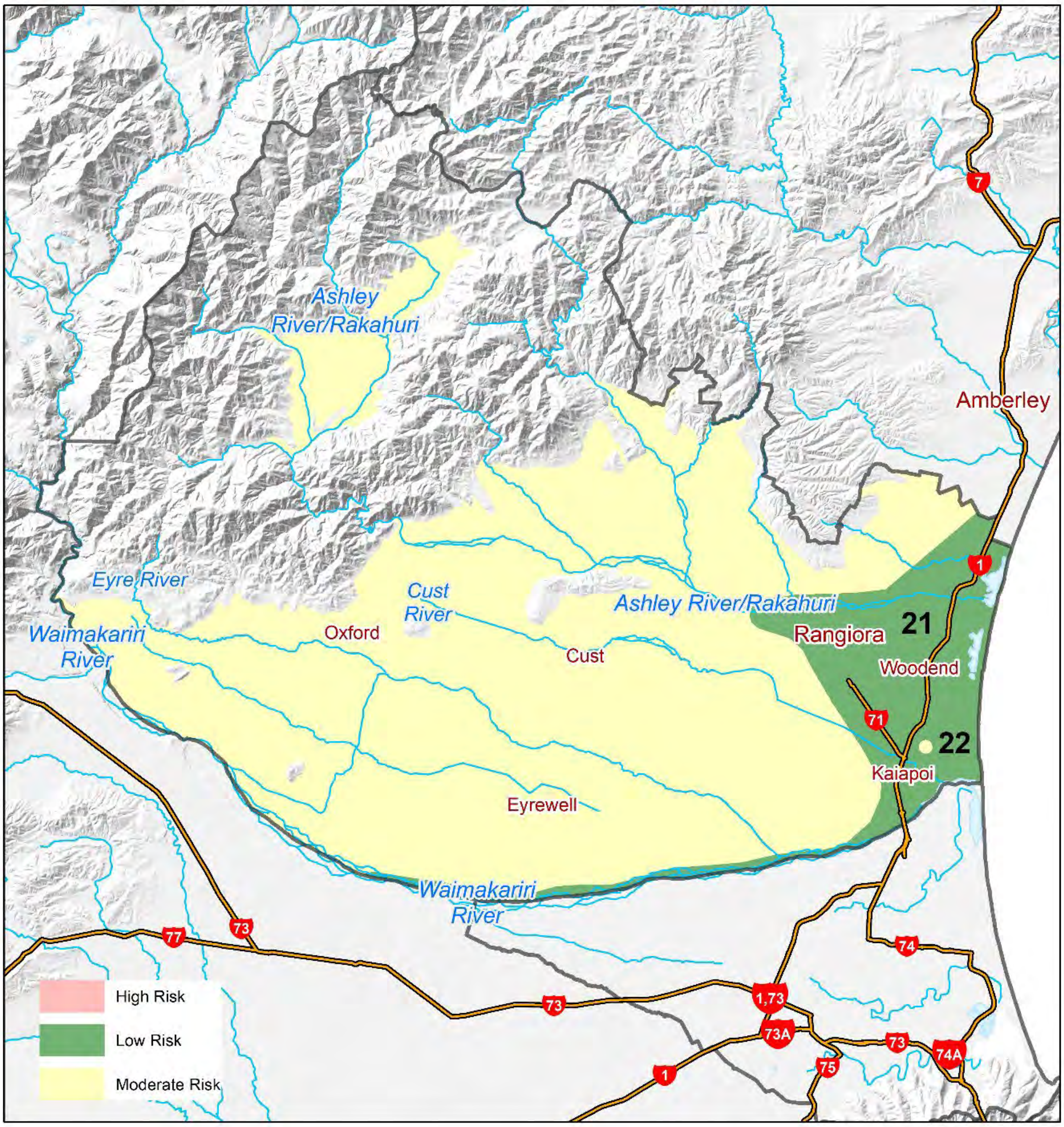

Figure 3-7: Risk map for Waimakariri zone. We discuss the numbered areas in the text

3.8 Hurunui-Waiau

Figure 3-7 shows the nitrate risk map for the Hurunui-Waiau zone based on data currently available.

We identified three low-risk areas in this zone. The area along the coast (23) near Amberley has low dissolved oxygen, so we do not expect any nitrate to persist there.

A small area around Waipara was mapped as low risk in previous reports, but the data that defined the area are now mostly more than 10 years old. Our nearest ongoing monitoring well just outside the low-risk area has nitrate concentrations near 50% MAV. We also know there is no reticulated wastewater in Waipara township and a high density of onsite wastewater

discharges. For these reasons we have changed the low-risk area to moderate risk, which is also the risk class of the surrounding area, until we can collect more current nitrate data.

Concentrations of nitrate are low in the area near Spotswood (24) due to recharge from the Waiau River and we have mapped a low-risk area around the wells where we have never seen elevated nitrate concentrations.

Nitrate concentrations in other areas that we sample are highly variable over short distances, showing the effects of human activities. We have assigned a moderate-risk to those areas. There are isolated wells with nitrate concentrations over the MAV and increasing trends in the Culverden Basin and at Parnassus (25). There is still no high-risk area there at present, but we will keep an eye on these areas as irrigation systems change and new irrigation schemes come online.

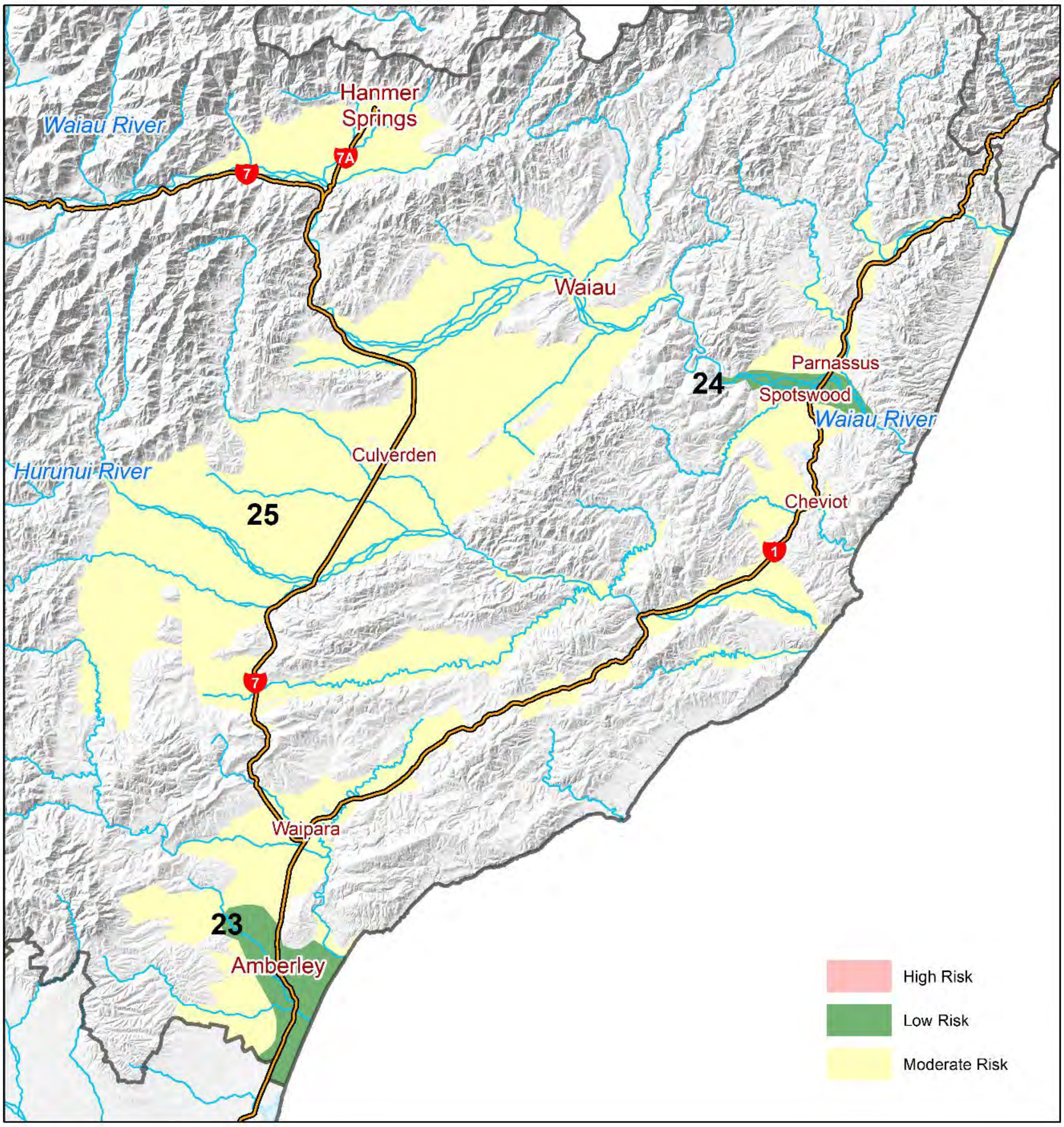

Figure 3-8: Risk map for Hurunui-Waiau zone. We discuss the numbered areas in the text

3.9 Kaikoura

Figure 3-9 shows the nitrate risk map for the Kaikoura zone based on data currently available.

Groundwater use in the Kaikoura zone is mainly on the plain near the Kaikoura township. None of the samples we have collected in this zone have had nitrate concentrations above the MAV and we have not observed any increasing trends in nitrate. Low dissolved oxygen in the groundwater near Kaikoura means that we would also not expect nitrate to persist.

However, we do not have samples available throughout this area and therefore we have only marked-out low-risk the area (28) where we do have data available. We have not shown the inland portion of the Kaikoura zone because no aquifer sediments are mapped there.

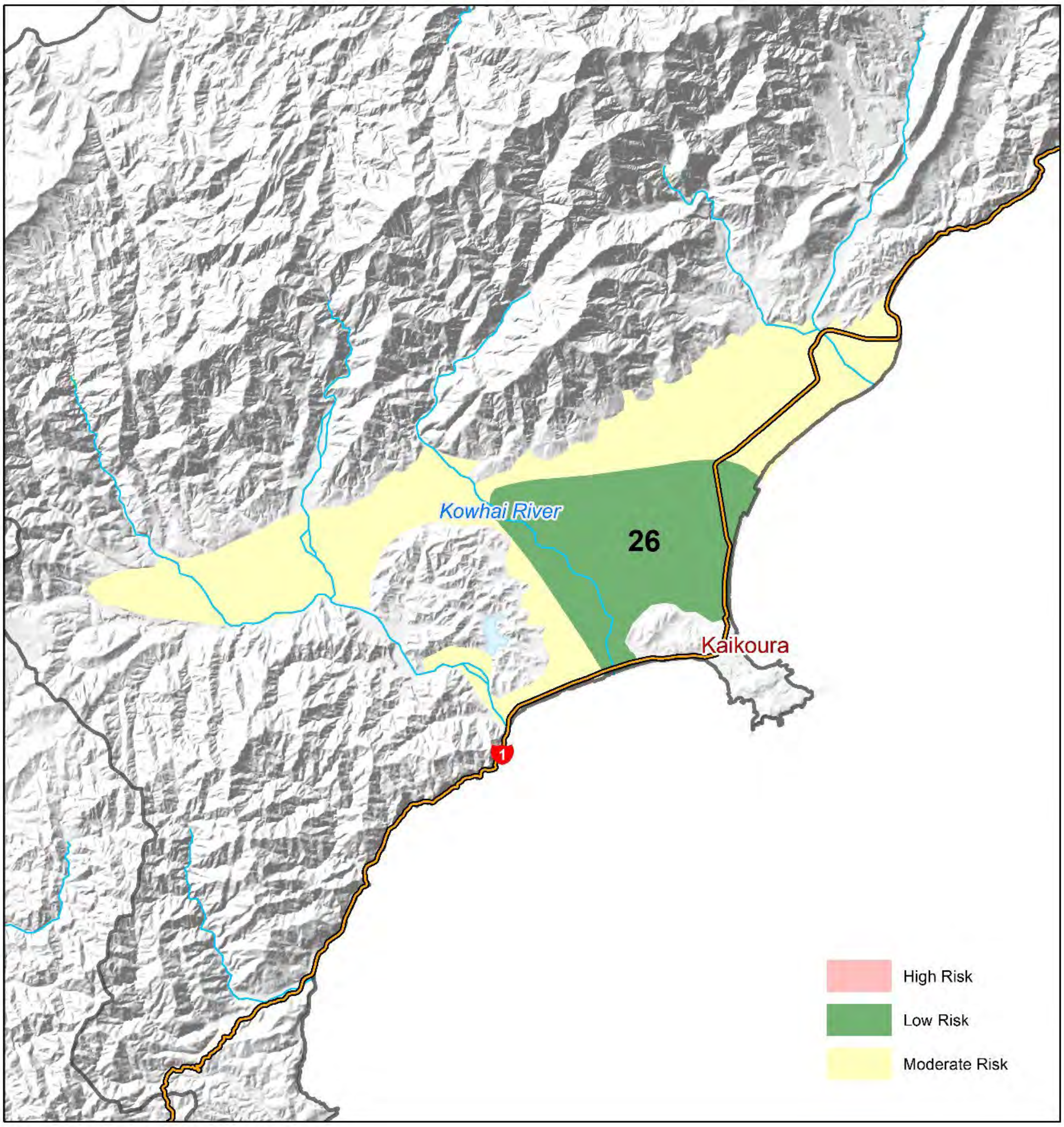

Figure 3-9: Risk map for Kaikoura zone. We discuss the numbered area in the text

4 Acknowledgements

This update of the report and maps was prepared by Lisa Scott, Marta Scott and Ben Wilkins with support from Kurt VanNess and Jennifer Tregurtha. We would like to thank all the Environment Canterbury Groundwater Science Section staff for collecting the data and their helpful comments; Maureen Whalen and Carl Hanson for reviewing this update and Denise Tully from Community and Public Health/Te Mana Ora for her feedback.

5 References

Aitchison-Earl, P. L. 2019: *Sources of nitrate in groundwater in the Tinwald, Ashburton area*, Environment Canterbury, Technical report: R19/85.

Alkhaier, F. and Scott, M. 2017. *Risk maps of nitrate in Canterbury groundwater, updated December 20157.* Environment Canterbury, Technical report: R17/46.

Canterbury Mayoral Forum 2009: Canterbury Water Management Strategy. Strategic Framework - November 2009, Report available from https://www.ecan.govt.nz/your-region/plans-strategies-and-bylaws/canterbury-water-management-strategy/ (accessed March 2020).

Canterbury Regional Council 2012: Proposed Canterbury Land and Water Regional Plan, Volume 1, August 2012, Available from https://www.ecan.govt.nz/your-region/plans-strategies-and-bylaws/canterbury-land-and-water-regional-plan/ (accessed March 2020).

Dench, W. 2017. *Identifying changes in groundwater quantity and quality resulting from border-dyke to spray irrigation conversion*, Master of Water Resource Management thesis, University of Canterbury, College of Science, Waterways Centre for Freshwater Management, p 95.

Hayward, S. A. and Hanson, C. R. 2004. *Nitrate contamination of groundwater in the Ashburton-Rakia plains*. Environment Canterbury, Technical report: R04/9.

Hanson, C. and Abraham, P. 2010. *Nitrate contamination and groundwater chemistry – Ashburton-Hinds plains*. Environment Canterbury, Technical report: R10/143.

Ministry for the Envrionment (MfE) 2019. Environment Aotearoa 2019. Published by the New Zealand Ministry for the Environment, Wellington. Available from https://www.mfe.govt.nz/environment-aotearoa-2019 (accessed March 2020).

Ministry of Health (MoH), 2018. *Drinking-Water Standards for New Zealand 2008 (revised 2018)*. Published by the New Zealand Ministry of Health, Wellington.

Scott, L., Hanson, C. and Cressy, R. 2011. *Groundwater quality investigation of the Rangitata-Orari area.* Environment Canterbury, Technical report: R11/56.

Scott, M. and Hanson, C. 2013. *Risk maps of nitrate in Canterbury groundwater.* Environment Canterbury, Technical report: R13/44.

Scott, L. and Hanson, C. 2015. *Risk maps of nitrate in Canterbury groundwater, updated June 2015.* Environment Canterbury, Technical report: R15/75.

Smith, V. R. 1993. *Groundwater contamination from activities at a freezing works*. Environment Canterbury, Technical report: R93/37.

Webb, T., Hewitt, A., Lilburne, L., and McLeod (Landcare Research) and Close, M. (Environmental Science & Research), 2010, *Mapping of vulnerability of nitrate and phosphorus leaching, microbial bypass flow, and soil runoff potential for two areas of Canterbury*, Environment Canterbury, Technical report: R10/125.

Environment Canterbury Report No. R20/18
ISBN 978-1-98-859389-0 (web)
978-1-98-859390-6 (print)

Facilitating sustainable development
in the Canterbury region
www.ecan.govt.nz

Environment Canterbury offices

Christchurch
200 Tuam Street
PO Box 345
Christchurch 8140

P 03 365 3828
F 03 365 3194

Timaru
75 Church Street
PO Box 550
Timaru 7940

P 03 687 7800
F 03 687 7808

Kaikōura
96 West End
PO Box 59
Kaikōura 7340

P 03 319 5781
F 03 319 5809

Report number: R20/18