Land and Water Committee

Agenda

Tuesday 27 September 2022

1.00pm

Council Chamber
215 High Street
Rangiora

Members:

Councillor Sandra Stewart (Chairperson)
Deputy Mayor Neville Atkinson
Councillor Kirstyn Barnett
Councillor Al Blackie
Councillor Niki Mealings
Councillor Paul Williams
Mayor Dan Gordon (ex officio)

The Chairperson and Members
LAND AND WATER COMMITTEE

AGENDA OF THE LAND AND WATER COMMITTEE TO BE HELD IN THE COUNCIL CHAMBER, 215 HIGH STREET, RANGIORA ON TUESDAY 27 SEPTEMBER 2022 AT 1PM.

Recommendations in reports are not to be construed as Council policy until adopted by the Council

BUSINESS

Page No

1 APOLOGIES

2 CONFLICTS OF INTEREST

Conflicts of interest (if any) to be reported for minuting.

3 CONFIRMATION OF MINUTES

3.1 Minutes of a meeting of the Land and Water Committee held on Tuesday 17 May 2022

5-10

RECOMMENDATION

THAT the Land and Water Committee:

(a) **Confirms**, as a true and correct record, the circulated Minutes of the meeting of the Land and Water Committee held on 17 May 2022.

4 MATTERS ARISING

5 DEPUTATION/PRESENTATIONS

Nil.

6 REPORTS

6.1 Analysis of Recent Reports Covering Regional Water Quality Trends and Issues – Hayley Proffit (Water Safety and Compliance Specialist)

11-67

RECOMMENDATION

THAT the Land and Water Committee:

(a) **Receives** report No: 220808135617.

(b) **Notes** that trends for nitrate levels in both groundwater and surface water are observed as generally increasing over time throughout Canterbury.

(c) **Notes** the significant time lag between the introduction of land use changes and the observable effects of the changes to nitrate levels in groundwater.

(d) **Notes** that recent research has found an association between nitrate levels in drinking-water and an increase in adverse long term health effects. At present the current advice from government is that there is no clear or consistent evidence available to support this conclusion and further studies are necessary.

(e) **Notes** that Council 3 Waters staff are aware of the issue, routinely monitor the council owned drinking-water supplies for nitrate and evaluate the risk further through the Drinking-water Safety Plan (DWSP) risk assessment and planning processes. At this time nitrate levels in the council drinking-water supplies **do not** present an immediate risk to compliance or human health.

(f) **Notes** limited information is available on private and individual water supplies in the district.

(g) **Recommend** that the Council give consideration to funding an assessment of all private and individual water supplies in the District as part of the Draft 2023/24 Annual Plan.

(h) **Circulates** this report to the Council and Community Boards for information.

6.2 Pinevale Farm Earthworks Incident Report – Angela Burton (Water Environment Advisor)

68-72

RECOMMENDATION

THAT the Land and Water Committee:

(a) **Receives** Report No. 220915160331.

(b) **Notes** that recent earthworks at Pinevale Farm do not appear to have impacted the planting previously funded by the Cam River Enhancement Fund.

(c) **Notes** that the Environment Canterbury Incident Response Team are currently investigating the works to determine if the activity may has breached any rule in the Land and Water Regional Plan.

(d) **Notes** that Council staff will work with Environment Canterbury, Synlait Milk Limited and the landowner/leasee at Pinevale Farm find a solution for the future.

(e) **Circulates** this report to the Mahi Tahi Committee and Council for information.

7 PORTFOLIO UPDATES

7.1 Biodiversity – Councillor Sandra Stewart

7.2 Natural, Coastal and marine Areas – Councillor Al Blackie

8 QUESTIONS

9 URGENT GENERAL BUSINESS

NEXT MEETING

This is the final meeting of the Land and Water Committee for the 2019-22 electoral term.

The new Council will be sworn into office late October 2022, with Council and Committee meetings resuming from mid-November 2022. Further information will be advertised and listed on the Council’s website

WAIMAKARIRI DISTRICT COUNCIL

MINUTES OF THE MEETING OF THE LAND AND WATER COMMITTEE HELD IN THE COUNCIL CHAMBER, 215 HIGH STREET ON TUESDAY 17 MAY 2022 AT 1PM.

PRESENT

Councillors S Stewart (Chairperson), N Atkinson (departed at 1.35pm), K Barnett, A Blackie, N Mealings, P Williams and Mayor D Gordon (departed at 1.35pm).

IN ATTENDANCE

Councillor P Redmond

C Brown (Manager Community and Recreation), G Cleary (Manager Utilities and Roading), S Allen (Water Environment Advisor) G Macleod (Community Greenspace Manager), S Hart (Strategy and Business Manager), B Dollery (Community Greenspace Ecologist – Biodiversity), G Maxwell (Technical Assistant- Policy), E Harvie (Coordinator Waimakariri Landcare Trust) and A Connor (Governance Officer).

1 APOLOGIES

Moved: Councillor Stewart Seconded: Councillor Williams

THAT an apology for early departure be received and sustained from Mayor Gordon and Councillor Atkinson.

CARRIED

2 CONFLICTS OF INTEREST

There were no conflicts of interest declared.

3 CONFIRMATION OF MINUTES

3.1 Minutes of a meeting of the Land and Water Committee held on Tuesday 22 March 2022

Moved: Councillor Stewart Seconded: Councillor Barnett

THAT the Land and Water Committee:

(a) **Confirms**, as a true and correct record, the circulated Minutes of the meeting of the Land and Water Committee held on 22 March 2022.

CARRIED

4 MATTERS ARISING

There were no matters arising.

5 DEPUTATION/PRESENTATIONS

5.1 Update on North Brook Trail – E Harvie (Coordinator Waimakariri Landcare Trust)

E Harvie introduced the Waimakariri Landcare Trust. The following points were highlighted:

- A lack of connectivity between trails in the district was highlighted as well as a disconnect between agricultural areas leading to a disjoint between urban and rural communities. Also the degradation of indigenous ecosystems and lack of indigenous plant species.

- Concept was to have a trail with planting on one side and fencing of the active farm side as well as information boards and signage about different aspects of the walkway.

- Opportunity to use the existing structure Arohatia te awa had developed with local ruhanga and Fonterra who had verbally offered to provide the plants.

- Stage one of the project ran from Marsh Road to Boys Road and stage two from Boys Road to the Northbrook Wetland.

- Had received funding from Waimakariri District Council and the Waimakariri Water Zone Committee

E Harvie asked for support from Waimakariri District Council staff for assistance with road safety, culverts and surveying as these would need to be part of the first step in stage one to ensure public safety. C Brown advised that the Utilities and Roading Team would be able to assist with that and the Greenspace team would be able to help with further funding for the project. G Cleary confirmed that they would be able to help and were happy to provide any information to assist.

Councillor Williams questioned if there was any budget for long term maintenance. C Brown stated there was a standard budget for Arohatia te awa projects in the Long Term Plan which would cover this project , however there was still further work that needed to be done. However at present there was no budget.

Councillor Stewart queried what the next steps would be taken. C Brown noted that G Cleary would request the appropriate staff member to contact E Harive and B Dollery.

Councillor Barnett sought clarity on whether the end of stage one at Boys Road was located next to a milking shed or where the cows crossed the road and how the smell would be managed. E Harvie noted the milking shed was on Marshs Road and that the farm would have compliance requirements for effluent.

Councillor Mealings asked where the boundary for the farm on the north east was. E Harvie explained it was north of the trail and the land owner would be notified of the proposal.

Councillor Stewart thanked E Harvie and commented that this was an exciting project.

6 REPORTS

6.1 Application to the Biodiversity Fund – G Maxell (Policy Technician) and G MacLeod (GreenSpace Manager)

G MacLeod acknowledged that this had been the first application received toward the Biodiversity Fund. The landowner Mia Hofsteede was requesting $5,204.62 to assist with the installation of a fence to protect the biodiversity of the planting. The application met eight points of the funding criteria.

Councillor Williams questioned what would stop animals from coming into the area as the fence would not fully enclose the area. G Maxwell advised that staff had spoken to M Hofsteede at length regarding this matter. The area being fenced was bordered by four properties. One of the properties on the right was already fully fenced to deter stock from accessing this section. Currently at M Hofsteed's property at 118 Yaxleys Road had some existing fencing. On the left hand side of 118 Yaxleys Road there were two property owners who would be contacted with regarding applying to the Biodiversity Fund for assistance to continue the fencing required. M Hofsteed's fencing would encapsulate the entire right side but not all 3.2 hectares. G MacLeod commented that having a further conversation with the other land owners regarding fencing the rest of the SNA to keep stock out of the area would not be an issue. The proposed fencing on the side closest to the road would be the most important in protecting the SNA which would be covered with this proposal.

Councillor Redmond queried whether the information in paragraph 6.2 of the report was correct which stated that there were no sustainability and/or climate change impacts. G MacLeod replied that it could be taken as read that any report coming from greenspace would have a positive sustainability and/or climate change impact.

Councillor Blackie asked for clarification on what the different colours on the map depicting the fencing meant and what type of fencing was already existing. G Maxwell confirmed that the pink shading denoted existing fencing and the blue was the proposed fencing. The white indicated the existing boundary of the wetland and was not fenced. She was unsure what type of fencing was on site, however she would follow up on this..

Councillor Williams questioned what the cost would be for fencing the rest of the boundary which was currently unfenced. G MacLeod answered that the proposed fencing would protect a significant part of the wetland however the cost for fencing the rest of the area was yet to be determined.

Mayor Gordon and Deputy Mayor Atkinson departed at 1.35pm.

Moved: Councillor Stewart Seconded: Councillor Blackie

THAT the Land and Water Committee:

(a) **Receives** report No.220505071036.

(b) **Notes** the accumulated amount available for allocation in the Biodiversity Fund was $67,750.

(c) **Recommends** the Council approves funding of $5,204.62 from the Biodiversity Fund to Mia Hofsteede to fence wetland, flax and cabbage trees located at 118 Yaxleys Road.

CARRIED

Councillor Stewart commented that this was a significant wetland. She had been talking with the Councils ecologists and planning staff and they were putting together a package of support and management for applications like this. This was not currently finalised however it should bring in more applicants in the future. She also noted that Judith Roper-Lindsay the chairperson of the Waimakariri Biodiversity Trust was keen to be involved with this initiative. Granting this application would encourage an improved outcome with SNAs than currently enjoyed.

Councillor Williams believed it was important to fence but had reservations on whether the other property owners would support properly fencing the remaining area and if the proposed section would be sufficient. He stated that the Council needed to work hard to ensure the rest of the area was fenced and stock protected.

B Dollery commented that M Hofsteede's property had rare wetlands and was the only place in Canterbury that certain vegetation was found. The importance of the wetland on her property was significant And by taking small steps in the right direction would ensure the safety of stock and was the right way to go.

Councillor Mealings noted that the last time this fund was advertised was 2019 and had then only attracted one application which was granted since 2020. This land had been on the Council's radar which had been looked after since 1995 and had never received any funding. This was a great use of the fund and would hopefully encourage the surrounding properties to also fence the rest of the wetland.

Councillor Stewart stated the Council was putting together, not only a package of support, but also offering a rates remission. There was also access to a grant which was dependant on the size of the area to be protected. These benefits would hopefully see an uptake on this fund. There was less than 0.5% of indigenous biodiversity left in the Waimakariri District.

Councillor Blackie questioned if the fence would be hot wired. G MacLeod was unsure however would enquire.

6.2 <u>Zone Implementation Programme Addendum Capital Works Programme – 2022-23 – S Allen (Water Environment Advisor)</u>

S Allen noted there were many projects that would take place within this programme however she would be on parental leave and her cover would be leading the projects which might mean some of the details could change. The McIntosh Drain project would be in the same area as the flood improvement works for Kaiapoi. At the moment the proposed site was suitable for those plans however if something unforeseen happened, a new site would need to be chosen. Watercress and other exotic plants at the Jeffs Drain site had created a natural channel so that site may change in order to do the works in a more suitable location.

S Allen stated a significant recommendation was to discuss was the mahinga kai project which was led by Environment Canterbury. The watercress enhancement of the Cam River that started in 2021 had been successful and had been notified and was the best crop of watercress in many years despite recent flooding events. She had asked for a report from Environment Canterbury on the status of the project and how the capital expenditure budget would be best utilised. This report would either go to the Waimakariri Water Zone Committee or the Land and Water Committee in August 2022.

Councillor Williams sought clarity on whether the flow bags would hold up in a flood. S Allen advised they had to investigate any constraints on the hydraulic capacity and whether the Jeffs Drain site had any pinch points. The pinch points were located further down the stream. There was also a project plant in Jeffs Drain to help constrain high flows rushing through as pukekos removed all the plants. Wire cages were used in the Kaiapoi River to stop pukekos however if they had been used in this situation more damage would have been caused in the floods. It is recommended to further investigate hydraulic modelling to identify possible pinch points. With the current culverts it would be unlikely to exacerbate anything.

Councillor Stewart questioned what provisions were in place to stop wildlife from getting into the pumps. G Cleary confirmed there were fish screens on the pumps, which were substantial structures to ensure they were suitable to prevent fish getting in.

Moved: Councillor Stewart Seconded: Councillor Blackie

THAT the Land and Water Committee:

(a) **Receives** report No. 220328045801.

(b) **Approves** the proposed 2022-23 Waimakariri District Council capital expenditure work programme, based on the Zone Implementation Programme Addendum (ZIPA) recommendations.

(c) **Receives** an update on the progress of the Environment Canterbury watercress mahinga kai project on the Cam River before the $5,000 of WDC ZIPA budget was allocated to this specific project for 2022-23.

(d) **Circulates** this report to Council, Community Boards, WDC-Rūnanga liaison meeting and the Waimakariri Water Zone Committee for their information.

CARRIED

Councillor Stewart commented this was a good ongoing programme which was reduced due to Covid but the Council now had good targeted programmes. She would like to see something in writing about the watercress project.

Councillor Mealings noted it was disappointing to see lots of projects with zeros in the funding lines. She was pleased with the work the Council was doing but it would be good to see everyone involved doing their part.

Councillor Barnett noted that this funding originates from the whole district however the majority was dedicated to the eastern area.

7 PORTFOLIO UPDATES

7.1 Biodiversity – Councillor Sandra Stewart

- Attended Biodiversity Champions Working Group. Discussions around upping the profile of biodiversity. Tabled a biodiversity checklist:
  - Work regionally on biodiversity and remain in contact with other groups.
  - Identified structural support and higher profile needed for indigenous biodiversity.
  - Have space on every agenda where Council had an item whereby its effect on indigenous biodiversity would be noted.
  - Having advocacy through the mayoral forum.
  - Align key messages across the region.
- The Biodiversity Champions Working Group want to go from having a document to implementing the document.
- Draft National Adaption Plan assisting the New Zealand biodiversity strategy. Hoping for a briefing on what the Councils responsibilities were.
- Working on a way for GIS mapping showing all SNA wetlands and to be publicly accessible.

7.2 Land based Indigenous Reserves (Including River Margins) – Councillor Al Blackie

- The locations of the SNAs that were unknown had been located. One was down stream of McIntosh's hole and the other was halfway between the first location and the Yacht Club which was a bird sanctuary.
- Mahinga Kai project would start on 28 May 2022 with an official opening and a community planting day. Had spoken with Alistair Gray about upgrading the communications plan for the upcoming week as locals were unaware of the work being done until a social media post only two weeks before the date.

8 QUESTIONS

There were no questions.

9 URGENT GENERAL BUSINESS

There was no urgent general business.

NEXT MEETING

The next meeting of the Land and Water Committee is scheduled for 1pm, Tuesday 16 August 2022.

THERE BEING NO FURTHER BUSINESS THE MEETING CONCLUDED AT 2PM.

CONFIRMED

Chairperson

Date

WAIMAKARIRI DISTRICT COUNCIL

REPORT FOR INFORMATION

FILE NO and TRIM NO:	WAT-03 / TRIM 220808135617
REPORT TO:	LAND AND WATER COMMITTEE
DATE OF MEETING:	27 September 2022
AUTHOR(S):	Hayley Proffit – Water Safety and Compliance Specialist
SUBJECT:	Analysis of recent reports covering regional water quality trends and issues
ENDORSED BY: (for Reports to Council, Committees or Boards)	General Manager / Acting Chief Executive

1. SUMMARY

1.1 This purpose of this report is bring to the attention of the Land and Water Committee a summary of key points from three reports recently presented to the Waimakariri Water Zone Committee (WWZC).

1.2 The reports summarise water quality trends and issues observed across the Canterbury region, with a focus on increasing nitrate (which may be reported as nitrate-nitrogen but for simplicity referred to in this report as nitrate unless otherwise specified) concentrations in the water sources monitored. Increased nitrate levels can contribute to a decline in source water quality, with implications for ecological health and human health if the water source is used to supply drinking-water. Recent studies have also linked the presence of nitrates in drinking water to adverse long term human health outcomes, but there is still uncertainty in the scientific community around these conclusions. New Zealand specific studies are underway to help understand the possible risks further.

1.3 Nitrate is currently not found at levels of concern in the Waimakariri District Council's community groundwater drinking-water supplies. All drinking-water supplies are fully compliant with the Drinking-water Standards for New Zealand 2005 (Revised 2022) (DWSNZ) compliance requirements for nitrate monitoring. 3 Waters staff are aware of the risk nitrates may pose to the drinking-water sources, and assess and address the risk through statutory risk management planning processes.

1.4 Council staff have less understanding of the status of private and individual water supplies across the Waimakariri district, including possible water quality issues. Obtaining further information on this matter will assist Council in meeting new statutory obligations under the Local Government Act 2002, and increase Council understanding on how best to support and inform community members.

Attachments:

i. Natural Environment Committee Report: Long term trends – Groundwater. Carl Hanson

ii. Natural Environment Committee Report: Long term trends –Surface water. Helen Shaw

iii. What if allowable drinking-water nitrate limits are reduced to address emerging health effects Dr Tim Chambers and Bridget O'Brien (Trim: 220921163559).

2. RECOMMENDATION

THAT the Land and Water Committee:

(a) **Receives** report No: 220808135617.

(b) **Notes** that trends for nitrate levels in both groundwater and surface water are observed as generally increasing over time throughout Canterbury.

(c) **Notes** the significant time lag between the introduction of land use changes and the observable effects of the changes to nitrate levels in groundwater.

(d) **Notes** that recent research has found an association between nitrate levels in drinking-water and an increase in adverse long term health effects. At present the current advice from government is that there is no clear or consistent evidence available to support this conclusion and further studies are necessary.

(e) **Notes** that Council 3 Waters staff are aware of the issue, routinely monitor the council owned drinking-water supplies for nitrate and evaluate the risk further through the Drinking-water Safety Plan (DWSP) risk assessment and planning processes. At this time nitrate levels in the council drinking-water supplies **do not** present an immediate risk to compliance or human health.

(f) **Notes** limited information is available on private and individual water supplies in the district.

(g) **Recommend** that the Council give consideration to funding an assessment of all private and individual water supplies in the District as part of the Draft 2023/24 Annual Plan.

(h) **Circulates** this report to the Council and Community Boards for information.

3. BACKGROUND

3.1 The following paragraphs summarise the key points from the reports:

3.2 The first report titled *"Long Term Trends – groundwater and surface water*" is authored by Carl Hanson, Groundwater Science Manager at ECan, and focusses on nitrate concentrations in groundwater. Surface water trends were however covered in a separate report, the findings of summarised in points 3.5 to 3.9 below. The report summarises findings from ECan's long term groundwater monitoring programme, with 112 of the approximately 337 monitoring wells monitored for nitrate over the past 30 years. The report does not discuss any specific examples relating to groundwater in the Waimakariri district. The report makes the following key points:

3.3 While the rate of change is slow and non-linear, the overall trend is towards an increase in nitrate concentrations in groundwater over time.

3.4 There is typically a significant time lag between the introduction of land use management changes and the time the effects of the changes become evident. The time lag varies depending on specific catchment characteristics and other factors such as seasonal variations, however a 10 year time lag is the general rule of thumb recommended by ECan. The time lag is expected to be longer for the Council's deep groundwater sources, with age dating data indicating the water is many decades old. With many factors often contributing to nitrate accumulation, it can also be hard to tease out the reasons for and the effects of any changes.

3.5 The second report title *"Long Term Trends Surface Water"* is authored by Helen Shaw, Surface Water Science Manager at ECan. This report focusses on long trends in surface water in the Canterbury region. The report covers a wider range of water quality parameters relevant to ecological health, with water quality monitoring data coming from river and stream sites and lakes across the Canterbury region. The report does not provide any specific commentary on surface water in the Waimakariri district.

3.6 The report notes that while regional trends are useful to demonstrate overall patterns of change, the reasons for changes in indicator values can be complex and attributed to a range of factors. More detailed site specific analyses are typically required to identify specific causes of any changes to water quality. For the data assessed the following observations are noted:

3.7 Surface water quality trends for nitrate-nitrite nitrogen (NNN) in rivers and streams are similar to the groundwater quality trends, with an increasing trend demonstrated at >60% of sites over the 22 year period analysed. It is also noted that trends from a more recent time period (9 years) have shown over 50% of the sites now demonstrate decreasing NNN concentrations. Groundwater is the primary contributor to NNN levels in rivers, with land runoff and decomposition of organic matter contributing to a lesser extent.

3.8 Other water quality parameters assessed in rivers include dissolved reactive phosphorous (DRP), macroinvertebrate communities and turbidity. The trends noted in these parameters also vary, depending on the locality of the monitoring site and the time period relating to the data collected. Overall the report highlights the need for further information to correlate any trends in all the water quality parameters assessed with land use and management changes.

3.9 River flows are also assessed in the report. The data assessed demonstrated decreasing low flows in 10-year trend analysis, but no clear changes over 30 years. Further information is required to understand the long term impacts.

3.10 The third publication is a research paper prepared by Dr Timothy Chambers from the University of Otago and Bridge O'Brien from WSP New Zealand Ltd (formerly of Christchurch City Council (CCC) and titled *"What if allowable drinking-water nitrate limits are reduced to address emerging health effects".*

3.11 The impetus for this study comes from recent epidemiological studies, primarily the "Danish study" conducted by Schullehner et al. (2018) [1], hypothesising that drinking water containing nitrate-nitrogen at levels as low as 1 mg/L may increase the risk of adverse health outcomes including preterm births and colorectal cancers. This level of nitrate-nitrogen is considerably lower than the current Drinking-water Standards for New Zealand 2005 (Revised 2018) (DWSNZ) maximum acceptable value of 11.3 mg/L for nitrate-nitrogen (equivalent to 50 mg/L nitrate).

3.12 The authors used the 5th, 50th and 95th% percentile groundwater nitrate predictions from the groundwater model used to inform Plan Change 7 (PC7) of the Canterbury Land and Water Regional Plan (LWRP). A range of possible groundwater quality nitrate exposure scenarios were then established for the populations of both of Christchurch and Waimakariri districts.

3.13 The findings from the scenarios modelled concluded that up to an additional 32.7 and 9.8 (95% confidence interval (CI)) pre-term births per year in the Christchurch City and Waimakariri Districts respectively. Additionally, under a 95% CI scenario, an estimated 72.1 and 23.9 cases of colorectal cancer could occur per year. The economic burden of these nitrate attributable health outcomes was estimated to cost up to NZ$47.8 million each year.

3.14 The report also touched on the potential costs of ion exchange nitrate removal treatment for Christchurch City, including an estimated $610 for construction costs and $24 million per year operational expenditure. It is noted that Christchurch City water supply has a large number of pump stations where treatment plants would need to be installed.

Considerations for Council:

3.15 The findings in the ECan reports confirm the current understanding that nitrate levels are increasing in source waters over the Canterbury region. The 3 Waters team are aware of the issue and monitor each drinking-water source for nitrate at least annually. Findings to date confirm that nitrate is present at levels less than half the DWSNZ maximum acceptable value for nitrate in all drinking-water sources with the exceptions of the Ohoka Well 1 and Poyntz Road wells. These latter two wells have nitrate present at levels approaching the DWSNZ maximum acceptable value. These wells are not used to supply drinking-water and only retained for emergency purposes.

3.16 The possible risk that nitrates present to the Council drinking-water supplies are also addressed in each supply's DWSPs. Water supply specific Source Water Risk Management Plans (SWRMPs) are also currently being prepared by a consultancy on behalf of Council. The SWRMPs will cover the nitrate issue in further detail.

3.17 Approximately 80% of residents in the District are serviced by one of the Council's drinking-water supplies. The remaining 20% of properties are privately supplied. There is currently limited information available to Council regarding the water quality provided to this 20%.

3.18 Under section 125 of the Local Government Act 2002 Council is now obligated to assess at least once every three years, the access that each community in the District has to drinking-water services. This is a recent amendment to the Act, subsequent to the enactment of the Water Services Act 2021 in November 2021. According to Council records an assessment was last completed for the 2006-2007 Long Term Community Consultation Plan.

3.19 It is also noted that Recommendation 3.16 in the WWZC ZIPA recommends that Council, ECan and Te Whatu Ora – Waitaha Canterbury (formerly the Canterbury District Health Board) work together to a) develop a programme for testing and reporting of water quality in private drinking water supply wells and b) raise awareness of health impacts from high nitrates in drinking water.

Current national picture and future developments

3.20 The research into drinking water nitrate and adverse health risks is ongoing. The Office of the Prime Minister's Chief Science Advisor / Kaitohutohu Mātanga Pūtaiao Matua ki te Pirimia recently published a report summarising their review of the available evidence around nitrates and adverse health events. Evidence regarding nitrates and the possible associations with bowel cancer and adverse reproductive outcomes was assessed as part of the review.

3.21 The review found there was currently no consistent or clear evidence available to link adverse health outcomes to drinking-water nitrate consumption, acknowledging the difficulties in designing studies sufficiently robust to establish any correlations. The report recommended that the evolving evidence should continue to be monitored, while monitoring and compliance against the current DWSNZ maximum acceptable value for nitrate prioritised.

3.22 The Ministry of Health is responsible for providing policy advice to Taumata Arowai (the new drinking water regulator), and currently advises that the Ministry continues to review the evidence and research in this area. The DWSNZ have also been recently reviewed by Taumata Arowai, with no changes made to the maximum acceptable value for nitrate.

3.23 The Health Research Council of New Zealand has additionally recently announced funding for a study investigating the association between nitrate in drinking water and preterm births.

3.24 Reference to research paper referred to in bullet point 3.13: 1. Schullehner, J., Hansen, B., Thygesen, M., Pedersen, C. B., & Sigsgaard, T. Nitrate in drinking water and colorectal cancer risk: A nationwide population-based cohort study. *International Journal of Cancer*. 2018;143(1):73-79. https://doi.org/10.1002/ijc.31306.

4. ISSUES AND OPTIONS

4.1. The reports presented note that nitrate levels in source waters are increasing over time, with a significant time lag for changes to nitrate levels in water sources to become apparent. This presents both potential ecological and human health risks to ground and surface water sources across the Canterbury region. Recent academic publications such as the "Danish Study" have also highlighted that levels of nitrate in drinking-water may pose a risk to human health at levels much lower than currently deemed acceptable under the DWSNZ. The conclusions from this study are not supported by all scientists and further evidence is necessary to characterise this risk further.

4.2. At present the findings of these reports do not present an additional or immediate risk to the Council drinking-water supplies, so no further actions on top of what are already undertaken through the DWSP planning and WWZC ZIPA implementation processes are currently considered necessary. The completion of the water supply SRWMPs shall further support the understanding and management of this risk.

4.3. Community private water supply bores are also vulnerable to risks that source water nitrates present. Council 3 Waters staff currently provide information to residents through the Council website and on request, and will continue to do so as further information becomes available. If subsequent research determines nitrate to be toxic at lower levels than currently acceptable it may be possible that impacted residents may wish to access drinking water from a community drinking-water supply instead. This is an area for further consideration as additional information regarding possible health risks becomes available.

3.25 Acknowledging the limited information that Council has on private and individual water supplies at present, it is recommended that an assessment to identify and characterise private and individual water supplies across the district is scoped, costed and undertaken by Council staff. It is proposed that the data obtained from the assessment will be collated and captured in the Council GIS-based database platform Waimap.

4.4. The purpose and outcomes of this assessment will be used to support the statutory requirements of section 125 in the Local Government Act 2002 and fulfil Recommendation 3.16 in the WWZC ZIPA. It is recommended that funding for this work is assigned through the 2023/24 Annual Plan.

4.5. It is not a practicable or recommended option to "Do Nothing" when considering the potential regulatory compliance and financial implications of this issue. The current regulatory mechanisms and responsibilities in place for identifying and managing this issue already ensure that doing nothing is unrealistic.

4.6. **Implications for Community Wellbeing**

There are implications on community wellbeing by the issues and options that are the subject matter of this report. The provision of safe and reliable drinking-water is a fundamental need for the wellbeing of the community. Community wellbeing will additionally be supported by a healthy natural environment that sustains recreation and amenity, biodiversity and mahinga kai provision.

4.7. The Management Team has reviewed this report and support the recommendations.

5. COMMUNITY VIEWS

5.1. **Mana whenua**

Te Ngāi Tūāhuriri hapū are likely to be affected by, or have an interest in the subject matter of this report. The report highlights the current state of the environment and the need to give better recognition to Te Mana o Te Wai – prioritising the health of groundwater as a first priority.

5.2. **Groups and Organisations**

There are groups and organisations likely to be affected by, or to have an interest in the subject matter of this report, such as residents with private drinking-water bores. The Mandeville Residents Association regularly contacts Council staff regarding water quality issues and raises concerns through other channels such as the WWZC.

5.3. **Wider Community**

The wider community is likely to be affected by, or to have an interest in the subject matter of this report, given recent media interest in the publications linking nitrates levels in drinking-water to adverse health outcomes such as colorectal cancer. Community members periodically get in touch with the 3 Waters team inquiring about levels of nitrate in their drinking-water supply.

WDC staff believe while there is an awareness within the rural community of the nitrate issue, there is less knowledge amongst communities on how to manage the risks elevated drinking-water nitrates may pose. The limited feedback received indicates there is a need for Council and other public organisations to disseminate information and provide support to affected communities. Increasing Council understanding of the nitrate issue will assist and inform this approach.

6. OTHER IMPLICATIONS AND RISK MANAGEMENT

6.1. **Financial Implications**

6.1.1. There are no financial implications of the decisions sought by this report.

6.2. **Sustainability and Climate Change Impacts**

6.2.1. The recommendations in this report do have sustainability and/or climate change impacts. The management and safe use of groundwater will sustain rural communities into the future.

6.3 **Risk Management**

6.2.2. There are no risks arising from the adoption/implementation of the recommendations in this report. This report is for information only.

6.3 **Health and Safety**

6.2.3. There are no health and safety risks arising from the adoption/implementation of the recommendations in this report.

7. CONTEXT

7.1. **Consistency with Policy**

7.1.1. This matter is not a matter of significance in terms of the Council's Significance and Engagement Policy.

7.2. **Authorising Legislation**

7.2.1. The Water Services Act 2021 and Drinking-water Standards for New Zealand 2005 (revised 2018) set the Maximum Allowable Value (MAV) for nitrate in drinking water at 50 mg/L (equivalent to 11.3 mg/L nitrate-nitrogen).

7.3. **Consistency with Community Outcomes**

7.3.1. The Council's community outcomes are relevant to the actions arising from recommendations in this report.

7.3.1.1. There is a healthy and sustainable environment for all.

7.3.1.2. Cultural values relating to water are acknowledged and respected.

7.3.1.3. Harm to the environment from the spread of contaminants into ground water and surface water is minimised.

7.4. **Authorising Delegations**

7.4.1. No delegations apply to this report, as this report is for information only.

8.3. Long Term Trends - groundwater and surface water

Natural Environment Committee report

Date of meeting	6 April 2022
Author	Carl Hanson, Groundwater Science Manager
Responsible Director	Dr Tim Davie, Director Science

Purpose

1. This paper responds to the request from the Natural Environment Committee at its 2 December 2021 meeting for staff to “report back with long term trends on water quality and flows as soon as possible in 2022”.

2. Environment Canterbury has an extensive monitoring programme, which enables the Council to identify changes occurring, evaluate interventions, and develop appropriate management responses.

3. This paper focusses on nitrate-nitrogen concentrations in groundwater. Environment Canterbury is currently developing surface water analysis tools and statistics and building data viewers to share long-term surface water state and trend. The development of this surface water information is nearly complete and will be presented to the Committee at its next meeting on 18 May 2022.

Recommendations

That the Natural Environment Committee:

1. Receives the staff report on long term trends in groundwater quality.

Key points

4. The key points include:
   - Environment Canterbury’s long term monitoring network enables staff to assess changes in water resource state and trends over time.
   - Nitrate-nitrogen concentrations in Canterbury groundwater have been increasing since farming began in the region. Even by the 1970s/1980s, concentrations were well above natural levels.
   - Analysis of 30 years of data shows that the rate of change is slow and non-linear, but the overall direction of change is generally an increase in nitrate-nitrogen concentrations.
   - It can take time for changes to land management to result in changes in water quality, although lag times in some locations in Canterbury are likely to be sufficiently short to see responses. For the most part, the time lag between land use change and the start of resulting effects on groundwater nitrate

concentrations is on the order of five to ten years. Shorter lags exist where receiving environments are close to land sources. The full effects of changes may still take decades to come through, particularly for large catchments.

- It can be difficult to tease out the reasons for changes in groundwater quality; factors such as climate, natural events, permitted activities, and on-the-ground actions as part of plan implementation will be affecting water quality and it may be difficult to isolate the effects of specific interventions.
- Data analysis is currently being undertaken to prepare information to contribute to the development of the new regional planning framework.
- The focus of this paper is on the long-term water quality trends that are being identified through our groundwater monitoring programmes. Understanding why these trends are occurring, and what role the regional planning framework and on-farm changes have played in any change, is the focus of work being developed to inform the integrated regional planning framework.

Background

5. At its 2 December 2021 meeting, the Natural Environment Committee was presented with a report 'Water Monitoring - Recent Results and New Programmes'. At the meeting, the Committee requested staff report back with long term trends on water quality and flows as soon as possible in 2022.

6. Environment Canterbury currently has approximately 337 groundwater monitoring wells; 112 of these have more than 30 years' water quality data.

7. Over time our long-term monitoring programmes have evolved and expanded to respond to various statutory requirements, science, regulatory and planning needs.

8. The Science Group is currently checking data, developing statistics, and building data viewers to share state and trend information as part of the regional planning programme. This work is in progress - today's paper provides some of the data and information already prepared, focussing on nitrate-nitrogen concentrations in groundwater. Other work is still in development.

Groundwater State

9. The earliest picture we have of nitrate-nitrogen concentrations in Canterbury groundwater comes from work by the North Canterbury Catchment Board in the 1970s and early 1980s (Figure 1). Many of the concentrations found were low, but samples from several wells (12) had concentrations above 11.3 mg/L, the Maximum Acceptable Value (MAV) set in the New Zealand drinking-water standards, and there were many wells where concentrations were above half the MAV. Natural (pre-human settlement) nitrate-nitrogen concentrations were probably less than 1 mg/L, so the state of groundwater in the 1970s/1980s already reflected significant change. It is likely that concentrations have been increasing since significant farming with cultivation first began in the region in the 1800s.

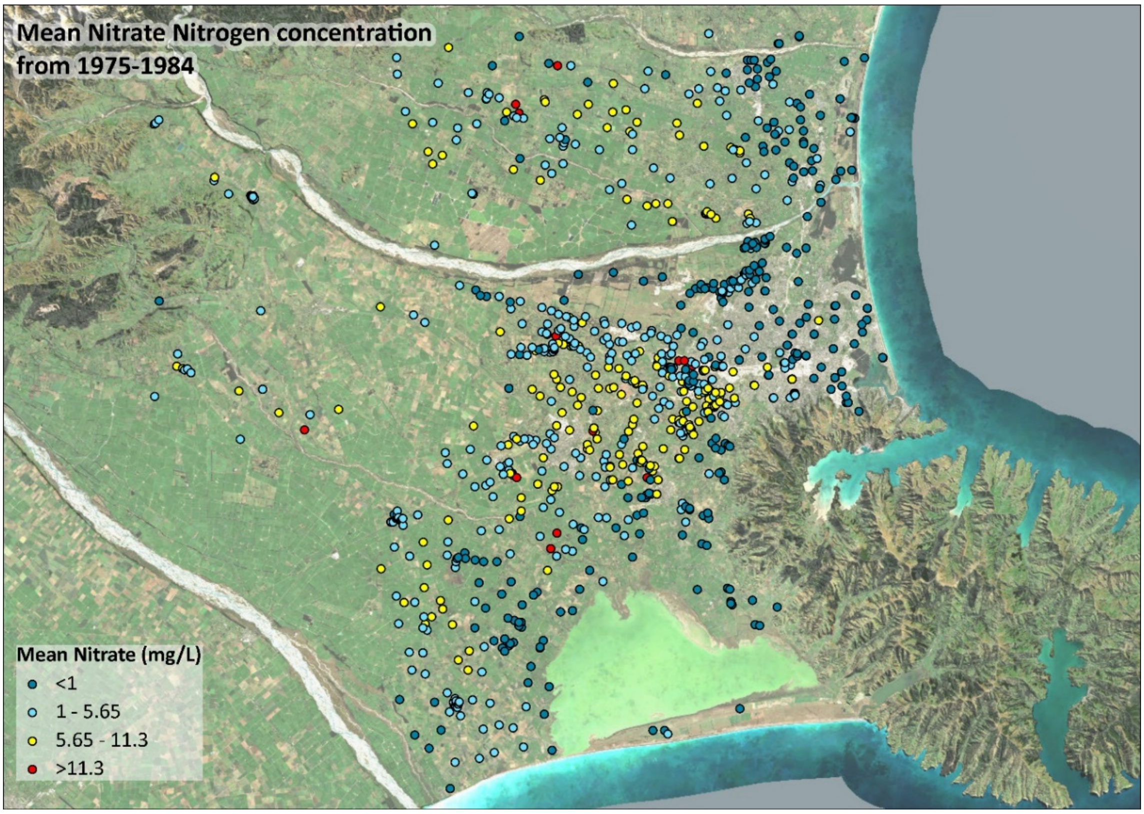


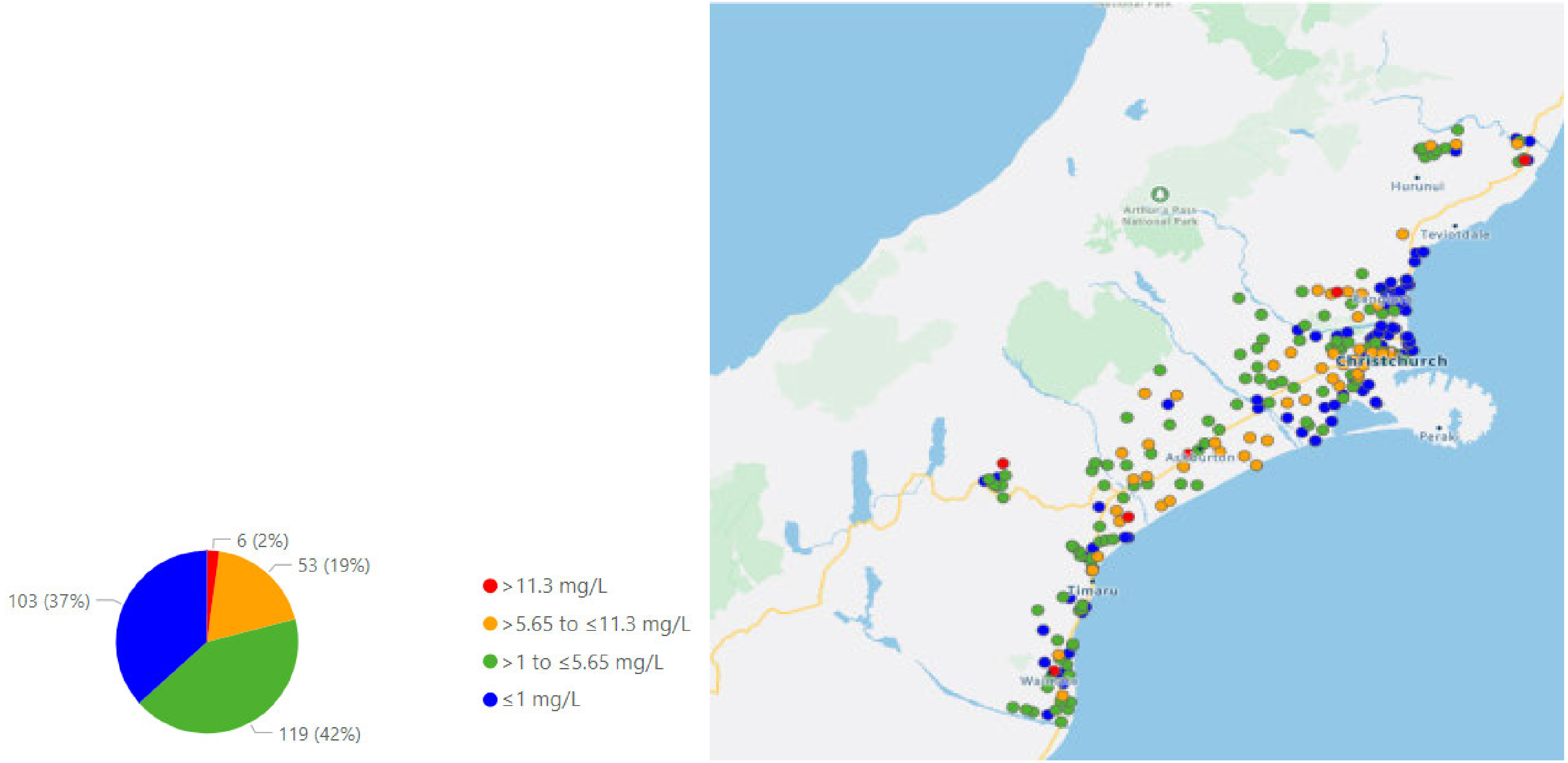
Figure 1: Groundwater nitrate-nitrogen concentrations measured by the North Canterbury Catchment Board from 1975 to 1984.

10. Long-term monitoring of groundwater in Canterbury began in 1986. Using data from this monitoring, we have undertaken some analysis of nitrate-nitrogen concentrations in Canterbury's groundwater. All statistics use a five-year median value for nitrate-nitrogen.

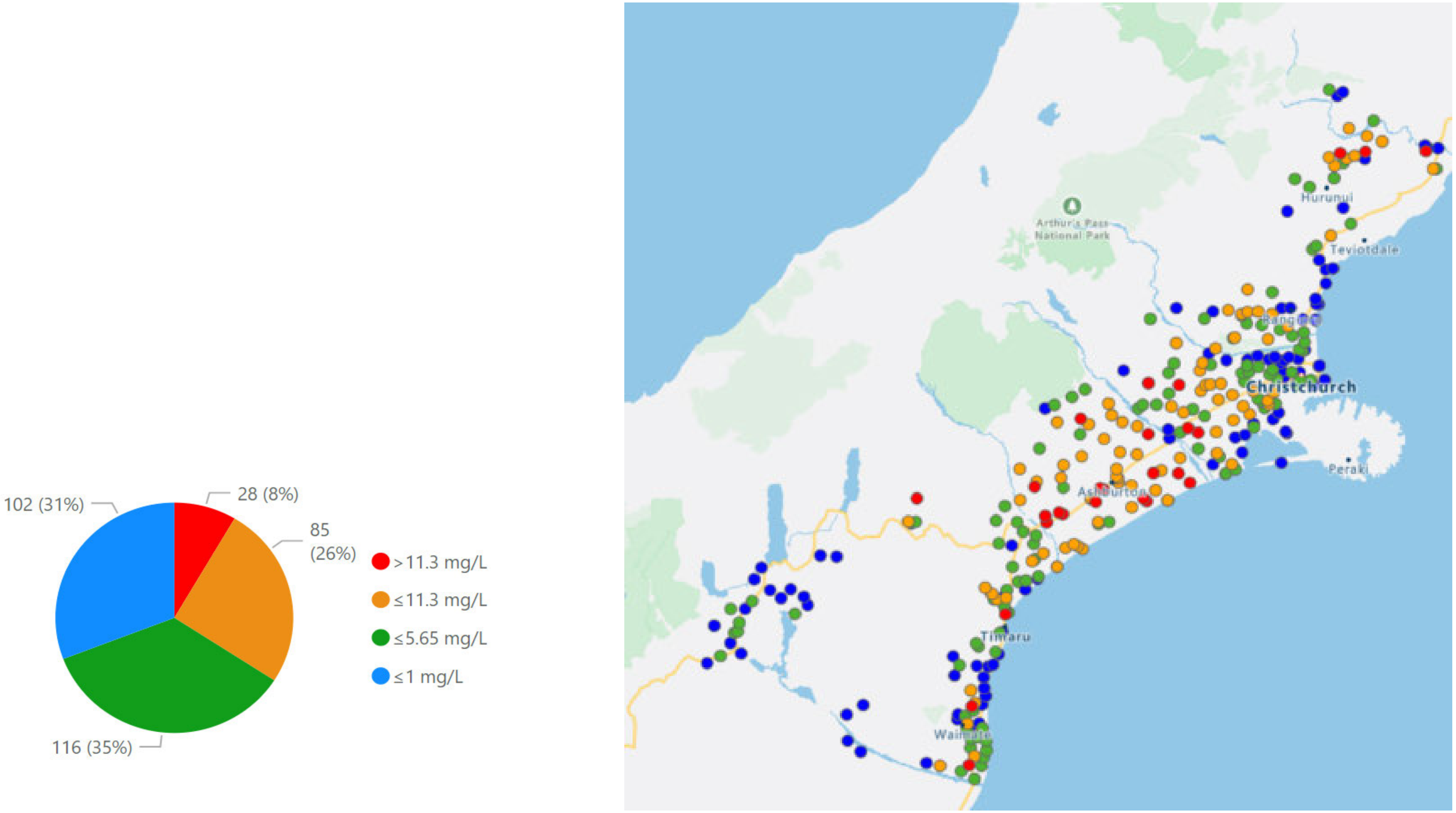
11. Figure 2 (over the next three pages) provides a summary of nitrate-nitrogen state for 1992, 2002 and 2021.


1 (1%)
21 (22%)
29 (31%)
43 (46%)
> 11.3 mg/L
> 5.65 to ≤11.3 mg/L
> 1 to ≤5.65 mg/L
≤1 mg/L
Hurunui
Teviotdale
Christchurch
Ashburton
Timaru
Waimate
Oamaru

A) 1992


6 (2%)
53 (19%)
103 (37%)
119 (42%)
> 11.3 mg/L
> 5.65 to ≤11.3 mg/L
> 1 to ≤5.65 mg/L
≤1 mg/L
Hurunui
Teviotdale
Christchurch
Timaru

B) **2002**



C) 2021

Figure 2: Groundwater nitrate-nitrogen State A) 1992, B) 2002, C) 2021. Number and percentage of groundwater sites at 4 nitrate concentration ranges.

12. Analysis of data from 1992, based on 94 groundwater sites on the Northern Canterbury plains, shows 99% of the wells' water quality met the current drinking water guideline for nitrate-nitrogen in drinking water (<11.3 mg/l).

13. Analysis of data from 2002, based on a wider number of 281 groundwater wells across a wider spread of Canterbury, shows a similar profile to the data from 1992; 98% met the current drinking water guidelines.

14. In 2021, 72% of the 331 groundwater sites across Canterbury met the guidelines.

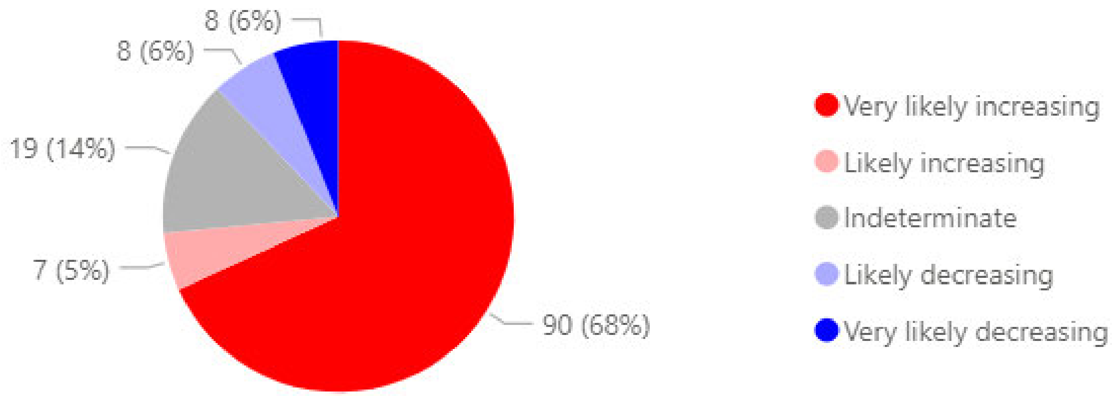
15. These figures show that while nitrate-nitrogen concentrations in groundwater have generally been increasing over time, the increase is relatively slow, and that while concentrations are clearly higher in 2021, there were a small number of elevated levels in 1992, and even 1984.

Groundwater Trend

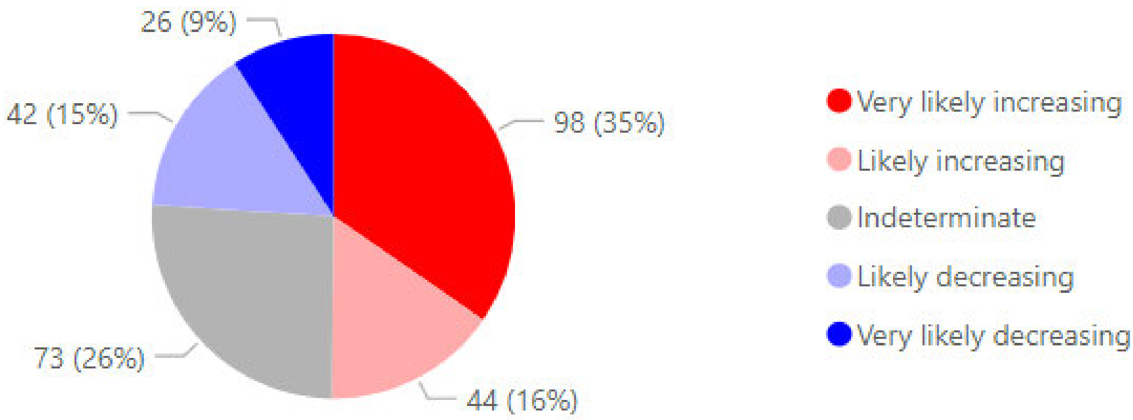
16. Figure 3 below provides an analysis of trends in nitrate-nitrogen concentrations in Canterbury's groundwater for a 30-year (1991-2021) and a 10-year (2011-2021) period.

17. The analysis in Figure 3 involves doing a trend analysis on every well record over the specified period and classifying the trend according to the likelihood of an increasing or decreasing trend. This approach is built on the same method used by the Intergovernmental Panel on Climate Change and is the same as used by the Ministry for the Environment (MFE) and Statistics New Zealand for their environmental reporting and the LAWA (Land, Air Water Aotearoa) website.

18. While response times to change on the land may be faster than 10 years in Groundwater (see below), staff recommend that 10 years be used as the minimum 'time step' for trend analysis, to ensure that factors such as weather events (floods, droughts) are not skewing results.



A) 30 years



B) 10 years

Figure 3: Trends in nitrate-nitrogen in Canterbury Groundwater (A - 30-year, B-10 year)

19. Over the past ten years, we've seen increasing trends (likely and very likely) in 51% of the wells analysed and decreasing trends in 24% of the wells. In comparison, 73% of the wells in the 30-year analysis show increasing trends, and only 12% show decreasing trends. This may seem to show an improvement in recent years, but you cannot draw that conclusion from this analysis alone. We also need to consider the non-linear character of groundwater change (Figure 4) and how the trends have changed with time (Figure 5).

20. When we consider the three wells shown in Figure 4, with data plotted over the 30-year period 1991 to 2021, it is clear they do not increase in the same way.

21. Concentrations in the first well, J38/0242 increased over the first ten years, then more or less levelled off. At the second well, K37/0468, the bulk of the increase occurred in the middle period. At the third well, K37/0243, most of the increase occurred in the final ten years. For any ten-year period, only one of these three wells show an increasing trend, but over the full thirty years, all three of them show increasing trends, but in a non-linear fashion.

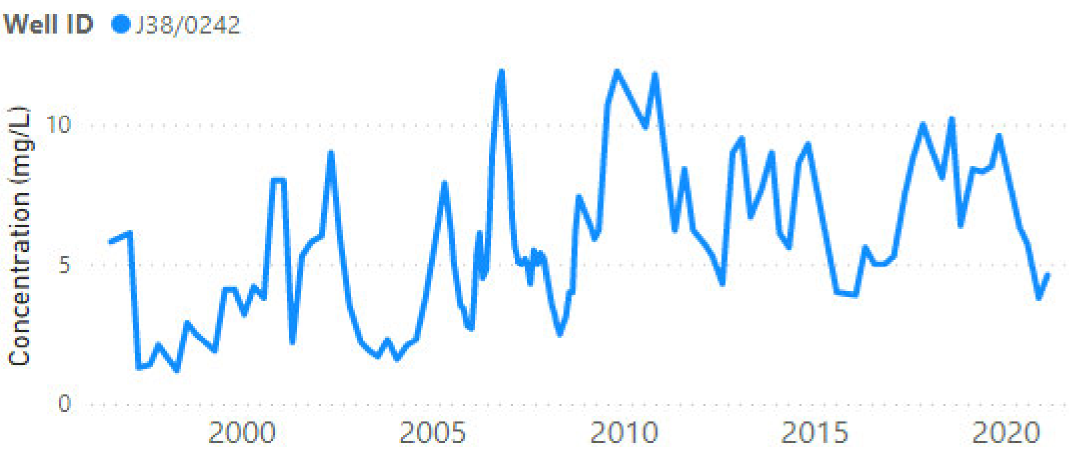


Figure 4: Examples of non-linear changes in nitrate-nitrogen concentrations in three wells

22. Environment Canterbury publishes an analysis of ten-year trends in nitrate concentrations every year in Annual Groundwater Quality Survey reports (available in the Document Library on the Environment Canterbury website). This analysis was first done in 2002 and has been consistently done since 2007. In every year that analysis has been completed, the results have been similar. Increasing trends in 16% to 37% of the wells have been observed, versus decreasing trends in 2% to 10% of the wells, with no clear trend in the results over the years (Figure 5).

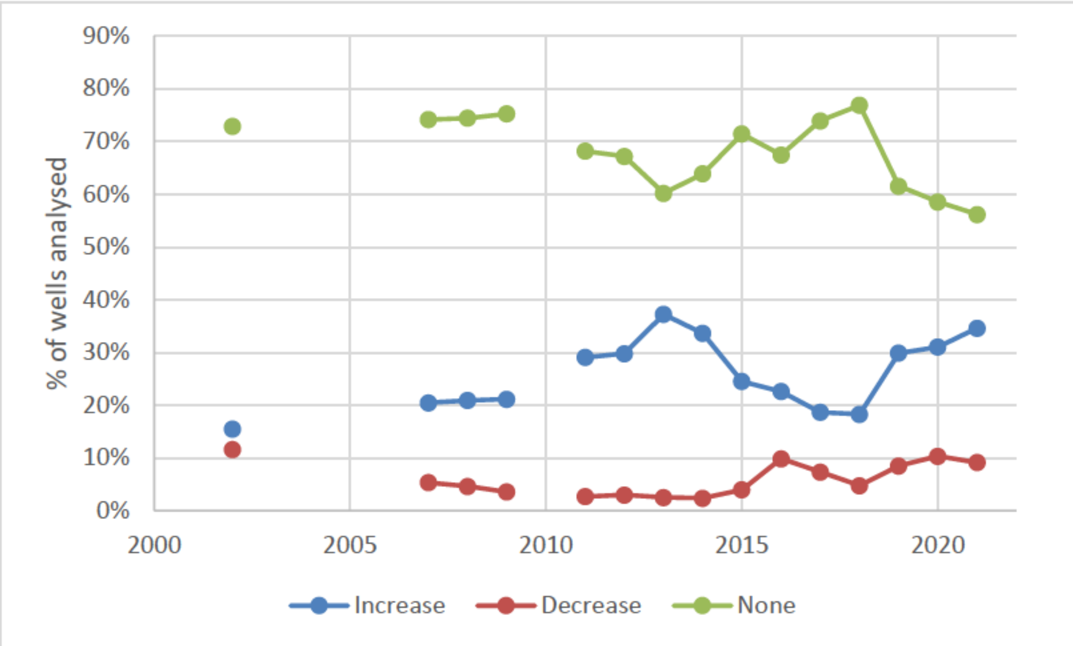


Figure 5: Rolling 10-year trends in nitrate-nitrogen in Canterbury Groundwater, reported in Annual Groundwater Quality Survey reports.

23. To be confident that we were seeing improvements in groundwater quality, we would expect our rolling 10-year analyses to show more decreasing trends over time and fewer increasing trends. Figure 5 does show more decreasing trends in recent years, but also more increasing trends, especially after heavy winter recharge in 2017.

24. In summary, it is likely that nitrate concentrations in groundwater have been increasing for many decades, probably since farming first began in the region, and our data from the past 30 years indicates that concentrations are still increasing.

Impact of lag times on changes in water quality

25. Environment Canterbury has been working with the community for many years to find ways to reverse the increasing trends in nitrate nitrogen concentrations in groundwater.

26. Since we have not yet seen any clear reversal of the trends, the question is being asked, how long will it take before we see the benefit of this work. There are two things to consider here. First, there is a time lag between when land use change occurs and when we see the effects of that change in water quality.

27. For groundwater quality, in most cases we would expect to see the first signs of change within a few years, though it will take much longer for the full effects of the change to come through. We would see these effects soonest in groundwater at the water table immediately beneath the land use change.

28. We know that nitrate can be flushed from the soil into the groundwater in a single heavy rain or snowfall event. Events such as the heavy snow in 2012 resulted in observed flushing of nitrate. This has been validated with field trial sites at Templeton, Burnham and Rolleston.

29. We have several examples of where we have seen nitrate concentrations in groundwater increase within a few years of land use change. These include:

- the Hinds area, after land use changes in the mid-2000s
- conversion from forestry to beef, then dairy, near Culverden
- change from border-dyke to spray irrigation in the lower Waitaki area.

30. Where the water table is deeper, it can take longer for the effects of land use change to reach the groundwater. An example of this is in the Te Pirita area, where the water table is 50 to 100m below the ground surface, nitrate concentrations in the groundwater have been increasing slowly since agricultural intensification (irrigation and dairy conversions) began in the 2000s.

31. Groundwater age tracer data suggests that it can take decades for the effects of land use change in the upper Canterbury Plains to reach coastal areas. This has been the method used to inform lag times within sub-regional planning processes such as the Waimakariri Plan Change 7 process.

32. Surface water quality often shows signs of improving water quality prior to groundwater. For example, recent work done under the Our Land and Water Science Challenge (McDowell et al., 2021) has estimated that catchment lag times across New Zealand vary from about 1 to 12 years, with a median of 4.5 years. Therefore, monitoring of small streams near where the on-the-ground action occurs within a catchment, will show the impact faster than in groundwater. The study did not include the Canterbury Plains. Lag times are likely to be much longer between land use in the upper plains and effects on groundwater and streams near the coast.

33. The second factor to consider is that there is often a delay between plan implementation and on-farm changes, creating another ‘lag’ of sorts. Environment Canterbury has delivered a regional and sub-regional planning framework over the past 12 years that requires on-farm reductions in nutrient losses to improve freshwater quality. However, on-farm changes due to this planning framework are still occurring.

34. Understanding what on-farm mitigations and interventions have been implemented over the past ten years, and in particular as part of the Good Management Practice and Auditing framework, will provide information and data to help understand and quantify changes to nitrate losses. This work will also be important to inform tools used in the future planning framework.

35. In summary, the analysis of time lags suggests that if widespread changes to land use management have been happening around the region over the past five to ten years, we would expect to be seeing some improvements in groundwater quality, even if the full effects of the changes might take decades to come through. The fact that we haven’t seen these improvements suggests that either the changes have not been enough to bring about widespread changes in groundwater quality, or they have not yet been fully implemented.

Next steps

36. The groundwater monitoring programme is well established with over 30 years' worth of data. The analysis of the surface water data is still under development and will be presented at the next Committee meeting on 18 May 2022. These data will play a critical role in supporting the mana whenua partnership and community engagement in the development of the new integrated regional plan.

Attachments

Nil

File reference	
Legal review	
Peer reviewers	Carl Hanson, Groundwater science Manager, Cameron Smith, Senior Strategy Manager

Environment Canterbury Regional Council
Kaunihera Taiao ki Waitaha

Memo

Date	26/07/2021
To	Brent Walton (Waimakariri Irrigation Ltd)
From	Amber Kreleger (Senior Groundwater Scientist) and Hamish Carrad (Senior Surface Water Field Scientist)
Reviewed by	Maureen Whalen (Team Leader Groundwater Science)
Approved by	Carl Hanson (Section Manager Groundwater Science)

Overview South Eyre Infiltration Trial 2018-2021

In this memo we present an overview of the history, installation, management and effectiveness of the infiltration trench trial at 426 Two Chain Road, Swannanoa / South Eyre. The three-year trial period ended on 16 July 2021 with the expiration of the related resource consents.

Background

Nitrate concentrations in groundwater and surface water in the South Eyre region and Silverstream are high. Groundwater samples with nitrate concentrations between 5.65-11.3 mg/L (between half the Maximum Acceptable Value (MAV) and MAV for nitrate) are common. Nitrate concentrations in Silverstream at Harpers Road generally sit around 9 mg/L, which exceeds the National Bottom Line for ecologically healthy waterways. Silverstream is a spring-fed stream, so the hypothesis is that high nitrate concentrations in groundwater contribute to high nitrate concentrations in the stream.

Waimakariri Irrigation Limited (WIL) provides farmers in their command area with irrigation water from the Waimakariri River via their irrigation scheme. WIL is interested in introducing on the ground actions like Managed Aquifer Recharge[1] (MAR) and Targeted Stream Augmentation[2] (TSA) to reduce nitrate concentrations in groundwater and springs in the Silverstream area. The approach[3] of the Canterbury Regional Council (CRC) is that on the ground actions require to be proven to a certain extent first before they can be adopted as a viable solution. Therefore, together with WIL, we undertook a low-cost farmer-lead infiltration test trial to assess if infiltration rates are favourable for MAR.

[1] Managed aquifer recharge means an activity that is for the express purpose of improving the quality and/or quantity of water in a receiving groundwater aquifer or a hydraulically connected surface water body.

[2] Targeted Stream Augmentation means the controlled and targeted addition of freshwater to a surface water body for the express purpose of increasing flows or improving the quality of fresh water in the receiving waterbody.

[3] As described in the supporting documentation for Plan Change 7 of the Land and Water Regional Plan

Scope

The aim of the infiltration test was to install an infiltration trench on a farm in the Waimakariri zone and investigate infiltration rates, the cost involved around the design, installation and maintenance of the infiltration trench site and any related management. CRC, as the consent holder, supported the projected with design and monitoring infrastructure while WIL was responsible for the installation of the trench, operational management and rehabilitation.

Location

The infiltration trench site is located at the western boundary of privately-owned farmland of Oscar Farm at 1061 South Eyre Road, Swannanoa (entry via 426 Two Chain Road), see Figure 1. The area surrounding the farm is predominantly rural land and lifestyle blocks.

Silverstream (Harpers Road) is located approximately 7 km downgradient of the trial site.

Figure 1 Location of the trench for the infiltration trial in South Eyre

Characteristics and Design

Trench

The infiltration trench is circa 150 m long, 2 m deep and has a width of circa 1.5 m at the bottom and 7.5-10 m at the top (see Figure 2). As can be seen from Figure 3, the trench has been dug perpendicular to the groundwater flow (the piezometric contours are based on measured groundwater level data in our CRC GIS Database).

Figure 2 Overview of the empty trench

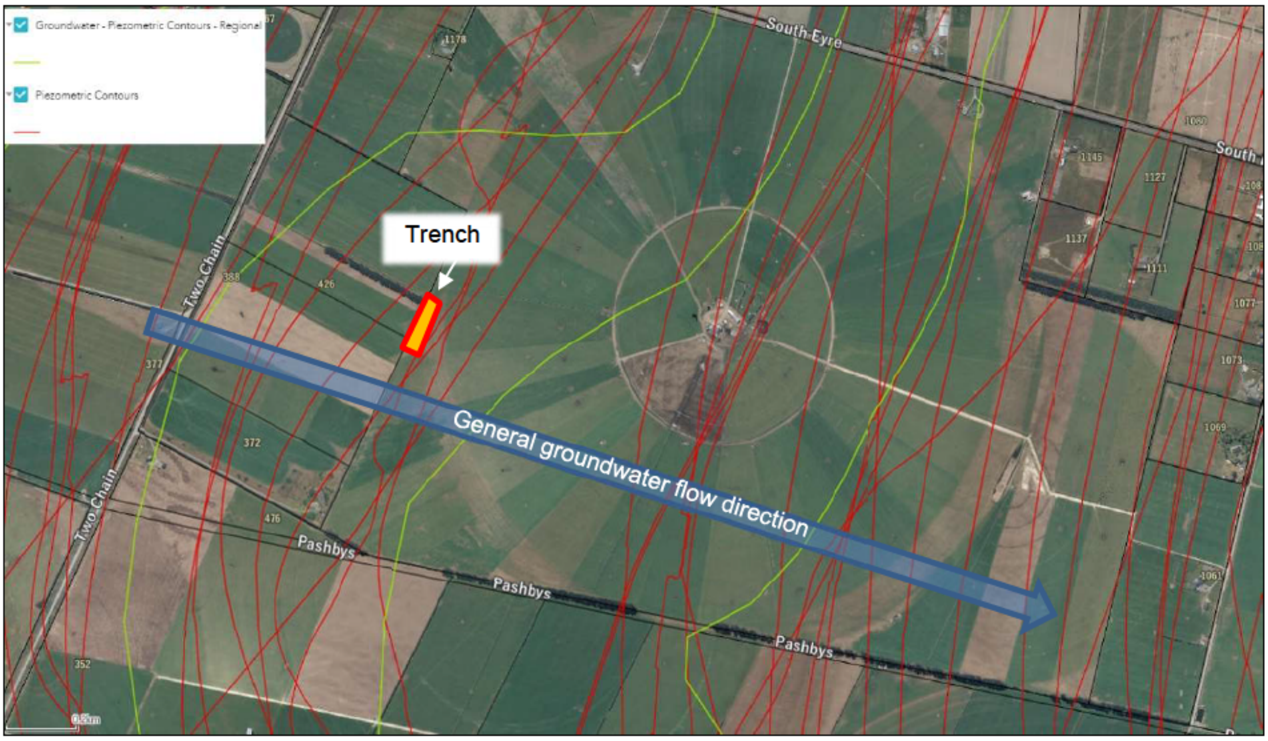


Figure 3 The infiltration trench is positioned perpendicular to the general groundwater flow direction

Soil

Photos of the soil profile are presented in Figure 4. Below a circa 400 mm thick brown topsoil, the subsurface consists of a mix of coarse-grained gravels and fine sand, from brown to light grey in colour. Borelogs in the area indicate that this lithology exists down to a depth of at least 23 m below ground level (bgl). Our S-Map data indicates that the area consists of Lismore soils (stony silty loam). The soil permeability for the site is ‘moderate over rapid’, which means a moderate draining soil sitting on top of a rapid-draining soil. The combined soil information indicates that this site is a suitable location for infiltration testing.

Figure 4 Photos of the soil profile in the trench

Depth to groundwater

There are two shallow bores located nearby that are part of our CRC groundwater Level Monitoring Network. Just south of the infiltration trench site is M35/4873, with a depth of 25.6 m and north of the site M35/11913, with a depth of 17.7 m. Figure 5 presents the location of these two shallow bores. BW23/0133 is a nearby deep bore.

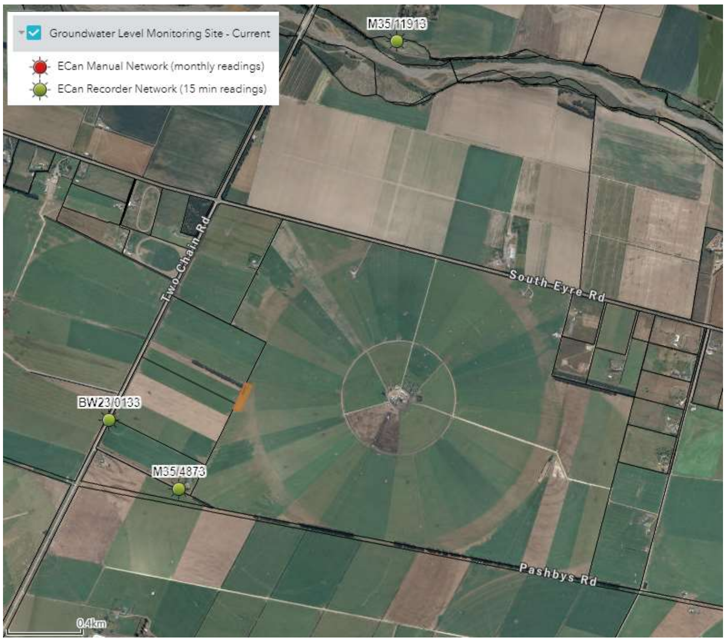


Figure 5 Location of nearby bores that are part of our Groundwater Level Recorder Network

Water Level Plots from the CRC Website for the two shallow wells are included in Figure 6 (M35/4873) and Figure 7 (M35/11913). These plots show that depth to groundwater increases in south-easterly direction towards the Waimakariri River. Based on this information we expect that average groundwater levels in the area of the infiltration trench are approximately 9-10 m bgl. 2018 was a relatively wet year in which maximum groundwater levels reached 4m bgl.

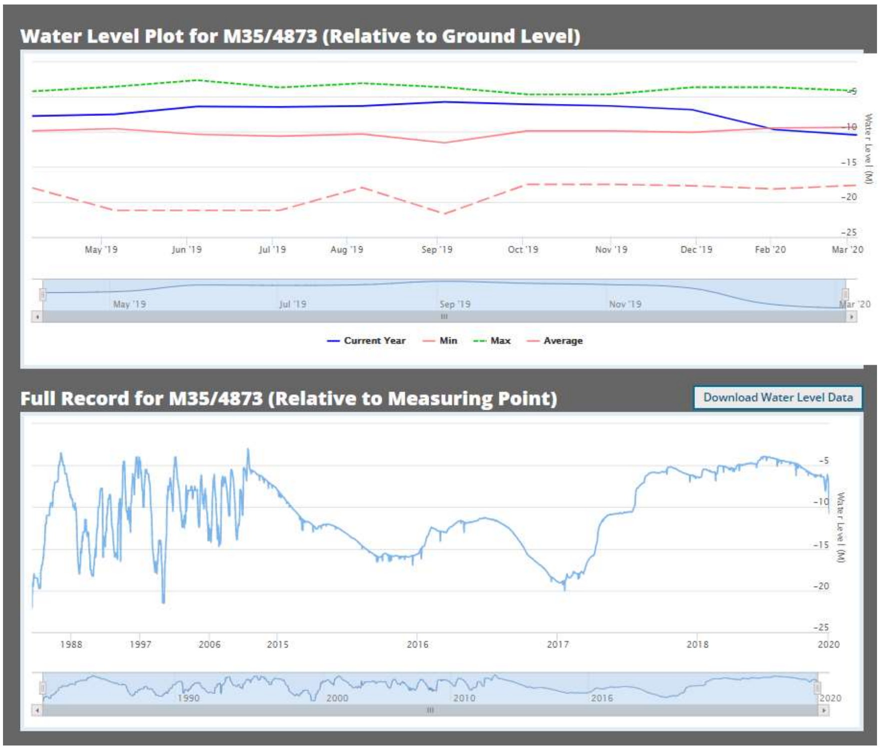


Figure 6 Water level graphs for M35/4873. The top graph displays measured water levels for March 2019-March 2020 and the minimum, maximum and average water levels based on the whole dataset.

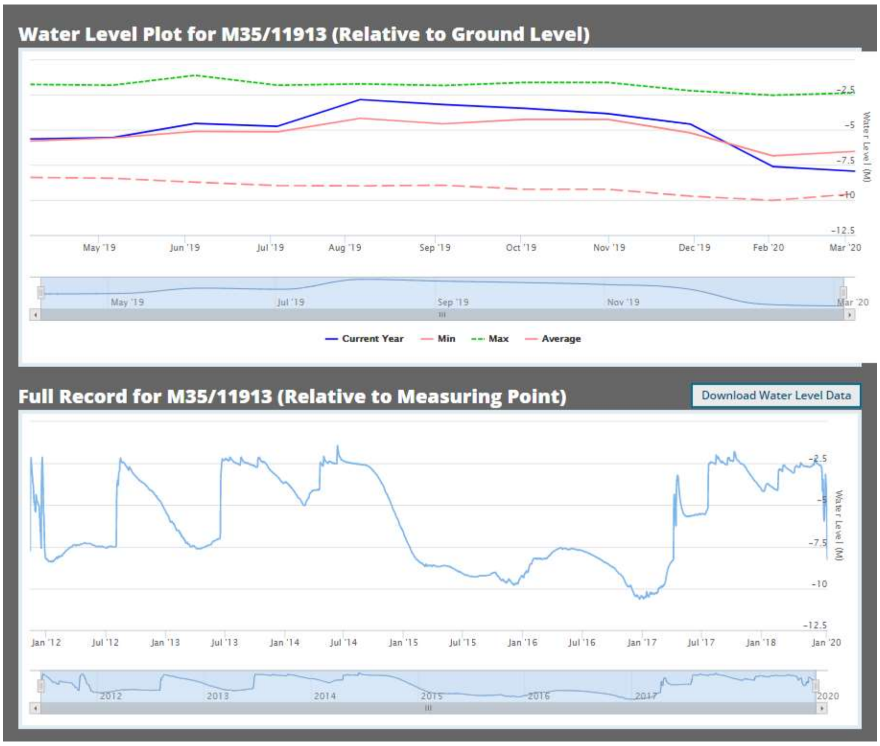


Figure 7 Water level graphs for M35/11913. The top graph displays measured water levels for January 2019-January 2020 and the minimum, maximum and average water levels based on the whole dataset.

Water source

Nearby water races provided the water source for the infiltration trench. These water races are part of the infrastructure of WIL, by which the scheme provides shareholders with irrigation water taken from the Waimakariri River. Water for the infiltration trench was mostly available outside irrigation season, approximately from April to September.

Design

The design of the trench needed to provide for

- Health and safety
- Inflow infrastructure
- Monitoring

Figure 8 gives an overview of the design layout.

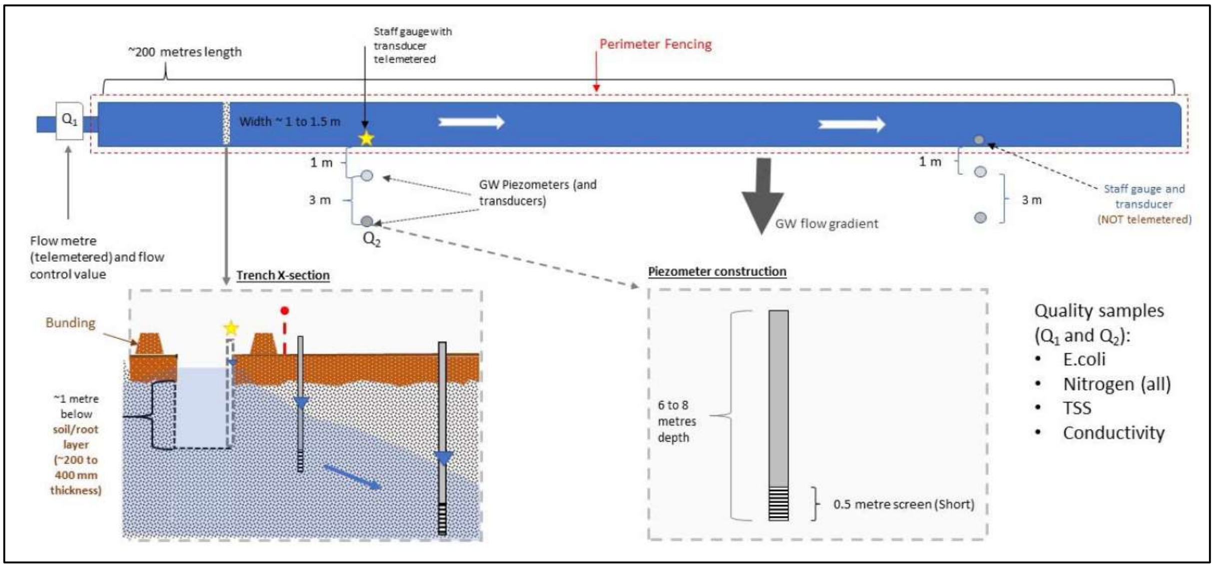


Figure 8 Design infiltration trench (WGA, 2018)

For health and safety reasons the trench was fenced off. Soil material excavated from the trench has been used to provide a safety bund around the trench. Site access was limited to project staff and all equipment and staff shoes entering the site were to be cleaned to help protect the spread of *M.Bovis*.

The trench was connected to the nearby water race via a bypass (culvert).

Monitoring

NIWA has installed flow meters in the water race, before and after the bypass, so the flow into the trench could be calculated.

The water depth was continuously logged with telemetered transducers on the north side of the trench, although at the start of the test it was also measured on the south side. The flow in the water race was also continuously logged upstream of the trench inlet and downstream. The difference in flow between these two locations should correspond with the trench inflow. The telemetered transducers provided for live data access via the NIWA Neon-website. The Neon Applications software is a suite of software and documentation which allows clients to monitor and acquire data remotely. The flow was periodically manually gauged to calibrate the automatically logged flows.

We installed 4 monitoring wells next to the trench using our piezo driver. Two were placed along the north side and two along the south side. The maximum depth of these wells was 5m bgl as the soil material prevented the piezo driver from going deeper.

Groundwater levels were continuously monitored via data loggers. Water quality samples from the trench and the two monitoring wells on the northside of the trench were taken monthly. These samples were analysed for basic suite of parameters, including nitrate-nitrogen and *E.coli*.

Operation

The Waimakariri River often contains suspended sediment, which affects infiltration rates of water into the trench. Therefore, to prevent the bottom of the trench from clogging up with silt, WIL would shut off the inflow to the trench for around 5 days when high turbidity was visible in the Waimakariri River.

WIL contracted a digger to clean the bottom and sides of the trench, when the infiltration rates were affected too much by silt clogging up the trench.

The inflow of the trench was also shut off if water levels in the trench created a risk of overflowing. Operators from WIL received a text message on their phone if trench levels were at risk of flooding.

Consenting process

Consents

The infiltration trench required resource consents to take, use and discharge water from the Waimakariri River, as they are discretionary activities. The excavation of the trench was a permitted activity. Resource consents were obtained on 16 July 2018 with an expiry date of 16 July 2021.

The take and use of water were authorised under CRC184025 and the consent allowed water only to be taken from the Waimakariri Irrigation Limited water race scheme under their resource consent CRC166677.

The discharge of water (the infiltration) was authorised under CRC184026.

Pre-application process

We engaged an external consultant (Tonkin+Taylor) to prepare the application for the resource consents. The contract scope included:

- Liaise with WIL personnel to reach agreement on use of infrastructure & consent conditions as applicable
- Attend pre-application meetings as required
- Work with ECan staff to address any requests for further information.

The use of water for infiltration testing is considered a non-consumptive use. Most of the water would infiltrate through ground into the underlying aquifer and therefore, there is no significant loss to the resource.

Application process

We lodged two applications. The application for the water take and use was supported by the report *Infiltration testing, Water take and use* (Tonkin+Taylor, March 2018) and the application for the discharge was supported by the report *Resource Consent Application and Assessment of Effects on the Environment Waimakariri Water Allocation Zone - Infiltration Testing Trial* (Tonkin+Taylor, March 2018).

We identified the landowner of the discharge site (Oscar Farming Co Limited) and WIL as adversely affected parties and we obtained written approval from both parties. Other parties (Tūāhuriri Rūnanga Waimakariri District Council and others) were advised of the application but did not respond.

During the application audit process, the Consent Planner identified some extra questions around groundwater mounding in the area due to the infiltration. We approached an external consultant (WGA) to provide a more in-depth assessment of the mounding risks and the monitoring efforts involved: *Supplementary Assessment of effects - Infiltration Testing Site (MAR) in Waimakariri Allocation Zone* (WGA, June 2018). The Consent Planner agreed with this assessment and proposed to grant the resource consents.

Installation and project management

We hired an external consultant (WGA) with extensive experience in setting up MAR projects to design the installation of the infiltration trench site. They designed the trench plan and related monitoring sites. WIL mostly organised the planning around the contracted digging work and the installation of inflow work and pipes and, together with the landowner, the health and safety measurements around fencing and the bunding of the trench. WGA engaged with NIWA for the flow gauging sites.

We installed the monitoring wells and set up the transducers for automated water level measurements. We had regular meetings with WIL during and after the installation of the trench.

Costs

Aside from cash contributions (payments for external advice, consents and labour, we supported the project with material, equipment, time and advice (so called ‘in kind’ resources). We were responsible for the costs for the consenting process, the external MAR consultant, the installation of the flow gauges by NIWA and the installation of the groundwater monitoring programme. WIL were responsible for the costs for the trench construction / future deconstruction and operational matters.

Table 1 gives an overview of the associated costs.

Table 1 Overview of the associated costs

Consent	Application* (ECan)	$3,500	
	Consultant (ECan)	$19,000	
Trench construction	Digger (WIL)	$3,055	
	Materials (WIL)	$5,233	
	Labour (WIL)	$225	
Installation Flow Monitoring	Equipment (NIWA)*	$6,800	
	Labour by NIWA (ECan)	$3,000	
Installation Groundwater Monitoring	Equipment (ECan)*	$3,800	
	Labour (ECan)*	$3,000	
Health & Safety	Fencing (landowner)*	$300	
Project management	WIL	$1,820	
	ECan	$3,000	
	Consultant (ECan)	$8,500	
Associated costs	Legal (WIL)	$2,300	
	CEO (WIL)	$1,140	
	Administration (WIL)*	$1,000	+
	Total	$65,673	
	In kind	$24,818	-
	Cash cost	$40,855	

* = Estimated costs. All the other costs have been confirmed

The costs do not include monthly monitoring costs (water levels and water quality) related to the consent conditions and the Baseline Monitoring. These costs are estimated at $310 for sample and laboratory costs and $500 for labour. We, as the consent holder, were carrying these costs.

Start infiltration trial winter 2018

The start of the trial kicked off on 6 August 2018 with a 5-day step test. The purpose of the step test was to assess the water levels in the trench and the groundwater monitoring wells while filling up the trench at different flow rates.

The recorded water levels during the step test are presented in the graph in Figure 9. During the step test flows were manually logged, see

Table 2.

As can be seen from the graph, the first two days of the test, all the water released into the trench infiltrated immediately without raising water levels in the trench, but groundwater levels along the north side of the trench were raised by 25-30 cm.

Table 2 Manually logged inflow rates for the trench during the step test

date	time	flow (L/s)
6/08/2018	9:30:00	5
6/08/2018	12:30:00	5
7/08/2018	12:30:00	17
8/08/2018	12:30:00	35
9/08/2018	12:30:00	55
10/08/2018	12:30:00	75

Increasing inflow rates to more than 30 L/s meant that water levels on the north side in the trench slowly equilibrated and groundwater levels next to the trench were raised by another 10-15 cm. After four days, when the inflow rate was set at 75 L/s, water levels on the south side of the trench increased to a depth of 65 cm, with a maximum increase in groundwater levels of 60 cm on the north side.

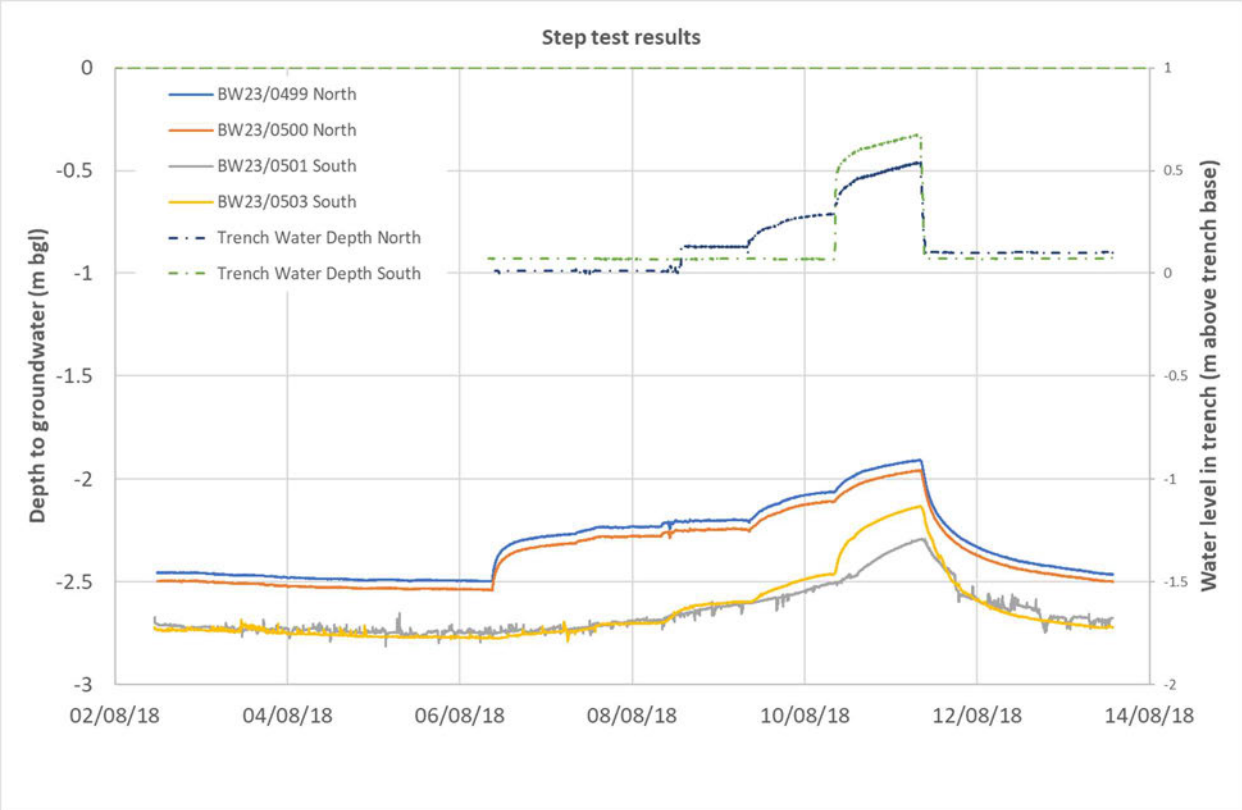


Figure 9 Recorded water levels during step test

The step test indicated that infiltration rates would be a lot higher than first estimated, as we initially thought the maximum infiltration rates would be around 30 L/s.

After the 5-day step test we decided to continuously fill the trench to 1 metre above the bottom, while monitoring the inflow and groundwater levels on the site, until the irrigation season started and water for the test site would no longer be available. The extended test period lasted from 17 August to 19 September 2018 (33 days). The recorded water levels and inflow rates during this extended test are presented in the graph in Figure 10.

As can be seen from Figure 10, the flow meters registered flows more than 100 L/s. Unfortunately, any flows higher than 100 L/s can be considered inaccurate due to material in the water race interfering with the flow meter readings. Therefore, any flows higher than 100 L/s should be disregarded in the graph. The average inflow rate of about 90 L/s equates to roughly 7,700 m^3 per day or 1,170,000 m^3 total volume infiltrated to groundwater outside the irrigation season over a period of 5 months.

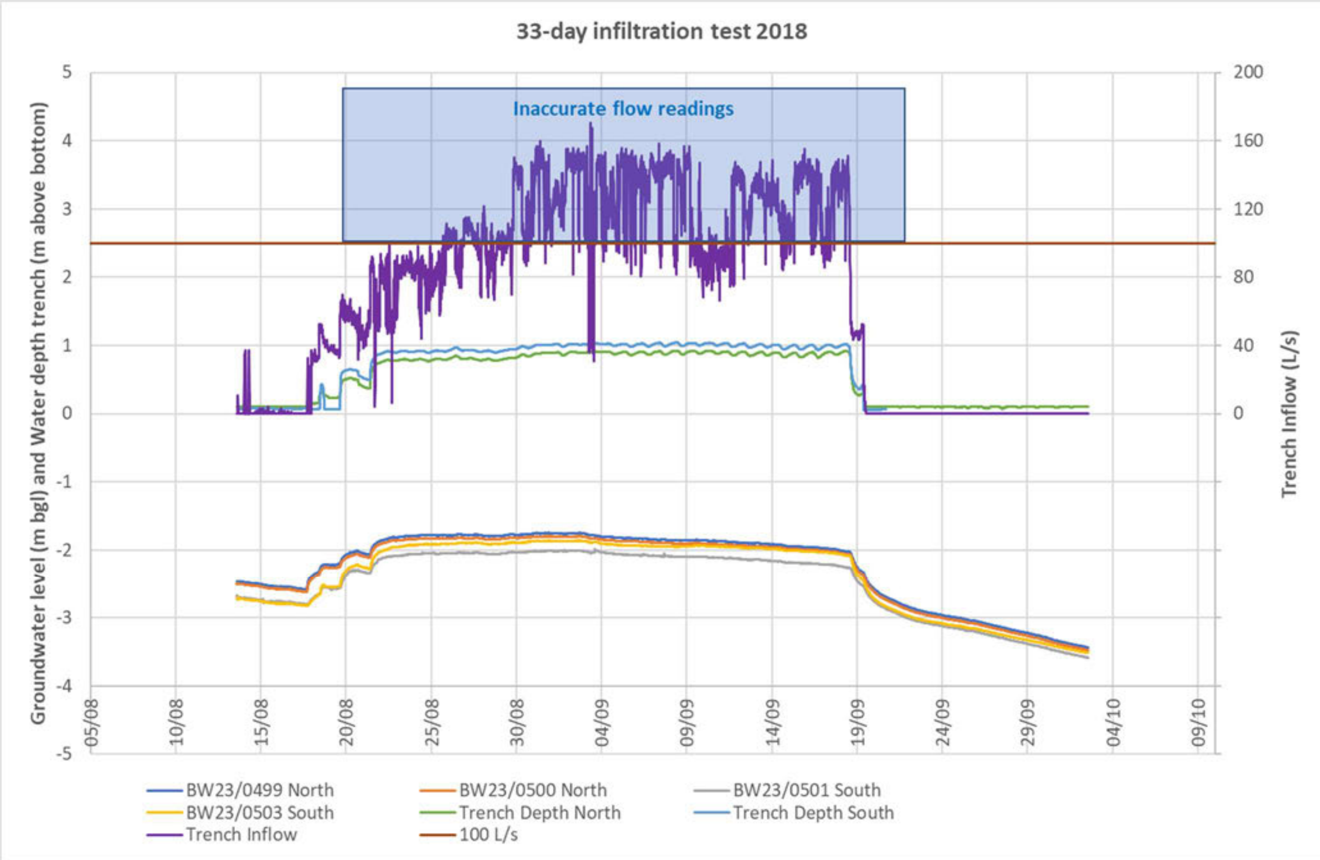


Figure 10 Water depth in trench, groundwater levels and inflow during the 33-day extension of the test in 2018. Measured flows have been reduced by 18% based on manual gauging results.

Full season infiltration trial 2019

During irrigation season no water was directed to the trench. On 30 March 2019 water was let in again until 15 October 2019, a total of six and a half months.
One of the issues affecting the infiltration capacity of the trench is high sediment in the water coming from the water races.

Table 3 gives an overview of the times that the inflow to the trench had to be shut off due to high sediment loads or related maintenance. Adding up all these periods gives us a total of 63 days within the 6.5 months that the infiltration trench was shut down due to high sediment loads and maintenance, which is around 30% of the time.

Table 3 Overview of periods when the inflow to the infiltration trench was shut off

Inflow shut off	Restart	Notes
31/05/2019 0:00	03/06/2019 13:00	Due to high sediment loads
27/06/2019 15:00	3/07/2019 6:00	Trench given quick clean out while with water still present in trench
3/07/2019 6:00	26/07/2019 13:30	Maintenance on water race and to clean trench while empty
31/07/2019 13:00	6/08/2019 14:00	Due to high sediment loads
10/08/2019 10:30	13/08/2019 9:30	Due to high sediment loads
17/09/2019 15:00	24/09/2019 19:00	Due to high sediment loads
30/09/2019 12:30	15/10/2019 8:00	Due to high sediment loads

On 15 July the bottom and the sides of the trench were cleaned with a digger, as the quick clean out two weeks before had not resulted in increased infiltration rates. Photos of the clean out are presented in Figure 11 and an overview of the water levels and inflow rates in Figure 12.

Figure 11 Photo A – Water in the trench has high turbidity. Photo B – The bottom of the trench after a quick clean with a digger while water was still standing in the trench. Photo C – the bottom of the trench after being thoroughly cleared by a digger during dry conditions

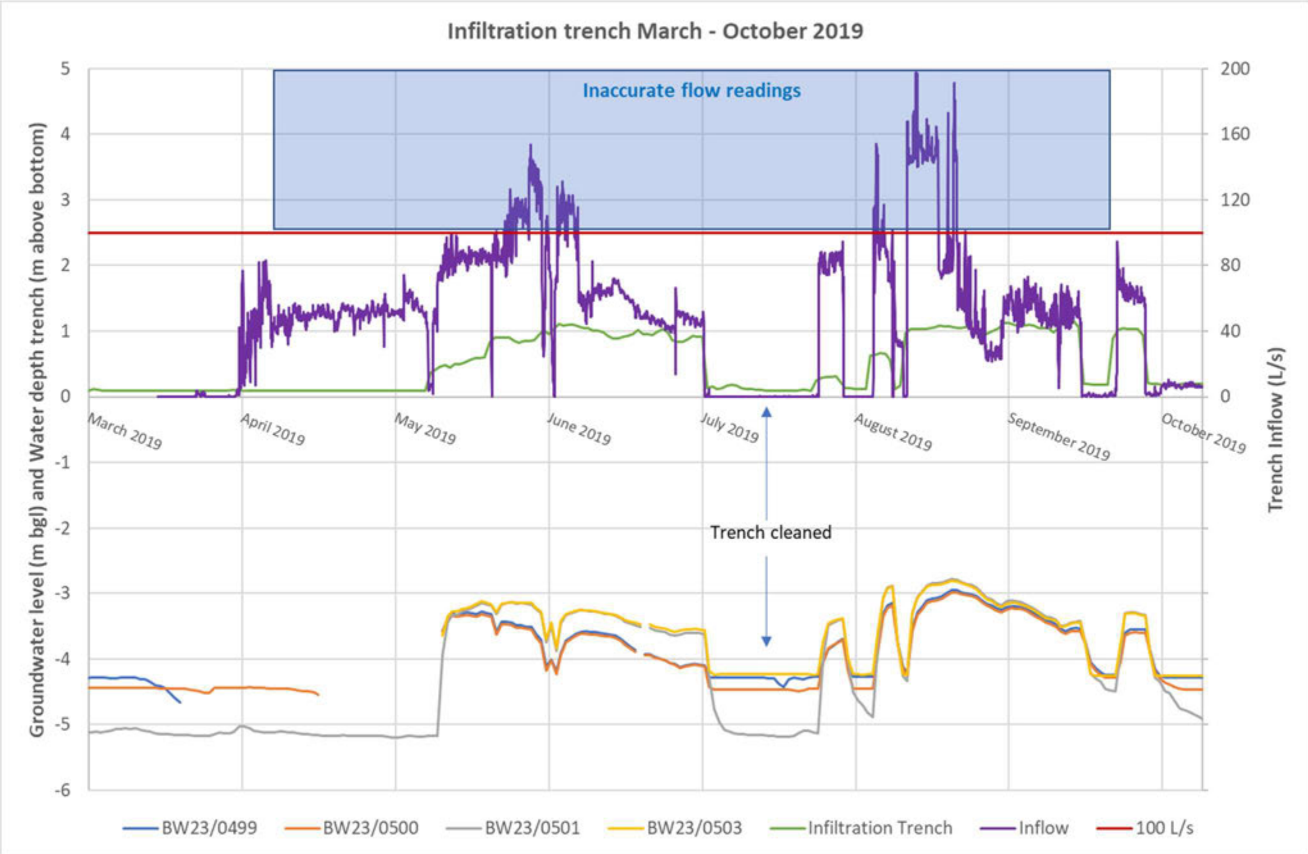


Figure 12 Water depth in trench, groundwater levels and inflow during 2019. Measured flows have been reduced by 18% based on manual gauging results.

The water levels and inflow presented in Figure 12 show that, initially, water levels didn't follow the increase of the inflow rates. This is probably due to failures with the water level measuring equipment. From the 11th of May groundwater levels went up as the water depth in the trench increased. Flow rates reached 100 L/s. During June the inflow rates had to be decreased to 50-70 L/s to prevent the trench from overflowing. This is an indication that infiltration rates decreased due to clogging of the trench with sediment. The thorough cleaning of the bottom and the sides of the trench on 15 July increased the infiltration / inflow rates up to 100 L/s again in August. By the end of August, they had to be dropped again to around 60 L/s to prevent the trench from overflowing. The reduction in infiltration rates is also reflected in the decline in groundwater levels in the monitoring wells.

Infiltration trial 2020 and 2021

The trench was not used for infiltration testing in 2020 and 2021. The consents for the trial expired on 16 July 2021 and the CRC Groundwater Field Scientists have since removed the monitoring infrastructure.

Nitrate concentrations near the trench

Nitrate concentrations in and near the trench have been regularly monitored during the trial periods. See Figure 13 for results for the period September 2018 – March 2021. Aside from monitoring at the infiltration trench trial site, we also monitored nitrate concentrations in two nearby bores: M35/7065 and M35/9028 as an indication of general nitrate concentrations in groundwater in the area. As the trench has not been in use during 2020 and 2021 no data has been collected at the trench site during these periods.

Before the start of the trial nitrate concentrations in groundwater near the trench were between 3.5-12 mg/L (bores BW23/0499 and BW23/0500). As the infiltration trial started fully in May 2019, nitrate concentrations in groundwater next to the trench declined to less than 0.2 mg/L, which is similar to nitrate concentrations in Waimakariri River water taken from the water race.

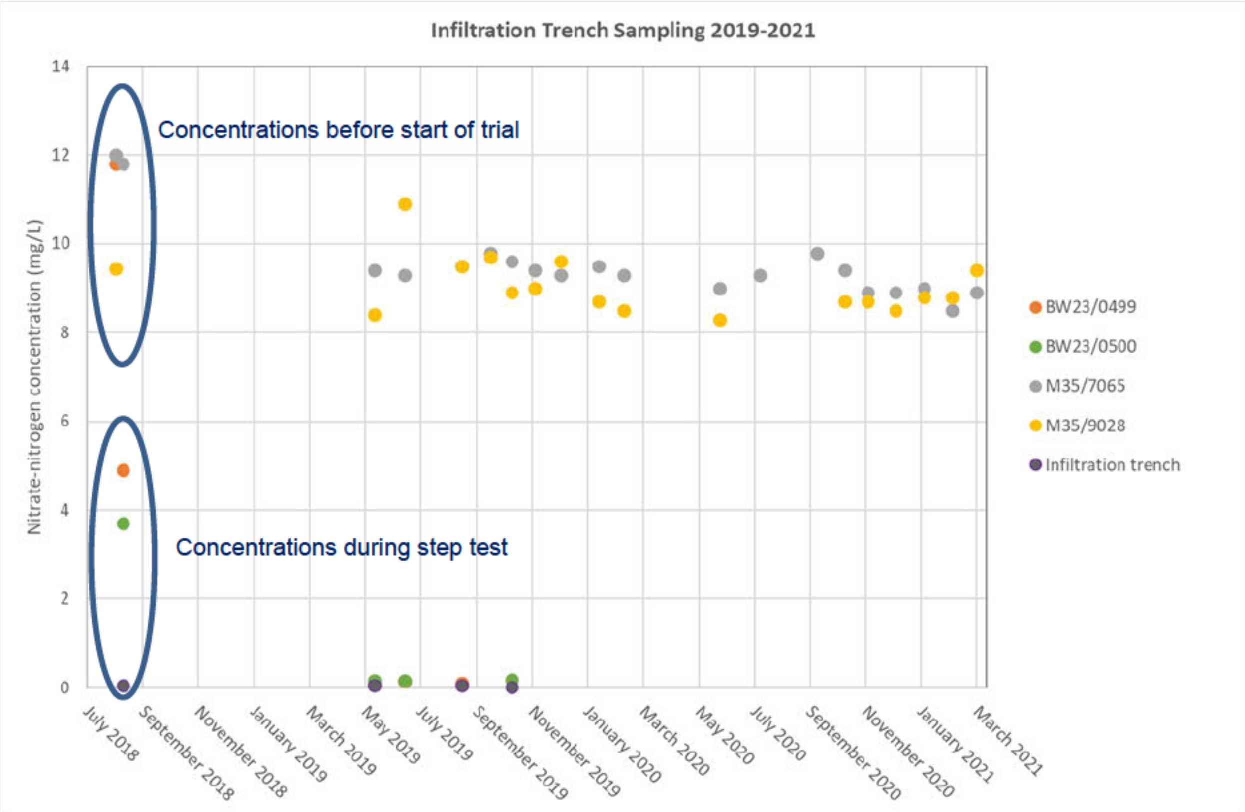


Figure 13 Nitrate concentrations of the trench water, groundwater in two monitoring bores on the northside of the trench (BW23/0499 and BW23/0500) and groundwater in a 24m deep irrigation bore 2,250 m east of the trench (M35/7065) and a 34 m deep irrigation bore 1,090 m north of the trench (M35/9028)

Aside from monitoring efforts directly related to the infiltration capacity of the trench, we also started a monitoring programme for nitrate concentrations in spring-fed streams in the Silverstream area. With the Silverstream area being more than 7 km downgradient of the trial site, we did not expect to see reducing nitrate concentrations as a result of the infiltration trial. The downgradient monitoring mostly serves as a *baseline* monitoring effort in anticipation of future land use changes upgradient of the spring-fed streams. Results of this monitoring program are presented in the Appendix.

Conclusion

The infiltration trench trial has been a collaborative success and, aside from the consenting process, was set up in a relatively short time. Due to WIL and CRC investing financial support ‘in kind’ the total costs of $65,600 were reduced to $40,800, of which the consenting process totalled $19,000. Based on our experience obtained with the trial we expect consenting costs should be able to be reduced to $5,000-$10,000.

The infiltration trench trial has showed that high infiltration rates up to 100 L/s can be achieved, provided that the trench will be regularly cleaned. Rates of 60 L/s are more realistic, and these are higher than the initially expected maximum rates of 30 L/s.

Maintenance is the main challenge for a successful infiltration trench, including shutting down the trench due to high sediment loads in the Waimakariri River. This could reduce the total infiltration period and volume by as much as 30%.

Locally, nitrate concentrations in groundwater close to the trench dropped significantly during infiltration periods, but it is unclear how far the effect of the infiltration trench trial has reached.

Appendix – Baseline monitoring

Aside from monitoring efforts directly related to the infiltration capacity of the trench, we also started a monitoring programme for nitrate concentrations in spring-fed streams in the Silverstream area. With the Silverstream area being more than 7 km downgradient of the trial site, we did not expect to see reducing nitrate concentrations as a result of the infiltration trial. The downgradient monitoring mostly serves as a *baseline* monitoring effort in anticipation of future land use changes upgradient of the spring-fed streams.

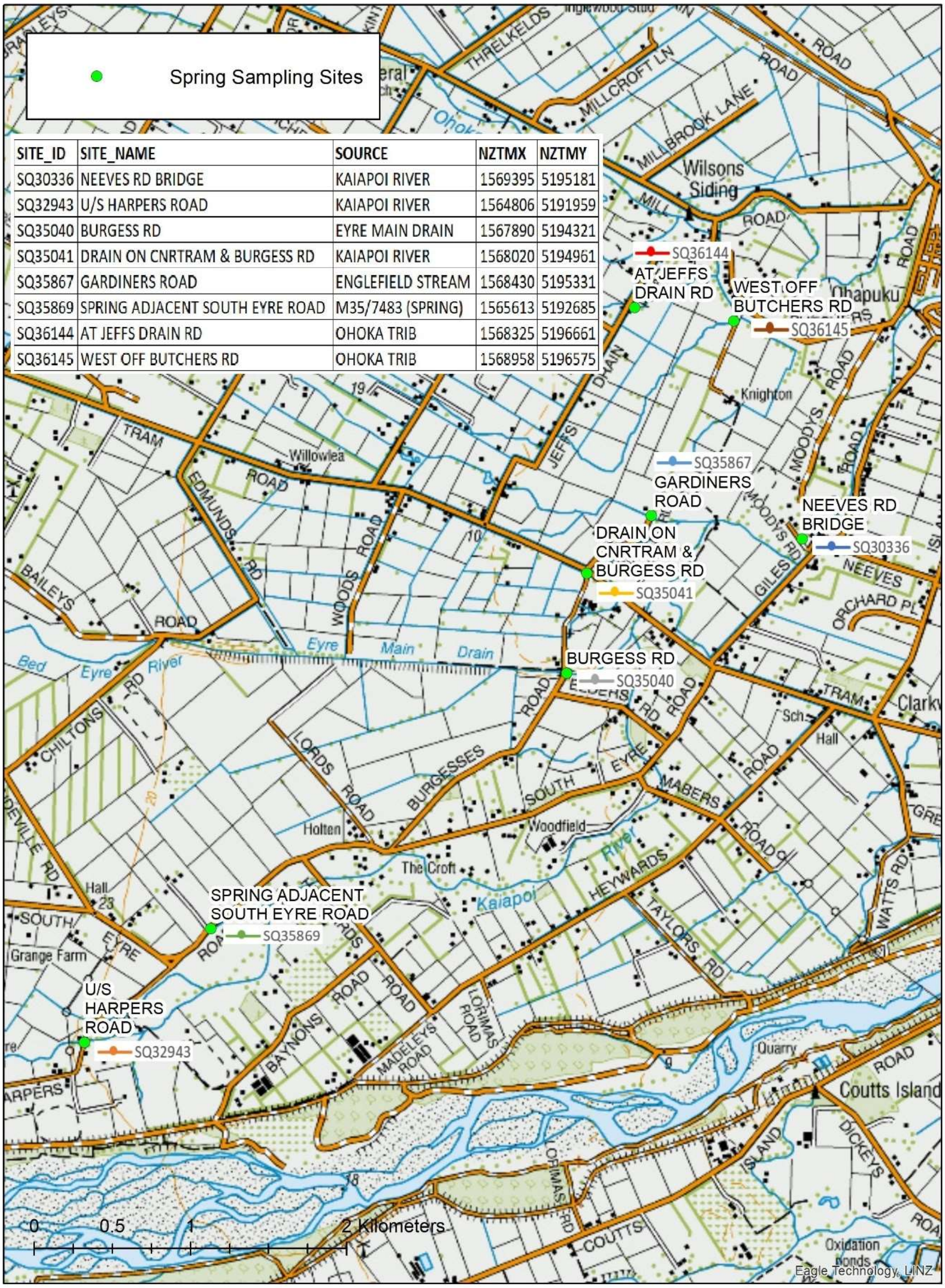
Figure 14 displays the monitoring sites (springs or spring-fed streams) downgradient of the infiltration trench site.

The monthly Baseline Sampling of springs started on 17 April 2019, two weeks after restart of the trial on 30 March 2019. Our Groundwater Science Field team carried out the sampling. Results are presented in the graph in Figure 15. For comparison, the graph also includes Silverstream at Harpers Road (upstream of the springs) and Island Road (downstream of the springs, which are sampled monthly by our Surface Water Field Team).

Data interpretation shows that the nitrate concentrations in the springs that feed into Silverstream are all below the nitrate concentrations measured upstream at Harpers Road.

The monthly data does not show large seasonal variation except perhaps at Jeffs Drain Rd (SQ36144), but the time series is too short to draw any conclusions yet.

Some sites show relatively low nitrate concentrations after October/November 2020, which could be connected to the above average dry weather conditions and below average groundwater levels we have been experiencing in Canterbury. Wetter conditions since June 2021 have likely caused the nitrate concentrations to increase again. This interaction needs further exploring for an interpretation with higher confidence.



SITE_ID	SITE_NAME	SOURCE	NZTMX	NZTMY
SQ30336	NEEVES RD BRIDGE	KAIAPOI RIVER	1569395	5195181
SQ32943	U/S HARPERS ROAD	KAIAPOI RIVER	1564806	5191959
SQ35040	BURGESS RD	EYRE MAIN DRAIN	1567890	5194321
SQ35041	DRAIN ON CNRTRAM & BURGESS RD	KAIAPOI RIVER	1568020	5194961
SQ35867	GARDINERS ROAD	ENGLEFIELD STREAM	1568430	5195331
SQ35869	SPRING ADJACENT SOUTH EYRE ROAD	M35/7483 (SPRING)	1565613	5192685
SQ36144	AT JEFFS DRAIN RD	OHOKA TRIB	1568325	5196661
SQ36145	WEST OFF BUTCHERS RD	OHOKA TRIB	1568958	5196575

Spring sampling locations Silverstream / Kaiapoi River

Figure 14 Spring sampling locations Silverstream / Kaipoi River

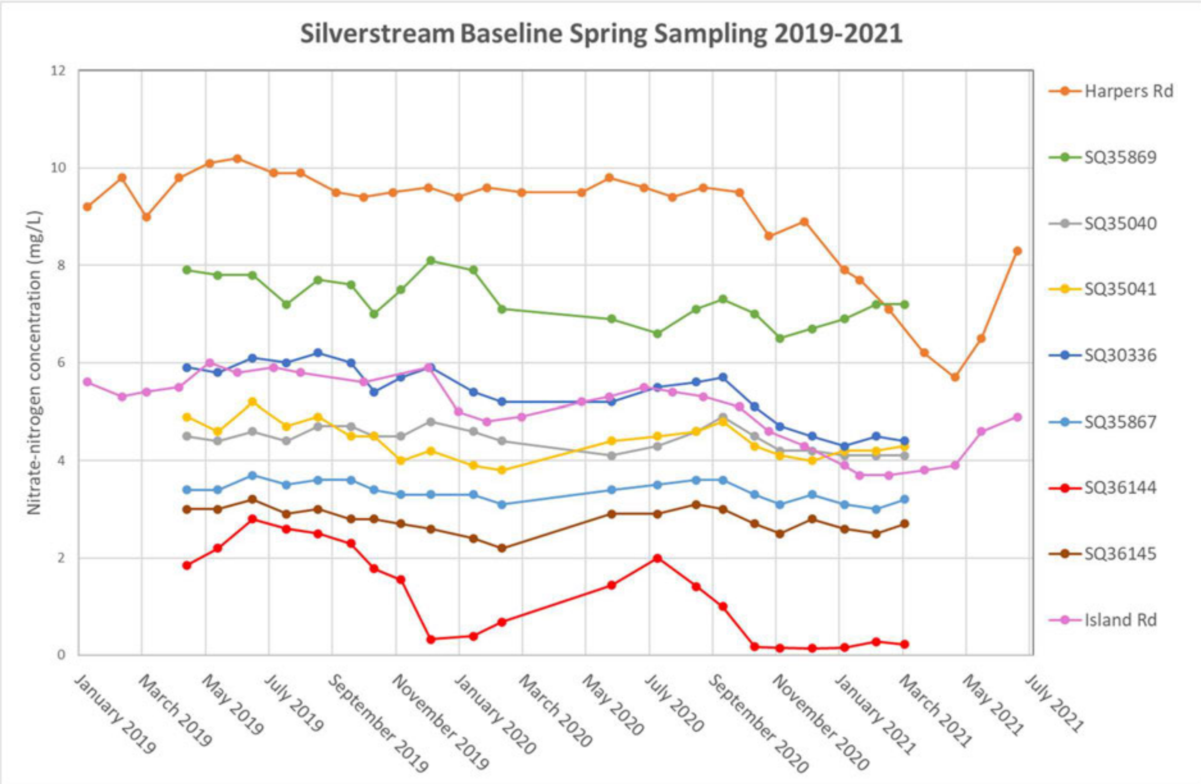


Figure 15 Baseline sampling results of springs near Silverstream, about 7 km downgradient of the infiltration trench trial site

WHAT IF ALLOWABLE DRINKING-WATER NITRATE LIMITS ARE REDUCED TO ADDRESS EMERGING HEALTH EFFECTS?

Dr Timothy Chambers (University of Otago) and Bridget O'Brien (WSP New Zealand Ltd)

ABSTRACT

Recent epidemiological evidence has found an increased risk of colorectal cancer and preterm births at nitrate-nitrogen concentrations as low as 1 mg/L in drinking water. This is much lower than the current maximum acceptable value of 11.3 mg/L for nitrate-nitrogen in the Drinking-water Standards for New Zealand and the World Health Organization Guidelines on Drinking Water Quality. The current limit is set to prevent the risk of blue baby syndrome. There is no limit set to prevent the health effects of long-term (for colorectal cancer) or prenatal nitrate exposure (for preterm births). One meta-analysis combining eight studies estimated that 1-8% of colorectal cancer is attributable to nitrate in drinking water.

This paper will discuss the health and economic implications of setting a nitrate limit based on the emerging evidence using a case study from Plan Change 7 of Environment Canterbury's Land and Water Regional Plan. The average nitrate-nitrogen concentration in Christchurch aquifers is 0.7 mg/L. However, elevated nitrate-nitrogen concentrations in deep bores north and west of Christchurch have been found, indicating anthropogenic sources of nitrate are already affecting Christchurch aquifers. Groundwater modelling found that it was likely that water north of the Waimakariri River contributes to the deep aquifers beneath Christchurch, and that nitrate from land intensification would likely lead to increased nitrate-nitrogen concentrations, with increases ranging from 0.9 – 7.6 mg/L (5^{th} and 95^{th} percentile scenarios).

We estimate there could be an additional 32.7 (95% confidence interval (CI) 8.9, 53.0) colorectal cancer and 9.8 (95%CI 8.0, 11.5) preterm births per year in the Christchurch City and Waimakariri District under the 5^{th} percentile scenario. Under the 95^{th} percentile scenario, this increases to an estimated 72.1 (95%CI 21.9, 107.2) and 23.9 (95%CI 19.9, 27.9) cases of colorectal cancer and preterm births, respectively. The estimated economic burden of these nitrate attributable health outcomes per year is between NZ$21 million under the 5^{th} percentile scenario and NZ$47.8 million under the 95^{th} percentile.

If water had to be treated to remove nitrate, ion exchange is the most likely treatment method, as this is well-proven and more cost-effective than other methods. However, this would be challenging in Christchurch due to the large number of pump stations where treatment plants would need to be installed. This could cost in the order of $610 million to construct and $24 million per year to operate. By way of comparison, this equates to 19 years of planned capital expenditure by Christchurch City Council on water supply and would result in a 75% increase in operational costs.

Nitrate-nitrogen concentrations above 1 mg/L have been found in many groundwater supplies around the country. The impact of lowering the limit in the drinking water standards would be significant in terms of source water risk management, restricting land use and increased water treatment requirements. However, not lowering the limit could result in higher rates of adverse health outcomes and other negative impacts on aquatic ecology.

KEYWORDS

Nitrate-nitrogen, colorectal cancer, preterm birth, drinking water standards, public health, nitrate treatment

NOMENCLATURE

Odds ratio (OR): a measure of association between an exposure and an outcome. The OR represents the odds that an outcome will occur given a particular exposure, compared to the odds of the outcome occurring in the absence of that exposure.

Confidence interval (CI): the probability with which an estimated interval will contain the true value of the parameter.

PRESENTER PROFILE

Dr Tim Chambers is a Senior Research Fellow at the University of Otago, Wellington. His research focuses on environmental epidemiology with a specific focus on the human health impacts of nitrate contamination in drinking water.

Bridget O'Brien is a Technical Principal – Water & Wastewater at WSP's Christchurch office. She is a Chartered Professional Engineer with over 20 years' experience both as a consultant and as a client at Christchurch City Council. She is passionate about drinking water safety and continuous improvement.

1 INTRODUCTION

Nitrate is one of the most common drinking water contaminants in New Zealand (NZ), largely driven by agricultural activity (nitrogen fertiliser application and livestock urine) (Morgenstern & Daughney, 2012). Nitrate leached into water from dairy farming has doubled since 1990 (Statistics New Zealand, 2019b). Emerging evidence has suggested a link between nitrate in drinking water and a range of adverse health outcomes (Manassaram et al., 2006; Temkin et al., 2019; Ward et al., 2018). The strongest evidence on these adverse health outcomes relate to colorectal cancer (Schullehner et al., 2018) and preterm births (Sherris Allison et al., 2021). The association between nitrate and adverse health outcomes have been observed as low as 1 mg/L nitrate-nitrogen. The current maximum acceptable value (MAV) for nitrate-nitrogen in the Drinking Water Standards for New Zealand (DWSNZ) (Ministry of Health, 2018a) and the World Health Organization (WHO) Guidelines on Drinking Water Quality is 11.3 mg/L (World Health Organization, 2017).

The current average nitrate-nitrogen concentration in Christchurch water supply bores is 0.7 mg/L (Christchurch City Council, 2021). However, elevated nitrate-nitrogen concentrations in deep bores north and west of Christchurch have been found, indicating anthropogenic sources of nitrate are already affecting Christchurch aquifers (Thorley, 2020). Groundwater modelling found that it was likely that water north of the Waimakariri River contributes to the deep aquifers beneath Christchurch, and that nitrate from land intensification in the Waimakariri District would likely lead to increased nitrate-nitrogen concentrations. The modelled increases ranged from 1.2 – 7.9 mg/L depending on which land use management and groundwater modelling scenario is used (Kreleger & Etheridge, 2019).

In this paper, we discuss the health and economic implications of setting a nitrate limit based on the technical reports and evidence prepared for Proposed Plan Change 7 of Canterbury's Land and Water Regional Plan.

1.1 THE MAXIMUM ACCEPTABLE VALUE FOR NITRATE

The current maximum acceptable value (MAV) for nitrate in the DWSNZ is 50 mg/L (which equates to 11.3 mg/L nitrate-nitrogen). This follows the Guidelines for Drinking-water Quality (World Health Organization, 2017) which are based on the risk to infants of developing methemoglobinemia (blue baby syndrome) and do not consider any other possible health conditions (Ward et al., 2018). Methemoglobinemia is a condition that affects infants where ingested nitrate causes the conversion of haemoglobin to methaemoglobin. Increased levels of methaemoglobin interfere with the blood's oxygen carrying capacity which restrictions oxygen delivery to cells in the body. Infants do not possess the enzymes necessary to facilitate the quick conversion of methemoglobin back to haemoglobin so are at heightened risk.

Colorectal cancer includes cancers of the colon or rectum, commonly referred to as bowel cancer. Colorectal cancer is the second highest cause of death in New Zealand (Ministry of Health, 2018c). New Zealand has one of the highest colorectal cancer rates in the world (Bray et al., 2018). Within New Zealand, South Canterbury, Southland, Wairarapa and Nelson Marlborough District Health Boards (DHBs) have the highest rates of colorectal cancer (Health Quality and Safety Commission of New Zealand, 2019). Canterbury DHB has an average rate of colorectal cancer incidence compared to other DHBs but has the highest number of colorectal cancer cases in New Zealand.

An estimated 90% of colorectal cancers (CRC) are sporadic (non-hereditary), meaning they develop after birth due to a range of modifiable risk factors (Purcell et al., 2017). A NZ study has estimated the colorectal cancer rates attributable to known risk factors including obesity (9%), alcohol (7%), physical inactivity (4%), smoking (3%), consumption of red meat (5%) and processed meat (3%) (Richardson et al., 2016). Emerging international evidence has suggested that nitrate contamination in drinking water is another potential risk factor for colorectal cancer (Temkin et al., 2019).

A recent meta-analysis that pooled the results from eight epidemiological studies reported a 4% increase in CRC risk per mg/L increase in nitrate-nitrogen concentrations (odds ratio (OR) 1.04, 95%CI 1.01, 1.07) (Temkin et al., 2019). Population-based studies in Denmark, USA, Spain and Italy have reported an increased risk of CRC from nitrate concentrations >0.87 mg/L (Schullehner et al., 2018); >1.01 mg/L (Weyer et al., 2001); >1.61 mg/L (Espejo-Herrera et al., 2016); >5.00 mg/L (De Roos et al., 2003). However, some studies have produced mixed results with null findings or non-linear relationships between nitrate in drinking water and colorectal cancer (De Roos et al., 2003; Jones et al., 2019; McElroy et al., 2008; Weyer et al., 2001). Some limitations of these studies producing null or inconsistent findings were 1) overly specific populations such as older women aged 55-69 (Jones et al., 2019; Weyer et al., 2001) or rural populations (McElroy et al., 2008); 2) lacking statistical power due to small samples when split across multiple exposure groups (McElroy et al., 2008); and 3) unreliable exposure measurements for nitrate.

The two most methodologically rigorous studies conducted to date on nitrate contamination and colorectal cancer are Schullehner et al. (2018) and Espejo-Herrera et al. (2016). Schullehner (2018), commonly referred to as "the Danish Study," was a nation-wide, cohort study across the Danish population (n = 3 million, with 44 million observed person-years) with individual-level exposure data linked to their residential histories back to 1978. This one study is larger than all other cohort studies combined. Espejo-Herrera (2016) was a case-control study with 1,869 CRC cases matched with 3,530 controls in Spain and Italy with individual-level exposure data linked to participant's residential history and accounted for key confounders (sex, age, socioeconomic status, physical activity, smoking and family history of CRC). Like Schullehner, this one case-control study is larger than all other case-control studies combined. However, these two studies did not provide a linear estimate (e.g. increased risk of colorectal cancer per mg/L increase in nitrate) so we have opted for the Temkin estimate in our analyses.

The proposed mechanism ingested nitrate impacts cancer is through a process of endogenous nitrosation. Ingested nitrate is reduced to nitrite by nitrate-reducing bacteria in saliva (Sinha et al., 2021). Nitrite under acidic gastric conditions reacts with nitrosatable compounds to generate N-nitroso compounds (NOC) which are known carcinogens (International Agency for Research on Cancer, 2010). NOC can induce DNA-damaging metabolites, which could lead to cancerous lesions in cells (Zhu et al., 2014). A recent study identified this specific DNA damage in biopsies from a cohort of 900 colorectal carcinoma cases (Gurjao et al., 2021). Red meat consumption was associated with the alkylating signature in colorectal cancer sites which provided molecular evidence of the mutagenic impact of dietary nitrite via the NOC pathway (Gurjao et al., 2021). A randomised-controlled trial with human participants showed nitrate in drinking water increased bio-makers of NOC formation in faeces (van Breda et al., 2019), which supports human feeding studies focusing on dietary nitrate consumption (Hughes et al., 2001; Rowland et al., 1991).

1.2 NITRATE AND PRETERM BIRTHS

Any birth that occurs before 37 weeks is defined as a preterm birth. In NZ, preterm birth is the leading cause of mortality in infants (23% of all deaths in 2017) and children under 5 years (22% of all deaths in 2018) (Ministry of Health, 2018c). Surviving preterm infants have higher rates of chronic health conditions including neurological and developmental disabilities, mental health, emotional and respiratory problems (Frey & Klebanoff, 2016). The impacts of prematurity worsen with lower gestation ages, with the most severe outcomes experienced by early preterm birth (Frey & Klebanoff, 2016).

Two narrative reviews assessing the impact of nitrate in drinking water on birth outcomes concluded there was evidence linking nitrate with preterm births, albeit with some limitations (Manassaram et al., 2006; Ward et al., 2018). Addressing some of these limitations, a recent retrospective cohort study of 4.6 million births in California from 2000-2011 observed an increased risk of early preterm birth (<32 weeks) for mothers exposed to nitrate >5 mg/L (OR 1.49 95%CI 1.42, 1.56) and >10 mg/L (OR 1.34 95%CI 1.12, 1.60) compared to mothers exposed to <5.0 mg/L (Sherris Allison et al., 2021). The authors also conducted a within-mother analysis of exposure-discordant consecutive births which controlled for inter-participant differences. The within-mother analysis showed pregnancies exposed to >5 mg/L (OR 1.47 95%CI 1.29, 1.67) and >10 mg/L (OR 2.52 95%CI 1.49, 4.26) had increased odds of early preterm birth compared to pregnancies exposed to <5 mg/L.

Established risk factors for preterm birth include maternal tobacco use, age, socio-economic status and obesity (Frey & Klebanoff, 2016). Several environmental exposures have been suggested as additional risk factors for preterm birth including air pollution (Shah & Balkhair, 2011) and nitrate contamination in drinking water (Sherris Allison et al., 2021). One proposed mechanism for nitrate impacting preterm birth is through oxidative stress. Oxidative stress is an imbalance of oxidants and antioxidants, which can cause accelerated ageing of fetal cells (Menon, 2014). The aging of fetal cells generate biomolecular signals that can trigger the labour process (Menon, 2014). One biomarker of oxidative stress is high methaemoglobin levels from the conversion of haemoglobin to methaemoglobin (a by-product of nitrate metabolism) (Bryan & Loscalzo, 2017). Elevated methaemoglobin levels have been observed in umbilical cord blood of pregnant women exposed to nitrate (Tabacova et al., 1998).

One UK study estimated the average health care costs and loss of family earnings at age 18 of an extremely early preterm birth (<28 weeks) and early preterm birth (<32 weeks) were NZ$248,000 and NZ$161,000, respectively (Mangham et al., 2009). In New Zealand, there is an average of 775 early preterm births each year which would be equivalent (based on the UK study,(Mangham et al., 2009) to an extra cost of NZ$150 million per year.

1.3 CANTERBURY GROUNDWATER QUALITY

1.3.1 CURRENT STATE OF CANTERBURY GROUNDWATER QUALITY

The median nitrate-nitrogen concentration in Canterbury's groundwater in 2019 was 3.4 mg/L, with values ranging from <0.05 to 23 mg/L (Environment Canterbury, 2020). Nine percent of monitoring wells exceeded the maximum acceptable value of 11.3 mg/L in the Drinking-water Standards for New Zealand (see Figure 1). Forty percent of wells had likely increasing or very likely increasing trends of nitrate-nitrogen concentrations (see Figure 2).

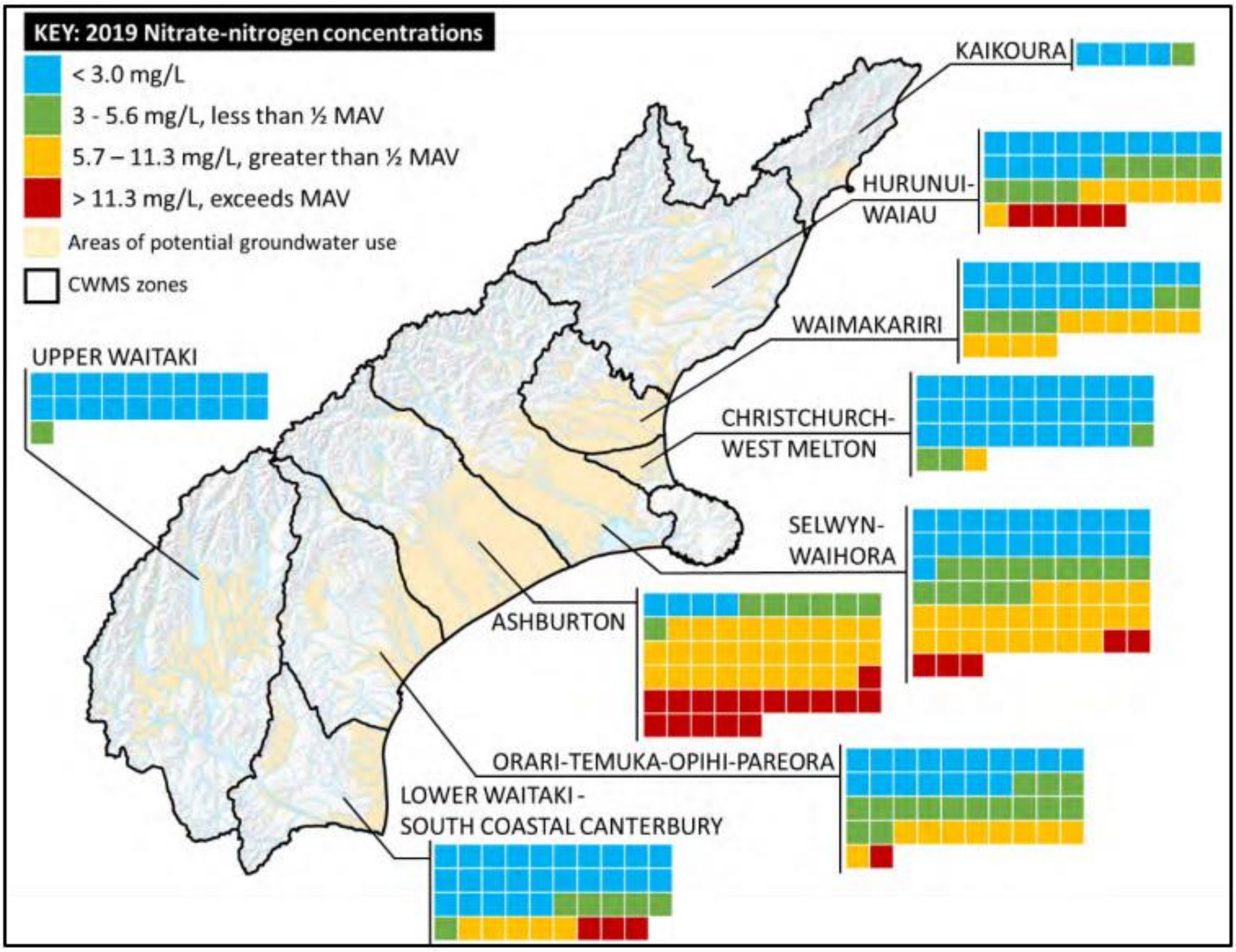


Figure 1: Summary of nitrate-nitrogen concentrations sampled in the 2019 annual survey (Figure 4 from Environment Canterbury (2020))

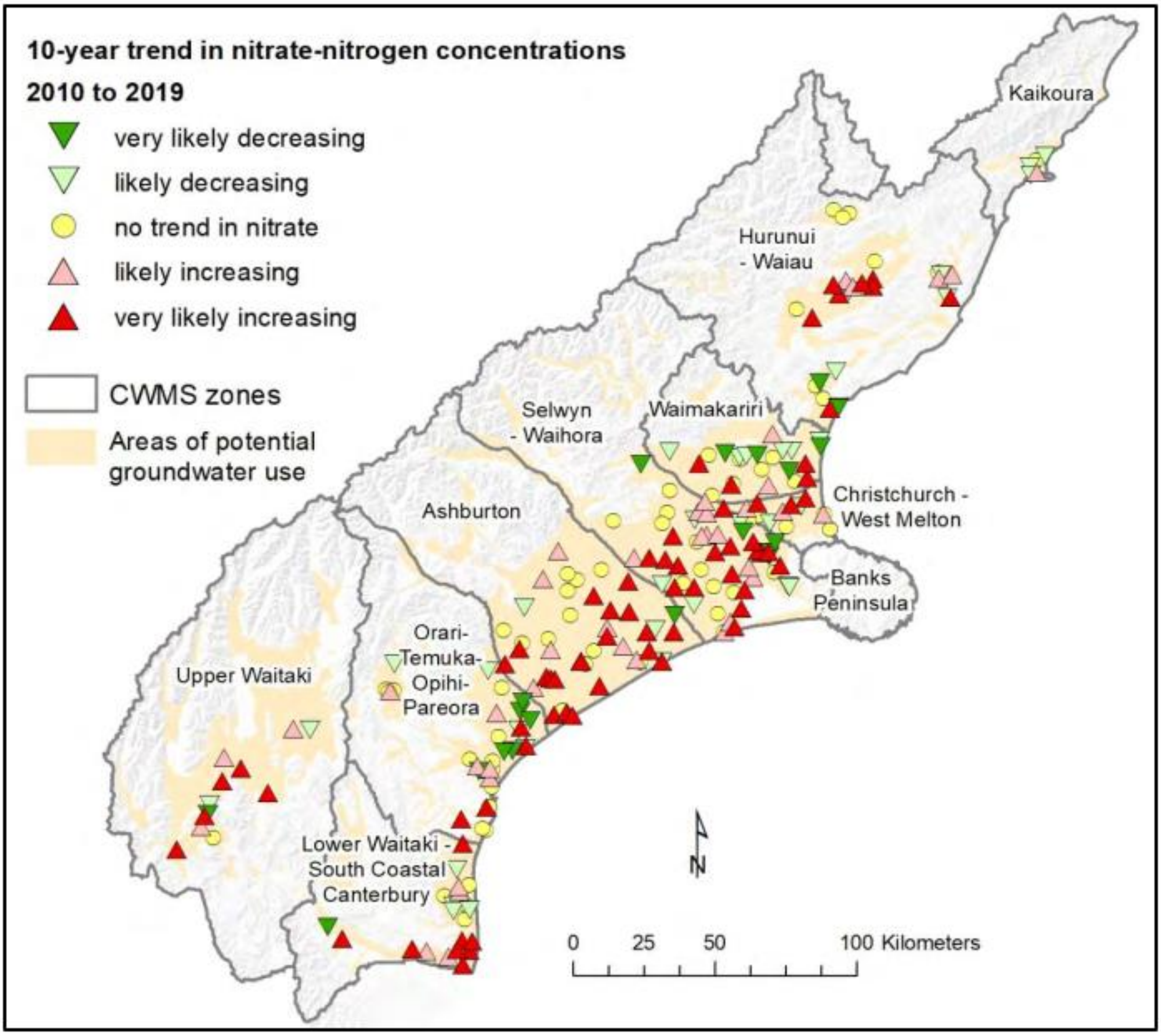


Figure 2: Ten-year trends (2010 – 2019) in nitrate-nitrogen concentrations in annual survey wells (Figure 6 from Environment Canterbury (2020))

1.3.2 CHRISTCHURCH WATER SUPPLY AND GROUNDWATER QUALITY

Christchurch is fortunate to have a very high quality groundwater source for the residents and businesses of the city and Lyttelton Harbour. This is the sole water supply source for Christchurch, Brooklands, Kainga, Lyttelton, Governors Bay and Diamond Harbour (total population 342,000).

There are 48 water supply pump stations spread across Christchurch city, which pump water from 142 wells directly into the water supply network. The water supply network is divided into eight water supply zones, with between two and 16 pump stations supplying each zone.

Recharge of the Christchurch groundwater system occurs in the unconfined areas primarily from drainage from the Waimakariri River and rainfall on a small area of the plains northwest of Christchurch. About three quarters of groundwater is recharged by Waimakariri River, with rainfall derived infiltration providing most of the remainder.

Another contributing source of groundwater to the deep aquifers in the north of Christchurch is deep flow beneath the Waimakariri riverbed from north of the Waimakariri

River. This is based on groundwater modelling undertaken by GNS for Environment Canterbury (Kreleger & Etheridge, 2019). The source area north of the Waimakariri River is shown in Figure 3. Therefore, increased nitrate leaching from land use intensification in the Waimakariri District would likely lead to increased nitrate-nitrogen concentrations in the deep Christchurch aquifers.

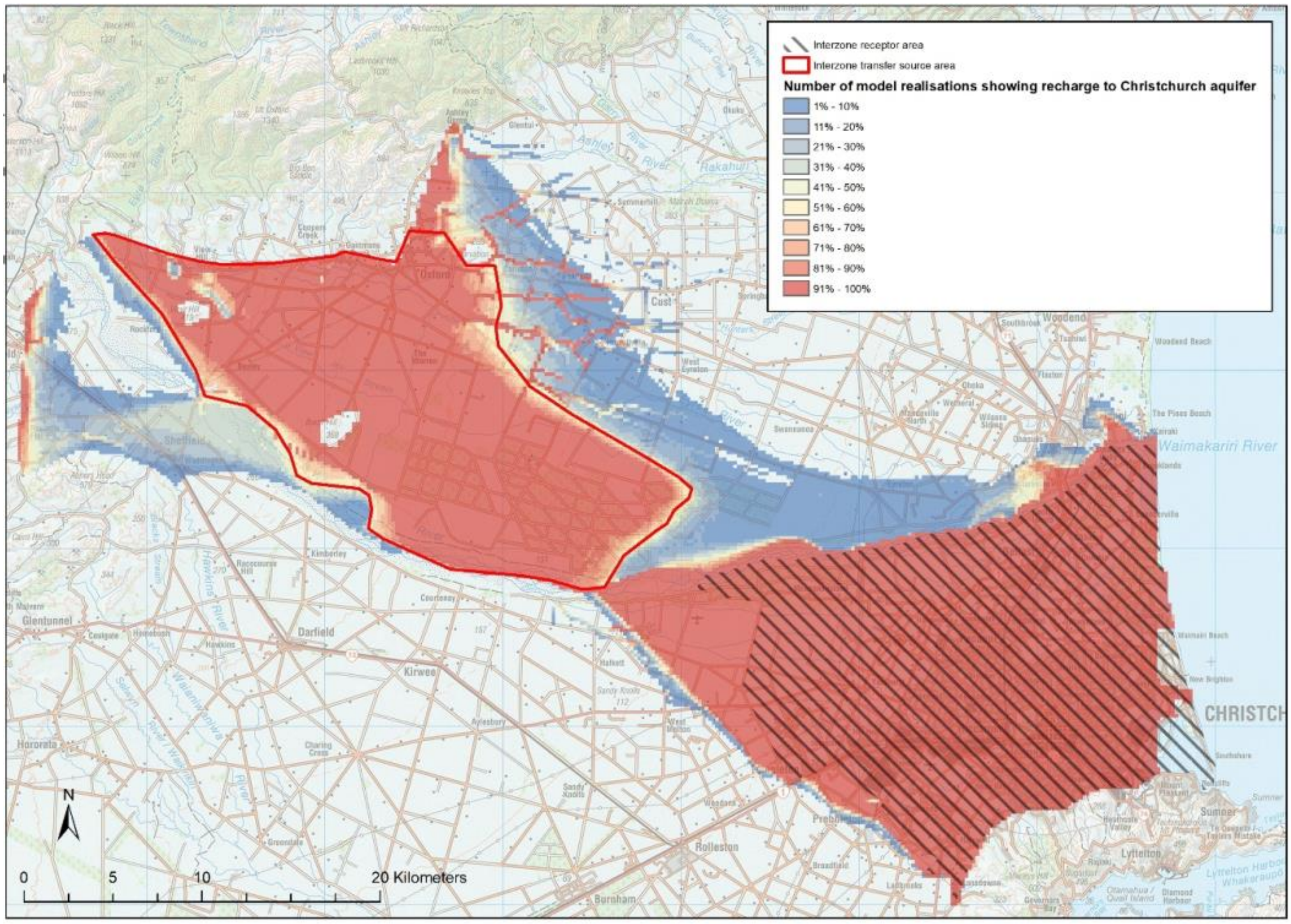


Figure 3: Waimakariri recharge sources of the Christchurch groundwater system (Figure 3-8 from Kreleger and Etheridge (2019))

The average nitrate-nitrogen concentration in Christchurch water supply bores in 2021 is 0.7 mg/L (Christchurch City Council, 2021). Elevated nitrate-nitrogen concentrations in deep bores in the northwest of Christchurch have been found where the current average concentration is 1.4 mg/L, indicating anthropogenic sources of nitrate are already affecting these aquifers (Thorley, 2020). Maximum nitrate-nitrogen concentrations measured in active water supply wells for the period 2008 – 2020 is shown in Figure 4, with values up to 4.2 mg/L.

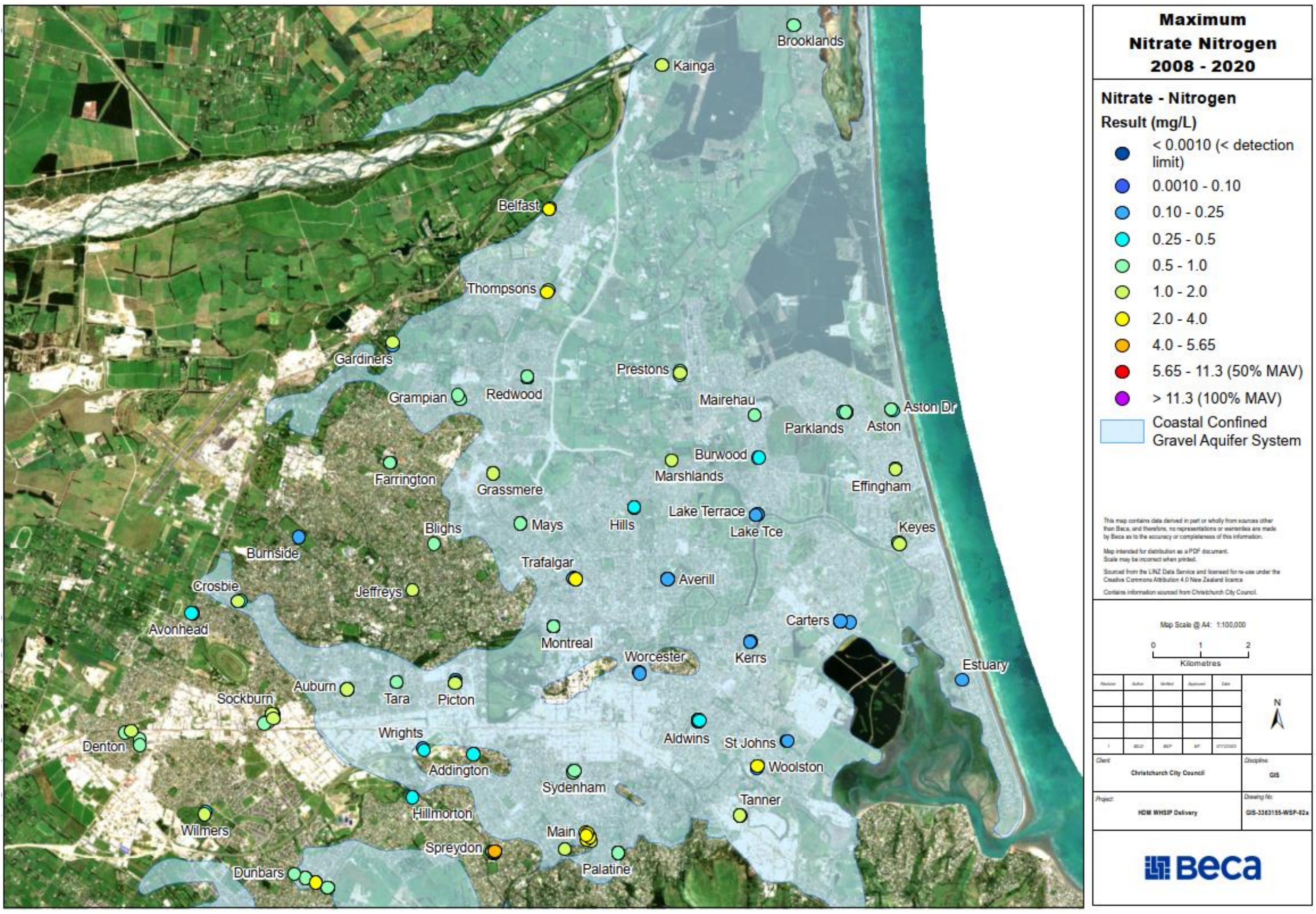


Figure 4: Maximum in nitrate-nitrogen concentrations in active water supply wells in Christchurch 2008 - 2020 (Christchurch City Council, 2020)

1.3.3 WAIMAKARIRI DISTRCT WATER SUPPLY

The Waimakariri District also relies on groundwater for its water supply. 53,800 people are served by water supplies owned and operated by the Waimakariri District Council. There are approximately 2,750 active private water supply wells in the district, with an estimated 6,900 people using these wells. The average nitrate-nitrogen concentration in Waimakariri District Council water supplies was 1.9 mg/L and in private water supply wells was 3.5 mg/L (Kreleger & Etheridge, 2019). The maximum nitrate-nitrogen concentrations in Waimakariri private water supply wells is shown in Figure 5.

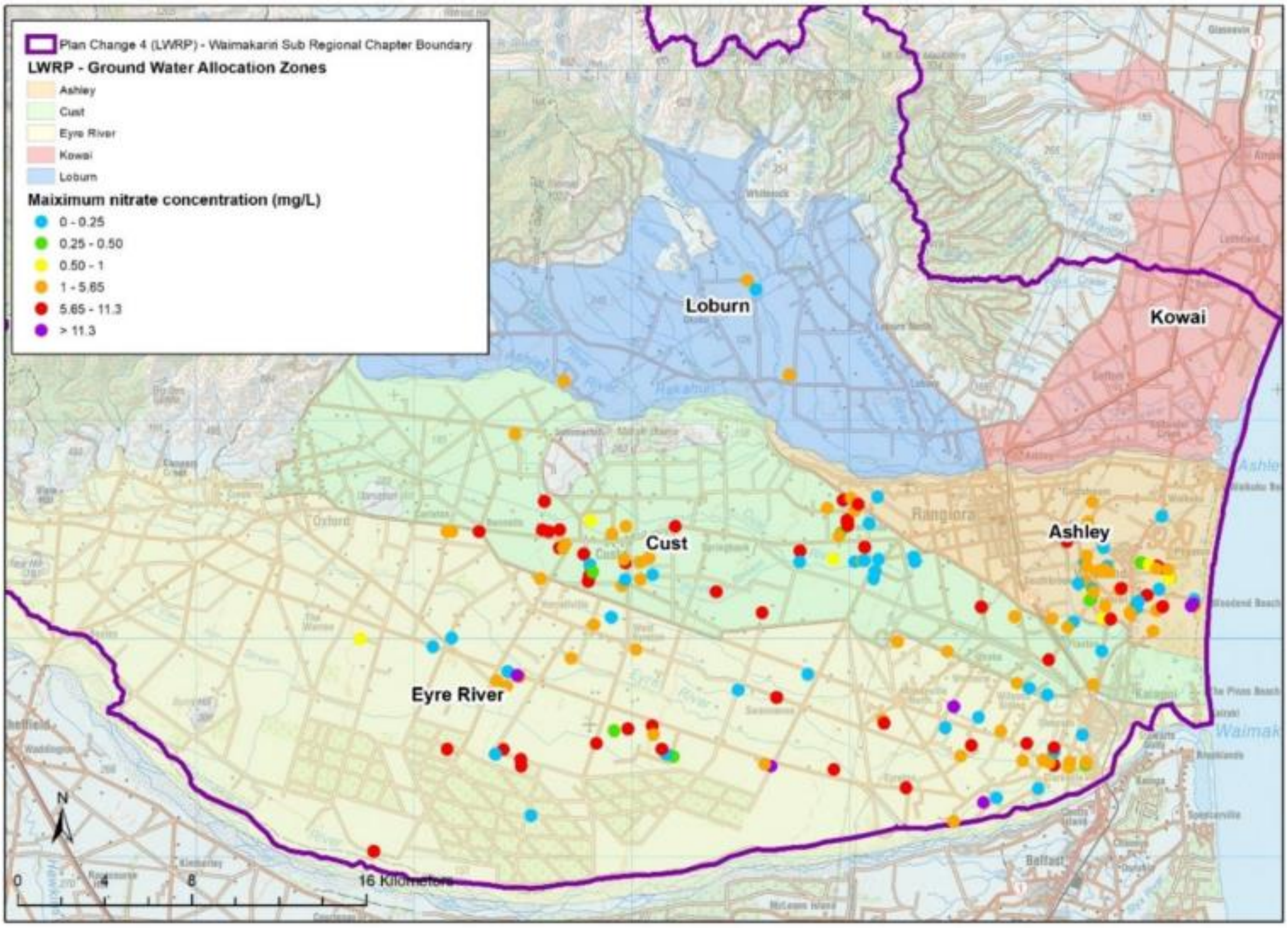


Figure 5: Measured maximum nitrate concentrations in private water supply wells in the Waimakariri District (Figure 2-11 from Kreleger and Etheridge (2019))

1.3.4 REGIONAL PLAN CHANGE SCENARIOS

ECan's Waimakariri Zone Committee set target nitrate-nitrogen concentrations for the Waimakariri and Christchurch aquifers to inform the Proposed Plan Change 7 of the Canterbury Land and Water Regional Plan. For the Waimakariri District, the target was 5.65 mg/L, which is half the DWSNZ MAV. For Christchurch aquifers the target was 3.8 mg/L, to protect the 90% of aquatic species, recognising the interconnectivity of the aquifers with spring fed streams.

Environment Canterbury and its consultants undertook extensive modelling and analysis to assess various land use scenarios that were considered for the proposed plan change. For simplicity, this paper focuses on the good management practice scenario, which is defined as the practices described in Industry-Agreed Good Management Practices Relating to Water Quality dated 18 September 2015 (Kreleger & Etheridge, 2019).

The aims of this paper were to:

1. Estimate the potential health burden attributable to nitrate in Christchurch and Waimakariri District under ECan Plan Change 7 Scenarios

2. Estimate the cost of the health burden attributable to nitrate and the cost of different nitrate treatment processes.

2 METHODS

We used the 5th, 50th and 95th percentile groundwater modelling nitrate predictions results for the good management practice scenario for ECan's Plan Change 7 to provide a range of possible groundwater quality scenarios in Christchurch and the Waimakariri District (Kreleger & Etheridge, 2019). Nitrate-nitrogen levels for the Waimakariri District were provided for community and private water supply wells, while only community wells were provided for Christchurch. Thus, we have three exposure groups for analyses. We took the current average nitrate-nitrogen for each exposure group reported as our current state. The input data used in our analysis is shown in Table 1.

In our analyses, we assumed 100% of the population were exposed to this level of nitrate. While the nitrate concentration varies depending on well location, as there appears to be a linear relationship between nitrate concentration and health effects, using the average concentration is appropriate at a population-based level.

Table 1: Population served and exposure scenarios for Christchurch and Waimakariri District drinking water supplies

Water supplies	Population Served[1] (n)	Percentage of Canterbury DHB[2] (%)	Current NO_3-N exposure (mg/L)	5th percentile scenario exposure (mg/L)[4]	50th percentile scenario exposure (mg/L)[4]	95th percentile scenario exposure (mg/L)[4]
Christchurch (community)	342,000	63	0.7[3]	3.0	5.2	7.6
Waimakariri (community)	53,800	10	1.9[4]	3.0	5.4	8.3
Waimakariri (private)	6,900	1.3	3.5[4]	3.1	6.3	10.2

[1] Retrieved from evidence in chief of Bridget O'Brien for Christchurch City Council for Land and Water Regional Plan Change 7 (O'Brien, 2020)
[2] Extracted from the 2018 Census
[3] Retrieved from Christchurch City Council water quality monitoring data 2021 (Christchurch City Council, 2021)
[4] Retrieved from Kreleger and Etheridge (2019)

2.1 COLORECTAL CANCER AND PRETERM BIRTH DATA

Colorectal cancer incidence data for the year 2017 was retrieved from the Ministry of Health from the New Zealand Cancer Registry (n=409) (Ministry of Health, 2018d). Early preterm birth (<32 weeks) incidence for the Canterbury District Health Board (CDHB) was retrieved from Ministry of Health Maternity Collection Database (n =496) (Ministry of Health, 2018b). We created a population-weighted colorectal cancer and preterm birth incidence for each study area. For example, Christchurch community supply served 63% of the CDHB population, thus we assigned 63% of the colorectal cancer and preterm cases to this supply (n=259 and n= 314, respectively).

2.2 POPULATION ATTRIBUTABLE FRACTION

Population attributable fractions (PAF) are used to estimate the proportion of disease in the population that could be prevented if the modifiable risk factor (or exposure) was eliminated (Webb et al., 2017). PAF analyses use the relative risk (RR) from epidemiological studies to estimate the potential population burden of a disease accounting for differences in exposure. To calculate the population attributable fraction for nitrate-attributable colorectal cancer and preterm births in our study areas, we first created an effective RR by multiplying the average exposure (or exposure scenario) by the relevant RR. For colorectal cancer we used the continuous RR from Temkin's meta-analysis (0.04 per 1mg/L increase) (Temkin et al., 2019). For preterm births we used Sherris' continuous RR (RR 0.01 per 1mg/L increase) (Sherris Allison et al., 2021). The effective RR was used in the standard PAF formula below in place of the RR:

PAF = $[P(RR-1)/Pe(RR-1)+1]$ x 100%

$Where\ Pe = the\ prevalence\ of\ exposure\ to\ the\ risk\ factor$

$RR = the\ relative\ risk$

Because we calculated an effective RR based on the average exposure, the prevalence of the risk factor was 100%. Confidence intervals (CI) were calculated using the lower and upper confidence intervals from Temkin (95%CI 1.01, 1.07) and Sherris (95%CI 1.009, 1.011).

2.3 DIRECT AND INDIRECT HEALTH-RELATED COSTS

To estimate the economic burden of nitrate contamination in drinking water we used available estimates of the direct and indirect costs of each colorectal cancer and preterm birth case. The economic cost of direct medical treatment for CRC in NZ is estimated to be NZ$43,000 per case (Blakely et al., 2015). The indirect costs (such as lost productivity) of each healthy year of life lost is estimated at NZ$69,000 (Temkin et al., 2019) while an estimated eight years of healthy life is lost per diagnosed colorectal cancer case (Ministry of Health, 2013). Thus, of each additional colorectal cancer case costs an estimated NZ$595,000 (indirect costs of $552,000 + direct costs of $43,000). One UK study estimated the average economic burden at age 18 of a preterm birth <28 weeks and preterm birth <32 weeks were NZ$248,000 and NZ$161,000, respectively (Mangham et al., 2009). Given our outcome only assesses preterm births 20 to 31 weeks, we took the average of these two figures (NZ$204,500).

3 RESULTS DISCUSSION

2.3 NITRATE-ATTRIBUTABLE COLORECTAL CANCER AND PRETERM BIRTHS

Table *1* shows the estimated burden of nitrate-attributable colorectal cancer and early preterm births in Christchurch and Waimakariri under ECan's nitrate management scenarios. Under current exposure, nitrate contamination in drinking water contributes to an estimated 6.6 (95%CI 1.7, 11.3) and 1.8 (95%CI 1.5, 2.2) colorectal cancer and early preterm cases per year in Christchurch, respectively. These rates rise to 60.4 (95%CI 18.3, 90.0) colorectal cancer cases and 20 (95%CI 16.6, 23.3) early preterm births in the 95th percentile scenario (7.5mg/L nitrate-nitrogen). While Waimakariri is projected to experience slightly higher nitrate exposure than Christchurch, its overall population contribution is low (3.5 colorectal cancer cases and one preterm birth per year under current exposure levels). However, Waimakariri rates of nitrate-attributable colorectal cancer are 2.8 times (community supplies) and 4.8 times (private supplies) higher than Christchurch under current scenarios. Differences in rates reduce under the ECan scenarios given the similarities in exposure estimates so are not reported here.

Table 1: Nitrate-attributable colorectal cancer and preterm births under ECan nitrate management scenarios

Area	Health outcome	Current	ECAN Scenario 5th percentile	50th percentile	95th percentile
Christchurch City[1]	Colorectal Cancer, n (95%CI)	6.6 (1.7, 11.3)	27.8 (7.5, 45)	44.6 (12.8, 69.2)	60.4 (18.3, 90)
	Preterm births, n (95%CI)	1.8 (1.5, 2.2)	8.3 (6.8, 9.7)	14 (11.6, 16.4)	20 (16.6, 23.3)
Waimakiriri community[2]	Colorectal Cancer, n (95%CI)	2.9 (0.8, 4.8)	4.4 (1.2, 7.1)	7.2 (2.1, 11.2)	10.2 (3.1, 15.0)
	Preterm births, n (95%CI)	0.8 (0.7, 1)	1.3 (1.1, 1.5)	2.3 (1.9, 2.7)	3.4 (2.8, 4.0)
Waimakiriri private[3]	Colorectal Cancer, n (95%CI)	0.6 (0.2, 1.0)	0.6 (0.2, 0.9)	1.1 (0.3, 1.6)	1.5 (0.5, 2.2)
	Preterm births, n (95%CI)	0.2 (0.2, 0.2)	0.2 (0.1, 0.2)	0.3 (0.3, 0.4)	0.5 (0.4, 0.6)
Total	Colorectal Cancer, n (95%CI)	10.2 (2.6, 17.4)	32.7 (8.9, 53.0)	52.9 (15.2, 82.0)	72.1 (21.9, 107.2)
	Preterm births, n (95%CI)	2.9 (2.4, 3.4)	9.8 (8.0, 11.5)	16.7 (13.8, 19.5)	23.9 (19.9, 27.9)

1 Current scenario = 0.65 mg/L N03-N; 5th Percentile = 3.0 mg/L N03-N; 50th Percentile = 5.2 mg/L N03-N; 95th Percentile = 7.6mg/L N03-N

2 Current scenario = 1.9 mg/L N03-N; 5th Percentile = 3.0 mg/L N03-N; 50th Percentile = 5.4 mg/L N03-N; 95th Percentile = 8.3 mg/L N03-N

3 Current scenario = 3.5 mg/L N03-N; 5th Percentile = 3.1 mg/L N03-N; 50th Percentile = 6.3 mg/L N03-N; 95th Percentile = 10.2 mg/L N03-N

Table 2 estimates the cost of nitrate-attributable colorectal cancer and preterm births under ECan's nitrate management scenarios. Current nitrate contamination costs an estimated NZ$6.7 million each year. The cost of 5th percentile scenario (3 mg/L) is NZ$21.5 million per year. The 95th percentile has direct and indirect health costs of NZ$47.8 million per year. The majority of the costs are associated with colorectal cancer but it should be noted the preterm birth estimates do not account for stillbirths or infant mortality associated with preterm births.

Table 2: Estimated cost of nitrate-attributable colorectal cancer and preterm births under ECan's nitrate management scenarios

Water Supply	Health outcome	Current	ECAN Scenario 5th percentile	50th Percentile	95th Percentile
Christchurch City and Waimakiriri district	Colorectal Cancer, $million (95%CI)[1]	6.1 (1.6, 10.4)	19.5 (5.3, 31.5)	31.5 (9.1, 48.8)	42.9 (13, 63.8)
	Preterm births, $million (95%CI)[2]	0.6 (0.5, 0.7)	2.0 (1.6, 2.3)	3.4 (2.8, 4)	4.9 (4.1, 5.7)

1 Each additional CRC case costs an estimated NZ$595,000 (indirect costs of $552,000 + direct costs of $43,000).

2 Economic burden at age 18 of a preterm birth <28 weeks and preterm birth <32 weeks were NZ$248,000 and NZ$161,000, respectively. Given our outcome only assesses preterm births 20 to 31 weeks, we took the average of these two figures (NZ$204,500).

2.3 WATER TREATMENT OPTIONS – COST

If water had to be treated to remove nitrate, ion exchange is the most likely treatment method, as this is well-proven and more cost-effective than other methods. However, this would be challenging in Christchurch due to the large number of pump stations where treatment plants would need to be installed. The cost of nitrate removal increases with the mass of nitrate to be removed. Evidence for Christchurch City Council considered the cost reducing a possible future nitrate concentration of 7.9 mg/L down to 5.65, 3.8 and 1 mg/L (half the DWSNZ MAV, the zone committee target and the target that CCC was requesting based on emerging health evidence respectively) (Birdling, 2020) The estimated capital and operating costs are shown in Table 4, along with net present value calculated over 100 years with a discount rate of 3%.

Table 4: Estimated cost of removing nitrate from the Christchurch water supply

	Target Future Nitrate-Nitrogen Concentration		
Cost Estimate	**5.65 mg/L**	**3.8 mg/L**	**1 mg/L**
Capital Cost	$347M	$461M	$610M
Annual Operating Cost	$13M	$18M	$24M
Net Present Value	$829M	$1,117M	$1,507M

By way of comparison, the cost of the scenario to reduce future nitrate concentrations to 1 mg/L equates to 19 years of planned capital expenditure by Christchurch City Council on water supply and would result in a 75% increase in operational costs (O'Brien, 2020).

This compares with the cost to farmers of implementing the nitrate loss reductions in Proposed Plan Change 7, which had a net present value of $457 million (Butcher, 2020).

4 CONCLUSIONS

Emerging health evidence has found links between nitrate-nitrogen concentrations much lower than the current DWSNZ MAV and colorectal cancer and preterm births.

We estimate there could be an additional 32.7 (95% confidence interval (CI) 8.9, 53.0) colorectal cancer and 9.8 (95%CI 8.0, 11.5) preterm births per year in the Christchurch City and Waimakariri District under the 5^{th} percentile scenario. Under the 95^{th} percentile scenario, this increases to an estimated 72.1 (95%CI 21.9, 107.2) and 23.9 (95%CI 19.9, 27.9) cases of colorectal cancer and preterm births, respectively. The estimated economic burden of these nitrate attributable health outcomes per year is between NZ$21 million under the 5^{th} percentile scenario and NZ$47.8 million under the 95^{th} percentile.

If water had to be treated to remove nitrate, ion exchange is the most likely treatment method, as this is well-proven and more cost-effective than other methods. However, this would be challenging in Christchurch due to the large number of pump stations where treatment plants would need to be installed. This could cost in the order of $610 million to construct and $24 million per year to operate. By way of comparison, this equates to 19 years of planned capital expenditure by Christchurch City Council on water supply and would result in a 75% increase in operational costs.

Across New Zealand, 19% of 433 monitoring sites exceeded the DWSNZ MAV for nitrate on at least one occasion between 2014 and 2018 in Statistics NZ's analysis of groundwater quality (Statistics New Zealand, 2019a). If a lower DWSNZ MAV for nitrate-nitrogen was adopted to account for the emerging health evidence around colorectal cancer and preterm births, this would have a significant impact on land use in water supply catchments and treatment.

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WAIMAKARIRI DISTRICT COUNCIL

REPORT FOR INFORMATION

FILE NO and TRIM NO:	DRA-19/220915160331
REPORT TO:	LAND AND WATER COMMITTEE
DATE OF MEETING:	27 September 2022
AUTHOR(S):	Angela Burton (Water Environment Advisor)
SUBJECT:	Pinevale Farm Earthworks Incident Report
ENDORSED BY: (for Reports to Council, Committees or Boards)	General Manager / Acting Chief Executive

1. SUMMARY

1.1. This report for information seeks to inform the Land and Water Committee that the Pinevale Farm earthworks incident is currently with the Environment Canterbury Incident Response Team and that Waimakariri District Council staff will work with Environment Canterbury, Synlait Milk Limited and the landowner/leasee at Pinevale Farm find a solution for the future.

1.1 There are multiple springs on Pinevale Farm that feed into the South Brook. Previous work undertaken by Cam River Enhancement Fund at Pinevale Farm included the native wetland and riparian planting of two fenced and stock excluded areas.

1.2 Earthworks were recently undertaken by the lease/landowner within the proximity of the Lehmans Road Spring planting area. There is no evidence that the earthworks undertaken had impacted the planting area, however the activity may have not complied with the rules in the Land and Water Regional Plan. During a site visit by a WDC staff member it was determined that plantings were intact and still fully contained within the double fenced area.

2. RECOMMENDATION

THAT the Land and Water Committee:

(a) **Receives** Report No. 220915160331.

(b) **Notes** that recent earthworks at Pinevale Farm do not appear to have impacted the planting previously funded by the Cam River Enhancement Fund.

(c) **Notes** that the Environment Canterbury Incident Response Team are currently investigating the works to determine if the activity may has breached any rule in the Land and Water Regional Plan.

(d) **Notes** that Council staff will work with Environment Canterbury, Synlait Milk Limited and the landowner/leasee at Pinevale Farm find a solution for the future.

(e) **Circulates** this report to the Mahi Tahi Committee and Council for information.

3. BACKGROUND

3.1. The Cam River Enhancement Fund was established by an Environment Court ruling in July 2001. This ruling required the consent holder (WDC) to provide an amount of $25,000 per year over a five year period for habitat restoration in the Cam River system. The purpose of the fund, as noted in the Environment Court decision, is to be used "for habitat restoration in the Cam River system… as agreed between North Canterbury Fish and Game Council and the consent holder in consultation with the Department of Conservation."

3.1. Sharemilker [redacted] of Pinevale Farm has a signed agreement with the district council which invested around $17,000 (Wai-ora Pinevale planting quote, TRIM: 211210197934) from the Cam River Enhancement and Protection Fund to plant and protect springheads and the stream/ watercourse running from the springs (see Figure 1) at the gum tree on the property along Fernside Road (Gum Tree Spring) and the spring alongside of Lehmans Road (Lehmans Road Spring). It is a two year contract involving planting – completed around October 2020 – and maintenance. (Cam River Enhancement Fund Report to Land and Water Committee 2020, TRIM: 200727094590). (Landowner/Leasee Maintenance Agreement, TRIM: 201008134883).

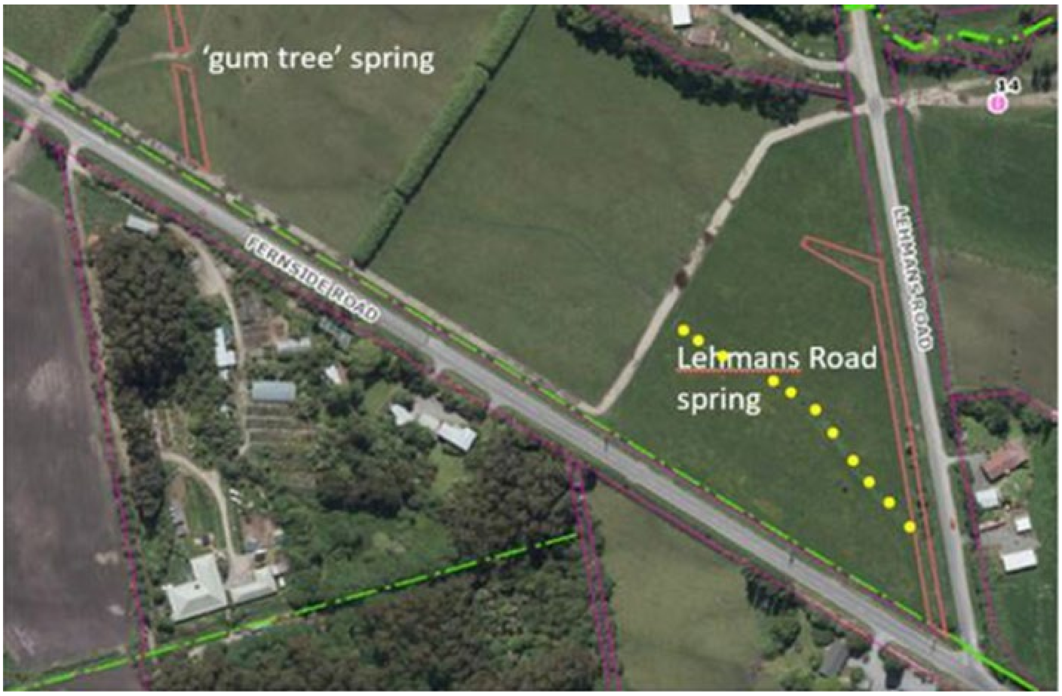
Figure 1: The two spring areas are shown in orange. The 'gum tree' spring on the left, and the 'Lehmans Road' spring on the right.

4. ISSUES AND OPTIONS

4.1. On 28th July 2022, Sandra Stewart noticed earthworks had occurred on and around the 'Lehmans Road' spring and stated that the Cam River Enhancement Fund plantings may have been impacted by these works. Photos (see Figure 2) were provided to Waimakariri District Council to determine if works were undertaken by Council or the lease/landowner. Confirmation was provided that the works were not undertaken by Council or any of its maintenance contractors.

Figure 2: Earthworks near the ‘Lehmans Road’ spring

4.2. On 3 August 2022, Mike Kwant (WDC Community Projects Officer) completed a follow up site visit to determine the state of the planting near the drainage works at the Lehmans Road plantings. Mike Kwant stated that there was no evidence the works area was a previously planted site. The earthworks follow the yellow dotted line within the Lehmans Road spring adjacent paddock (see Figure 3). Mike Kwant stated that the Lehmans Road plantings were intact and still fully contained within the double fenced area where earthworks had not occurred. The plantings at the Gum Tree Spring near Fernside road were not able to be viewed due to roadworks on Fernside Road.



4.3. Due to the nature of the earthworks, and the minimal impact on the plantings at the Lehmans Road Spring, this incident has since been passed onto the Environment

Canterbury Incident Response team for further investigation. Once Environment Canterbury has investigated the matter further, Waimakariri District Council will aim to work with the landowner/lease, Synlait Milk Limited and Environment Canterbury on a solution for the future.

4.4. The Waimakariri District Council is currently seeking to place a designation over the property on the corner of Lehmans Road and Fernside Road to allow for intersection and safety improvements along the Rangiora Route in the future (designations are areas on land set aside by Council for network utilities or public works). The plan is to take approximately 9000 square meters at 1 Lehmans Road, Rangiora over the next 10 years. The timeframe of these developments will be determined by council planning in the future. This future roading improvement may impact on the Cam River Enhancement Fund plantings located at the Lehmans Road Spring.

Implications for Community Wellbeing

There are not implications on community wellbeing by the issues and options that are the subject matter of this report.

4.5. The Management Team has reviewed this report and support the recommendations.

5. COMMUNITY VIEWS

5.1. Mana whenua

Te Ngāi Tūāhuriri hapū are likely to be affected by, or have an interest in the subject matter of this report. Therefore this report will be circulated at a Mahi Tahi Committee meeting.

5.2. Groups and Organisations

There are groups and organisations likely to be affected by, or to have an interest in the subject matter of this report, such as the North Canterbury Fish and Game Council.

The Cam River Enhancement Fund subcommittee, under which budget allocation was made but was disestablished in 2019, had representation from North Canterbury Fish and Game, Te Ngāi Tūāhuriri Rūnanga, the Cam River Working Party, as well as the agency representatives from the Department of Conservation and Environment Canterbury.

5.3. Wider Community

The wider community is not likely to be affected by, or to have an interest in the subject matter of this report.

6. OTHER IMPLICATIONS AND RISK MANAGEMENT

6.1. Financial Implications

There are no financial implications of the decisions sought by this report.

6.2. Sustainability and Climate Change Impacts

The recommendations in this report do not have sustainability and/or climate change impacts. The Cam River Enhancement Fund projects, including the planting in this area, are intended to move towards waterway management that is more self-sustaining and resilient to climate change.

6.3 Risk Management

There are not risks arising from the adoption/implementation of the recommendations in this report.

6.3 Health and Safety

There are no health and safety risks arising from the adoption/implementation of the recommendations in this report.

7. CONTEXT

7.1. Consistency with Policy

This matter is not a matter of significance in terms of the Council's Significance and Engagement Policy.

7.2. Authorising Legislation

Waterway management and the discharge of contaminants to waterways is controlled by the Resource Management Act (1991). Resource consents are issued under this Act.

7.3. Consistency with Community Outcomes

The following Council's community outcomes are relevant to the actions arising from recommendations in this report.

- There is a healthy and sustainable environment

7.4. Authorising Delegations

The Land and Water Committee has the delegation to consider matters related to the Cam River Enhancement Fund on behalf of Council.