Fonterra Kapuni

Monitoring Programme

Annual Report

2021-2022

Technical Report 2022-71

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Taranaki Regional Council

Taranaki Regional Council
Private Bag 713
Stratford

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Executive summary

Fonterra Limited (the Company) operates a lactose manufacturing factory plant located on Manaia Road at Kapuni, in the Kaupokonui catchment. The plant processes milk and whey permeate from dairy product manufacture around the North Island. There is also an inhalation grade lactose plant on the site operated by DFE Pharma (DFE plant), with stormwater discharges from the areas around this activity combined with those of the lactose plant under consents held by the Company. Wastewater from the factory site is disposed of by irrigation onto land on two nearby farms. This report for the period July 2021 to June 2022 describes the monitoring programme implemented by the Taranaki Regional Council (the Council) to assess the Company's environmental performance during the period under review. The report also details the results of the monitoring undertaken and assesses the environmental effects of the Company's activities.

During the monitoring period, the Company demonstrated a high level of environmental performance and high level of administrative performance.

During the year under review the Company held 17 resource consents, which included a total of 155 conditions setting out the requirements that the Company must satisfy. The Company holds two consents to allow it to take and use water, five consents to discharge stormwater and/or cooling water into the Kaupokonui and Motumate Streams, four consents to discharge wastes to land, five land use consents, and one consent to discharge emissions into the air at this site. Two of the consents, to discharge factory wastewater to land, were varied in July 2015 to include dairy shed effluent which previously had been discharged to surface water. Another two of the consents were granted in February 2016 to provide for the discharge of farm dairy solids and pond sludge to land. Four of the Company's consents expired in June 2017, with the applications put on hold so that the effects of these activities could be considered in combination with the effects of the seven further activities for which the consents expired in June 2019. Applications to renew these consents were received on 1 February 2019 and were put on hold until 19 December 2019 awaiting further information. There have been a number of further extensions to the timeframe by which the further information will be provided. The applications were still on hold at the end of the year under review. There are a total of 11 consented activities where the Company is operating under the expired consents until a decision is made on the renewal, as provided for by Section 124 of the *Resource Management Act 1991* (RMA). The applications indicate that the Company wishes to amalgamate activities under single consents where appropriate.

The Council's monitoring programme for the period under review included 6 inspections, 164 water samples from groundwater, streams and discharges that were collected for physicochemical analysis, two macroinvertebrate surveys of receiving waters, one deposition gauge survey, continuous in-stream temperature monitoring at two sites downstream of the site, flow recording in the Kaupokonui Stream, evaluation of the progress of riparian plans that are eligible for funding provided by financial contributions from the Company, and review of data provided by the Company.

Cooling water discharge volume metering had been introduced at the site as per the agreement between the Council and the Company, in relation to assessment of the consumptive nature of the take and future water allocation for the Kaupokonui Stream. Telemetry of abstraction from and discharge to the stream was also installed. On the whole, the provision of data was satisfactory during the year under review, although there were issues with the electronics of the metering system in the first three months of the year under review that resulted in the underreporting of the water abstracted during this time. Data recorded across the year under review indicated that there was little, if any, consumptive use outside the ± 10% cumulative measurement error of the metering devices. However, it is noted that this is excluding losses that may be occurring as the cooling water is discharged via the spray nozzles.

Physicochemical and ecological monitoring did not note any problems in regard to the abstraction of water from the Kaupokonui Stream for cooling water and general purposes, from site discharges to the

Kaupokonui Stream, or in the Waiokura or Motumate Streams from the discharges of wastewater to land on the Company's farms. It is noted that the removal of the Glenn Road weir is likely to result in a significant change in the fish community composition that will be able to access the potential fish barriers present in the reach of stream that influenced by the Company's activities. Consultation is on-going regarding the improvements that will need to be made to the weir and fish pass as the fish communities re-establish in the vicinity of the Company's site.

Temperature increase limits in the consent permitting cooling water discharges to the Kaupokonui Stream were complied with throughout the review period. The main cooling system was replaced in August 2015 with the system designed to ensure that the temperature differential and downstream temperature limits would be complied with. From November 2018 until part way through the 2019-2020 year, the Company ran the cooling system at the maximum cooling capacity. This resulted in the discharge temperature being significantly reduced, with a measurable reduction in the instream temperature differential. The reduced discharge temperature would have also minimised the potential for a thermal barrier to fish within the mixing zone. During the 2019 to 2022 years, further structural and operational changes have been made to the cooling water discharge system that ensure that the temperature differential restrictions on the consent were being met, whilst enabling the Company to operate the system in the most cost effective way. This more energy efficient operation of the cooling tower during the year under review has continued to result in an improvement when compared to the operation of the cooling system prior to November 2018. However, the temperature of the cooling water was increased when compared to the latter part of the 2018-2019 year, and there was loss of some of the gains that had been made in terms of the reduction in temperature within the mixing zone under the operating conditions adopted in the second half of the 2018-2019 year.

Irrigation onto the two dairy farms was, in general, well managed during the year under review, including the dairy shed effluent. No effect on the receiving waters from irrigation were found during the inspections, sampling or biological monitoring of the Kaupokonui, Motumate and Waiokura Streams.

Effects on the groundwater in the vicinity of the farms were varied, but most showed an impact on both mineral and organic component levels. This had been addressed through extension of the irrigation disposal system in 2007-2008, and by more intensive wastewater and groundwater monitoring. During the year under review, there was a higher nitrogen load applied to the paddocks than has been the case since the extension of the irrigation system. The nitrogen application rates ranged from 151 to 509 kg/ha/year with average application rates of 350, 423 and 425 kg/ha/year on Farms 1, 2 and 3 respectively. The annual median of results for the Farm 2 impact bore GND0638 was above the drinking water standard for nitrate-N for the year under review. Although the Company reduced nitrogen loadings on the paddock in which this bore is located, the additional two paddocks up gradient of this bore that were identified for a reduced irrigation load were found to have had a higher than average nitrogen load applied. On one occasion a combination of elevated soil moisture, elevated groundwater level, farm management practices and a series of irrigation events all contributed to a groundwater nitrate concentration that was more than twice the drinking water standard at Farm 3 impact bore GND0640. This highlights the importance of ensuring that the effects caused by stock management practices do not increase the potential for effects from the wastewater irrigation activities.

Two of the control bores (Farm 2 and Farm 3 control bores) continued to show elevations in groundwater nitrate-N concentrations that are, at times, in excess of drinking water standards. This is still to be explained after suitable investigation, with the anticipation that this will be a requirement of the renewed consent.

Stormwater from the site continued to be diverted to containment ponds, with the stormwater batch released after quality checks. Discharge samples were not collected during the year under review as the ponds were empty or at a low level at the time of the site inspection. The Company forwarded a copy of the stormwater logs to the Council and the ponds were only discharged when the quality of the stormwater was

satisfactory. The Company also checked the visual quality of the Kaupokonui Stream during the discharges and no adverse effects were found.

The lactose deposition rates recorded at all sites were above their respective historical medians at sites AIR002302, AIR002304, and AIR002305. The guideline value was not exceeded at any of the monitoring sites and no complaints were received by Council in relation to deposited particulates during the year under review. Inspections also found no evidence of depositions. No odours were noted off site during the year under review. Annual isokinetic stack sampling contracted by the Company found that the particulate emission rate of the flash dryer complied with the limit on the consent.

During the year, the Company generally demonstrated a high level of environmental and high level of administrative performance with the resource consents as defined in Appendix II. However, an improvement is required in the management of the Company's activities in relation to the discharge of wastewater to land on Farms 2 and 3. The concentrations of nitrate-N in one of the groundwater monitoring bores, returned an annual median that was above the drinking water standard. The Company continued to manage the use of the mitigation measures, identified in the 2020-2021 year due to the increased nitrate nitrogen in GND0638. Although a significant reduction has been achieved, further improvement is still desirable in the groundwater quality in the vicinity of this bore. A combination of farm management practices and wastewater irrigation resulted in a new maximum concentration being found at a monitoring bore on Farm 3 that was more than twice the drinking water standard on one occasion. The Company is reviewing the management of nutrients at the site and investigating options for wastewater treatment.

For reference, in the 2021-2022 year, consent holders were found to achieve a high level of environmental performance and compliance for 88% of the consents monitored through the Taranaki tailored monitoring programmes, while for another 10% of the consents, a good level of environmental performance and compliance was achieved.

This report includes recommendations for the 2022-2023 year, including a recommendation relating to the optional review of consents 10214-1.0, 10232-1.0, and 9546-1.

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1 Introduction

1.1 Compliance monitoring programme reports and the Resource Management Act 1991

1.1.1 Introduction

This report is for the period July 2021 to June 2022 by the Taranaki Regional Council (the Council) on the monitoring programme associated with resource consents held by Fonterra Limited (the Company). The Company operates a lactose processing facility situated on Manaia Road at Kapuni, in the Kaupokonui catchment, along with two operational dairy farms used for wastewater irrigation (Figure 1).

The report includes the results and findings of the monitoring programme implemented by the Council in respect of the consents held by the Company that relate to abstractions and discharges of water to land and water within the Kaupokonui, Motumate and Waiokura catchments, and the air discharge permit held by the Company to cover emissions to air from the site.

One of the intents of the *Resource Management Act 1991* (RMA) is that environmental management should be integrated across all media, so that a consent holder's use of water, air, and land should be considered from a single comprehensive environmental perspective. Accordingly, the Council generally implements integrated environmental monitoring programmes and reports the results of the programmes jointly. This report discusses the environmental effects of the Company's use of water, land and air, and is the 29th combined report and 32nd water related report by the Council for the Company.

1.1.2 Structure of this report

Section 1 of this report is a background section. It sets out general information about:

- consent compliance monitoring under the RMA and the Council's obligations;
- the Council's approach to monitoring sites though annual programmes;
- the resource consents held by the Company, for their Kapuni lactose plant;
- the nature of the monitoring programme in place for the period under review; and
- a description of the activities and operations conducted in the Company's site/catchment.

Section 2 presents the results of monitoring during the period under review, including scientific and technical data.

Section 3 discusses the results, their interpretations, and their significance for the environment.

Section 4 presents recommendations to be implemented in the 2022-2023 monitoring year.

A glossary of common abbreviations and scientific terms, and a bibliography, are presented at the end of the report.

1.1.3 The Resource Management Act 1991 and monitoring

The RMA primarily addresses environmental 'effects' which are defined as positive or adverse, temporary or permanent, past, present or future, or cumulative. Effects may arise in relation to:

a. the neighbourhood or the wider community around an activity, and may include cultural and social-economic effects;
b. physical effects on the locality, including landscape, amenity and visual effects;
c. ecosystems, including effects on plants, animals, or habitats, whether aquatic or terrestrial;

d. natural and physical resources having special significance (for example recreational, cultural, or aesthetic); and

e. risks to the neighbourhood or environment.

In drafting and reviewing conditions on discharge permits, and in implementing monitoring programmes, the Council is recognising the comprehensive meaning of 'effects' inasmuch as is appropriate for each activity. Monitoring programmes are not only based on existing permit conditions, but also on the obligations of the RMA to assess the effects of the exercise of consents. In accordance with Section 35 of the RMA, the Council undertakes compliance monitoring for consents and rules in regional plans, and maintains an overview of the performance of resource users and consent holders. Compliance monitoring, including both activity and impact monitoring, enables the Council to continually re-evaluate its approach and that of consent holders to resource management and, ultimately, through the refinement of methods and considered responsible resource utilisation, to move closer to achieving sustainable development of the region's resources.

1.1.4 Evaluation of environmental and administrative performance

Besides discussing the various details of the performance and extent of compliance by the consent holders, this report also assigns a rating as to each Company's environmental and administrative performance during the period under review. The rating categories are high, good, improvement required and poor for both environmental and administrative performance. The interpretations for these ratings are found in Appendix II.

For reference, in the 2021-2022 year, consent holders were found to achieve a high level of environmental performance and compliance for 88% of the consents monitored through the Taranaki tailored monitoring programmes, while for another 10% of the consents, a good level of environmental performance and compliance was achieved.[1]

1.2 Process description

The manufacturing of lactose is based on the processing of milk and whey permeate, which is the by-product of the production of cheese and casein. Whey permeate contains typically contains 78 to 88% lactose; which is most of the lactose present in the original milk source. At this site the lactose is extracted and purified through a process that includes evaporation and crystallisation. The lactose is then dried and packed into different grades that meet a diverse range of customer needs and requirements. The plant typically operates for about 310 days per year. Approximately 50,000 tonnes of lactose is produced per annum with the peak daily processing rate being about 200 tonnes/day of lactose.

The lactose process (Figure 2) uses raw water from the Kaupokonui Stream for the evaporator condensers. Once water has passed through the condensers it is returned to the stream via the cooling tower system. In the summer, the increased stream water temperature may not be suitable for cooling the refined and edible crystallisers in the required time, so bore water may be brought into service. The cooling water systems are single pass, which do not require the use of any treatment chemicals. The cooling water from the condensers passes through a cooling tower and is discharged to the stream via spray nozzles that further reduces the temperature of the condenser cooling water so as to minimise temperature rises in the stream.

Steam used for the lactose process is imported to the plant, via a 3 km pipeline, from the Todd Energy Gas Treatment Plant (Todd) at Kapuni. The first delivery of steam was in December 1997. This has reduced the

[1] The Council has used these compliance grading criteria for more than 18 years. They align closely with the 4 compliance grades in the MfE Best Practice Guidelines for Compliance, Monitoring and Enforcement, 2018

use of water treatment chemicals at the lactose plant considerably, which has therefore reduced the amount of process waste discharged from the site, and reduced the potential for chemical spillages. Steam condensate is returned to Todd via a pipeline for reprocessing.

Plant washdown and other process wastes are disposed of by a land irrigation system. The wastewater is irrigated onto the Company's two farms, which are located close to the lactose plant site. There is a component of the monitoring programme in place to assess the effects of wastewater from the irrigation on groundwater and on surface water quality.

Emissions of lactose powder into the atmosphere from the driers are mitigated by the use of cyclones and a wet scrubber. The cyclones and wet scrubber remove lactose particles from the exhaust of the driers to prevent product loss to the atmosphere.

Figure 1 shows the location of the Company's Kapuni lactose factory, North, South and (extended) No. 3 farms, and the Kaupokonui, Motumate and Waiokura Streams, which are referred to throughout this report.

In the 2014-2015 dairy season, Farm 2 and Farm 3 were merged into one dairy unit and renamed "Kapuni Farms". The name of the other farm remained "Farm 1". Table 1 summarises the nomenclature that has been used to describe the various farms as the farming activities have changed over the years. Due to the way in which the wastewater irrigation information is provided and analysed, and for consistency, where possible the primary nomenclature used in this report is Farm 1, Farm 2 and Farm 3.

Table 1 Farm nomenclature

Primary nomenclature used in this report	Previous nomenclature	Current Farm names
Farm 1	Northern Farm	Kapuni Farm
Farm 2	Southern Farm	Kapuni Farms
Farm 3	No. 3 Farm	
	No. 3 Extension	

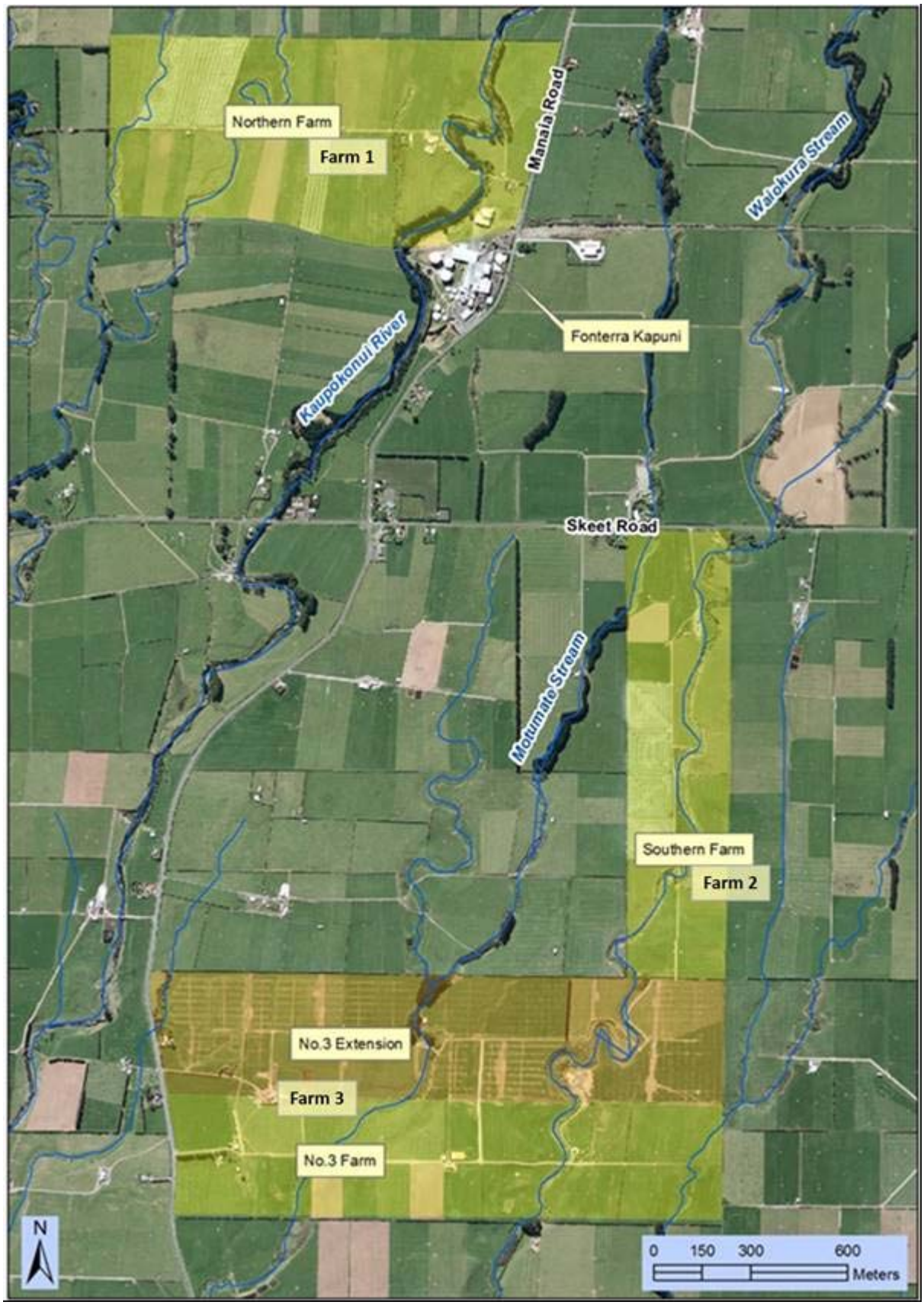

Figure 1 Location of Fonterra Ltd's lactose factory, farms and the Kaupokonui, Motumate and Waiokura Streams

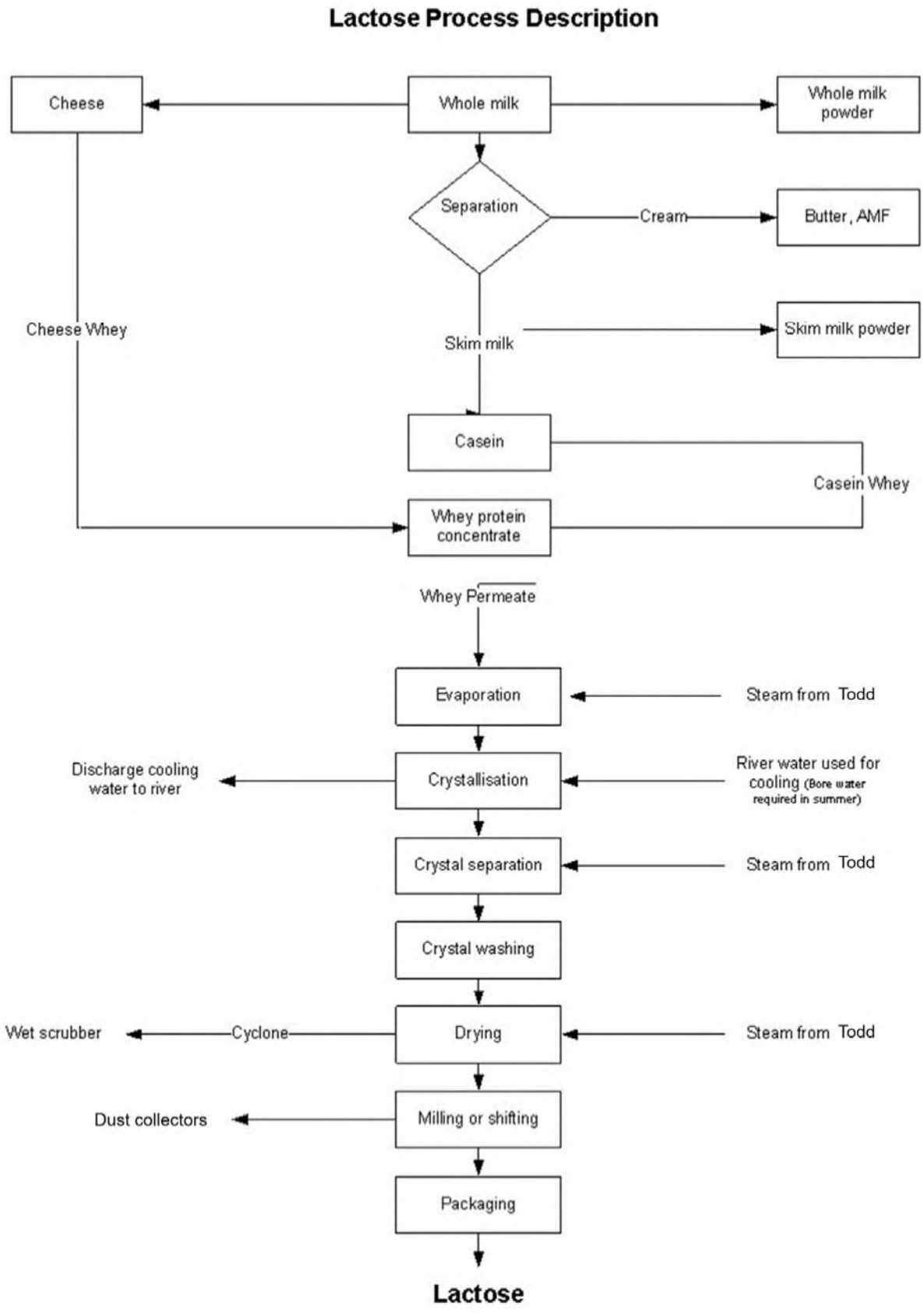

Figure 2 Lactose process diagram

1.3 Resource consents

The Company holds 17 resource consents the details of which, along with relevant consent related activities are summarised in Table 2. Summaries of the conditions attached to each permit are set out in Section 3 of this report, with consent related activities and information that is relevant to the monitoring and compliance assessment for the year under review explained further in this section.

A summary of the various consent types issued by the Council is included in Appendix I, as are copies of all permits held by the Company during the period under review.

It is noted that the consent held to install a dual culvert in the Waiokura Stream (consent 10412-1) had not been given effect to prior to the lapse date of 31 March 2022. This consent has now lapsed, and the Council has been advised that the Company will not be lodging a new application for this activity.

1.3.1 Status of expired consents – Section 124 protection

Section 124 of the RMA provides for consent holders to continue to operate under the terms and conditions of the existing consent until a decision is made on the renewal. This applies at the Council's discretion where an application to renew the consent is made between three and six months prior to its expiry, or as a right when the application is made more than six months prior to expiry.

A number of the Company's consents expired on 1 June 2017. Applications to renew these consents were received on 1 December 2016. These applications were put on hold with the Company's agreement so that the applications for these consents could be decided upon at the same time as the consents that were due to expire on 1 June 2019. This was to allow potential cumulative effects of the activities to be considered and addressed in complementary consent conditions. The applications to renew the consents expiring in June 2019 were received on 1 February 2019.

The applications were put on hold under Section 92 of the RMA pending the provision of further information.

The further information requested was:

1. Justification/evidence to demonstrate that the existing water take is 10% consumptive;
2. Justification for retaining (and not lowering) the existing consented water take rate of 225 litres/second;

Council staff have recently put together some data which suggests that in the last couple of years, the rate of take was less than ~150 L/s 95% of the time.

3. A Cultural Impact Assessment;
4. With regards to the assessment of alternatives provided with the application, the Company is to provide a cost/benefit analysis of distributing cooling water over a larger area i.e. expanding the length of stream that the spray booms cover (resulting in a spray area that is less concentrated), and reasons why this option is/is not a viable alternative.

The Company asked for the standard 15 working days specified in the RMA to be extended to 19 December 2019 to allow Ngati Tu sufficient time to complete the cultural impact statement. This was agreed. A number of further extensions have been requested, with the cultural impact statement being received on 28 June 2021. Due to the release of the National Policy Statement on Freshwater Management 2000 (NPS-FM) and associated National Environmental Standards for Freshwater (NES-FW) after the applications were received, it has been agreed that further work is required to address any matters arising from the legislative requirements associated with these documents. The Company has asked for a further extension to allow this work to be completed prior to the continuation of the processing of the applications.

1.3.2 Abstraction consents 0302-3 and 0920-3 and National Regulations

In addition to the consent requirements, the activity must also comply with the Resource Management (Measurement and Reporting of Water Takes) Regulations 2010 (the Regulations).

The Regulations require the following:

- all water permits allowing the taking of 5 L/s or more to collect and report records to a set minimum requirement;
- measurement at the point of where the water is taken from the river, lake or groundwater system (unless otherwise approved by the Council to be in another location);
- continuous records of daily volumes to be collected using an appropriate flowmeter with the data transferred to the Council on at least an annual basis;
- the flowmeter to meet an accuracy standard, and should be properly installed and calibrated independently every five years; and
- the consent holder is to be responsible for recording and transferring the data to the Council.

All abstractions captured under the Regulations were required to be compliant by 10 November 2016. The Council retains the authority to apply more stringent requirements on consent holders over and above those set out in the Regulations through the setting of consent conditions.

1.3.3 Proposed amalgamation of consents

There have been a number of changes to the site discharge methodologies in recent years namely:

- The diversion of the cooling water previously discharged under consent 0924 to the cooling towers, bringing it under the discharges covered by consent 0919; and
- The diversion of the stormwaters covered by consents 4604, 6423 and the stormwater discharged from one of the outfalls covered by consent 0924 to the northern stormwater pond, which has a single outfall.

This leaves the stormwater discharged from the southern stormwater pond as the only stormwater discharge originally authorised under consent 0924.

In the application to renew the consents for the site, it has been requested that all stormwater discharges be authorised by one consent (replacement of 0924-3, 4604-2, and 6423-3, with 6423-4) and that the discharge of wastewater from the factory and dairy shed effluents to the two farms also be amalgamated under one consent (replacement of consents 0922-3.2 and 0923-3.3 with 0922-4).

Table 2 Summary of consents held by Fonterra Ltd for the lactose plant at Kapuni

Consent number	Purpose	Commencement	Review	Expiry	Renewal application received	Consent status at 30 Jun 2022
Water abstraction permits						
0302-3	To take and use up to 19,500 cubic metres/day [225 litres/second] of water from the Kaupokonui Stream for cooling water and general purposes associated with lactose manufacturing	9 Jun 1999	-	1 Jun 2019	1 Feb 2019	Expired - S.124 Protection (on hold further information)
0920-3	To take up to 700 cubic metres/day of water from a bore in the Kaupokonui Catchment for factory cooling water using plate heat exchangers	4 Feb 1999	-	1 Jun 2017	1 Dec 2016	Expired - S.124 Protection (on hold further information)
Water discharge permits						
0921-3	To discharge up to 850 cubic metres/day of cooling water from plate heat exchangers and plant cooling system into an unnamed tributary of the Motumate Stream at two different locations	4 Feb 1999	-	1 Jun 2017	1 Dec 2016	Expired - S.124 Protection (on hold further information)
0919-3	To discharge up to 19,500 cubic metres/day of cooling water from a lactose manufacturing plant via an outfall, cooling tower and/or spray system into the Kaupokonui Stream	9 Jun1999	-	1 Jun 2019	1 Feb 2019	Expired - S.124 Protection (on hold further information)
0924-3	To discharge up to 1,440 cubic metres/day of stormwater and cooling water from a lactose manufacturing plant through two outfalls into the Kaupokonui Stream	9 Jun 1999	-	1 Jun 2019	1 Dec 2016. Stormwater discharge activity to be combined under 6423-4	Expired - S.124 Protection (on hold further information)
4604-2	To discharge up to 280 litres/second of stormwater from the factory extension site via a 525 mm diameter pipe into the Kaupokonui Stream	4 Feb 1999	-	1 Jun 2017	1 Dec 2016. Activity to be combined under 6423-4	Expired - S.124 Protection (on hold further information)
6423-1	To discharge stormwater from an inhalation grade lactose plant site into the Kaupokonui Stream	4 Feb 1999	-	1 Jun 2017	1 Dec 2016	Expired - S.124 Protection (on hold further information)

Consent number	Purpose	Commencement	Review	Expiry	Renewal application received	Consent status at 30 Jun 2022
Air discharge permit						
4032-5	To discharge emissions into the air from the manufacture, drying, packaging and storage of lactose and associated processes and from the inhalation grade lactose plant	2 Jun 2004	-	1 Jun 2019	1 Feb 2019	Expired - S.124 Protection (on hold further information)
Discharges of waste to land						
0922-3.2	To discharge combined dairy effluent and factory wastewater (evaporator condensate, washings, processing wastes and stormwater) from a lactose manufacturing plant by spray irrigation onto and into land	15 Jul 2015	-	1 Jun 2019	01 Feb 2019	Expired - S.124 Protection (on hold further information)
0923-3.3	To discharge combined dairy effluent and factory wastewater (evaporator condensate, washings, processing wastes and stormwater) from a lactose manufacturing plant by spray irrigation onto and into land	15 Jul 2015		1 Jun 2019	1 Feb 2019. Activity to be combined under 0922-4	Expired - S.124 Protection (on hold further information)
10214-1.0	To discharge solid farm dairy effluent onto and into land	5 Feb 2016	June 2023	1 Jun 2041	-	Current
10232-1.0	To discharge pond sludge from farm dairy effluent onto and into land	5 Feb 2016	June 2023	1 Jun 2041	-	Current
Land use permits						
4623-3.0	To use a weir in the bed of the Kaupokonui Stream, and to dam water for water supply purposes	15 Dec 2017	-	1 Jun 2019	1 Feb 2019	Expired - S.124 Protection (on hold further information)
6948-1	To erect, place, maintain and use pipeline crossings over the Motumate and Waiokura Streams, for the purposes of conveying irrigation wastewater	18 Sep 2006	-	1 Jun 2023	-	Current
7121-1	To erect, place and maintain a stone lined bank on the left bank of Dunns Creek for erosion control purpose	23 May 2007	-	1 Jun 2023	-	Current
9546-1	To install a dual culvert in the Waiokura Stream, including the associated streambed and reclamation	18 Apr 2013	June 2023	1 Jun 2029	-	Current
10412-1.0	To install a dual culvert in the Waiokura Stream, including the associated disturbance of the stream bed	10 Mar 2017	-	-	-	Lapsed as of 1 March 2022

1.4 Monitoring programme

1.4.1 Introduction

Section 35 of the RMA sets obligations upon the Council to gather information, monitor and conduct research on the exercise of resource consents within the Taranaki region. The Council is also required to assess the effects arising from the exercising of these consents and report upon them.

The Council may therefore make and record measurements of physical and chemical parameters, take samples for analysis, carry out surveys and inspections, conduct investigations and seek information from consent holders.

The monitoring programme for the Company's Kapuni site consisted of five primary components.

1.4.2 Programme liaison and management

There is generally a significant investment of time and resources by the Council in:

- ongoing liaison with resource consent holders over consent conditions and their interpretation and application;
- discussion over monitoring requirements;
- preparation for any consent reviews, renewals or new consent applications;
- advice on the Council's environmental management strategies and content of regional plans; and
- consultation on associated matters.

1.4.3 Site inspections

Six routine compliance monitoring inspections were carried out during the monitoring period, with additional inspections undertaken at times when the water intake was being desilted. The reduced inspection frequency was as per the recommendations of the 2020-2021 Annual Report. This recommendation was made on the basis that very few issues had been found at inspection over several years. There was provision in the monitoring programme for additional targeted activity related inspections to be carried out if need arose. Additional inspections were carried out following notifications relating to the cleaning of the site effluent tank and desilting of the water intake area.

With regard to consents for the abstraction of or discharge to water, the main points of interest were plant processes with potential or actual discharges to receiving watercourses, including contaminated stormwater and process wastewaters at the factory site and at the farms used for irrigation. Air inspections focused on plant processes with associated actual and potential emission sources and characteristics, including potential odour, dust, noxious or offensive emissions and spray drift during irrigation events. Sources of data being collected by the Company were identified and accessed, so that performance in respect of operation, internal monitoring, and supervision could be reviewed by the Council. The neighbourhood was surveyed for environmental effects. An additional annual dairy inspection was also undertaken focusing on the management of the farm dairy effluent systems.

1.4.4 Chemical sampling

The Council undertook sampling of both the discharges from the site and the water quality upstream and downstream of the discharge point and mixing zone.

A 24 hour composite or grab sample was collected of the spray cooling wastewater on ten occasions. The samples were analysed for BOD_5 (total and filtered), pH, conductivity and turbidity.

The Kaupokonui Stream was sampled on five occasions at three sites. The samples were analysed for temperature, BOD_5 (total and filtered), pH, conductivity, turbidity, dissolved reactive phosphorus, nitrates, ammonia-N and total nitrogen. The Motumate Stream was sampled at four sites on six occasions. The samples were analysed for temperature, BOD_5, conductivity, dissolved reactive phosphorus, ammoniacal nitrogen, nitrate, pH, and turbidity, on six occasions, and anion/cation balance on three occasions. The Waiokura Stream was also sampled at four sites on six occasions. The samples were analysed for temperature, BOD_5, conductivity, dissolved reactive phosphorus, ammoniacal nitrogen, nitrate, pH, sodium and turbidity.

Samples are scheduled to be collected from the cooling water discharge daily composite, and the northern and southern stormwater pond outfalls. The samples are analysed for total BOD_5, conductivity, pH, turbidity, suspended solids and oil and grease. No stormwater pond samples were collected during the year under review as the pond levels were low and no discharges were occurring at the time of the site inspections

Groundwater from 12 bores on the three farms were sampled on six occasions and the samples were analysed for temperature, COD, conductivity, dissolved reactive phosphorus, ammoniacal nitrogen, nitrate, total nitrogen and pH on each occasion. Additional parameters were determined on three occasions, including those necessary for the determination of the anion/cation balance.

Deposition gauges were placed at selected sites in the vicinity of the factory site on one occasion. The collected samples were analysed for COD, enabling the lactose deposition rate to be estimated.

1.4.5 Biomonitoring surveys

A biological survey of the macroinvertebrate communities was performed on two occasions in the Kaupokonui Stream to determine whether or not the discharge of stormwater and cooling water from the site has had a detrimental effect upon the communities of the stream. Two biological surveys were also performed in Dunns Creek and the Waiokura Stream to monitor the effects from irrigation of wastewater and stormwater onto land in the catchments of these two streams. During the biomonitoring surveys in the 2019-2020 year, consideration was given as to the value of adding biomonitoring in the Motumate Stream to the programme, given the extent of the irrigation area that this small stream runs through. It was found that the stream habitat in the stretch through the irrigation areas did not have suitable habitat to provide meaningful evaluation of the potential impacts of the irrigation activities at this stage. This was predominantly because any potential environmental effects resulting from the wastewater irrigation would be obscured by the elevated nitrates in the upper catchment of this stream. This was investigated by Council during the 2020-2021 year, with no point source discharges found in the upstream environment. The introduction of biomonitoring in the Motumate Stream will only be re-visited if reductions in the nitrate concentration of the Motumate Stream above the site are observed, and/or if stream habitat improves.

A fish monitoring survey was undertaken during the year under review along with observations of any fish species spotted above the weir at the time of the site inspections being noted.

Fish surveys had been scheduled to occur on a triennial basis, with the most recent survey being the fifth triennial site fish survey undertaken in the Kaupokonui Stream in March 2020. Under this current schedule, the next survey would have been due next in the 2022-2023 monitoring year.

The fish barrier presented by the Glenn Road weir was addressed by its removal in February 2021. Following the removal of the weir, Environmental DNA (eDNA) monitoring was undertaken in an attempt to assess the effectiveness of removing the barrier on the upstream fish communities. Sampling upstream of the weir indicated that inanga and torrentfish were now present, showing that the enhancement project was successful. It is now expected that these new species, and perhaps higher abundances of other species already present upstream of the Glenn Road weir, would begin to penetrate further up into the catchment, and that they may eventually reach the Fonterra spray cooling water discharges and weir. As a result the scheduling of the fish surveys under this programme was revised to include an annual electric fishing survey

and provision for two spotlighting surveys if required, whilst the fish communities are stabilising following the removal of the downstream fish barrier.

1.4.6 Review of consent holder's data

A large amount of data is supplied by the Company in relation to stream abstraction records, cooling water discharge temperatures and rates, irrigation records, wastewater composition, soil test results, receiving water temperatures, and details on the discharges from the stormwater ponds. This data is assessed by Council staff to confirm compliance with consent conditions, as well as to assess site performance in relation to the "best practicable option" conditions, and to assess if there are any actual or potential environmental effects occurring that are not adequately addressed by the conditions of the consents.

2 Results

2.1 Water

2.1.1 Review of consent holder's data

The Company supplied various data to the Council in the form of monthly environmental reports and electronic data. The data covers information in relation to calibration of the consent holder's instream temperature monitors, stream temperature compliance data, effluent irrigation volumes, effluent composition, stream and bore extraction volumes, and cooling water discharge temperatures and rates. These data were regularly reviewed by Council in terms of compliance with consent conditions and, where necessary, the Company was immediately advised of any necessary follow-up action to be taken. A review of this data follows.

2.1.1.1 Stream abstraction records

The Company holds consent 0302-3 which allows the abstraction of up to 19,500 m^3/day (225 L/s) from the Kaupokonui Stream. Special conditions attached to the consent require the Company to undertake daily monitoring of the water abstracted from the stream, and to forward such monitoring data to the Council. The Company supplies both the daily abstraction volume and the abstraction rate. One minute data is provided, which Council processes to provide the 15 minute average data used to assess consent compliance.

Under the *Resource Management (Measurement and Reporting of Water Takes) Regulations 2010*, the Company was required by 10 November 2012 to take continuous measurements and keep daily records of volume taken, and thereafter supply the daily abstraction data by 31 July each year for the preceding 1 July to 30 June period.

Abstraction rate is measured by a magnetic flow meter on the supply line from the stream pumps to the factory that was commissioned on 24 December 2008. Independent verification of the accuracy of the meter was last undertaken in May 2021, with a copy of the verification report provided to Council. Table 3 contains a summary of statistics from the daily abstraction data electronic record provided by the Company, with the abstraction rates illustrated in Figure 3 and Figure 4[2].

It is noted that during the year under review, the Company notified the Council that, due to an issue with the electronics of the abstraction measuring system, the abstraction volumes from July to the beginning of October were being underreported. This was logged as an unauthorised discharge and is discussed further in Section 2.3. Although this would have had little impact on the data reported for July 2021 due to the low volumes abstracted during the winter shutdown, the data provided for August and September should be treated with caution.

The daily stream abstraction data summaries in Table 3 and Figure 3 illustrate that the Company continued to take a significant volume of water from the stream during the 2021-2022 monitoring period. However, it is noted that the volumes abstracted were again significantly lower than the permitted take of 19,500 m^3/day.

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[2] Earlier Annual Reports used a combination of data from the daily abstraction data provided by the Company in a monthly report, and the abstraction rates from the electronic data sent through to Council on a daily basis. In the 2019-2020 Annual Report it was confirmed that any potential reporting discrepancies or data transmission issues were negligible, following the resolution of the issues causing the more significant discrepancies that had been occurring prior to the 2018-2019 year. Therefore the data assessed here is based on the electronic record only.

Table 3 Summary of water abstraction volumes from the Kaupokonui Stream

Month	Average daily abstraction (m^3/day)	Minimum daily abstraction (m^3/day)	Maximum daily abstraction (m^3/day)	Number of days per month daily abstraction >19,500 m^3	Average abstraction rate (L/s)	Maximum abstraction rate (L/s)	Total time per month abstraction rate> 225 L/s	Missing records
Jul 21[a]	1,558	0	6,137	0	18	102	0	No gaps
Aug 21[a]	3,931	1,534	7,705	0	44	136	0	No gaps
Sep 21[a]	5,595	2,405	9,843	0	62	173	0	No gaps
Oct 21	9,635	7,888	12,040	0	111	183	0	No gaps
Nov 21	10,965	8,025	14,832	0	128	201	0	No gaps
Dec 21	9,637	6,937	11,931	0	111	192	0	No gaps
Jan 22	9,325	6,611	11,953	0	109	192	0	No gaps
Feb 22	9,235	5,445	12,808	0	108	194	0	No gaps
Mar 22	8,341	2,565	12,237	0	97	190	0	No gaps
Apr 22	8,009	6,159	11,462	0	93	161	0	No gaps
May 22	5,455	2,890	8,281	0	65	137	0	No gaps
Jun 22	3,123	243	5,209	0	18	102	0	6 days[b]

Key: a abstraction flow rates known to be an underestimate

b Gap due to PLC replacement during winter shut down – Council advised that any river water volume abstracted was very low in relation to normal activity.

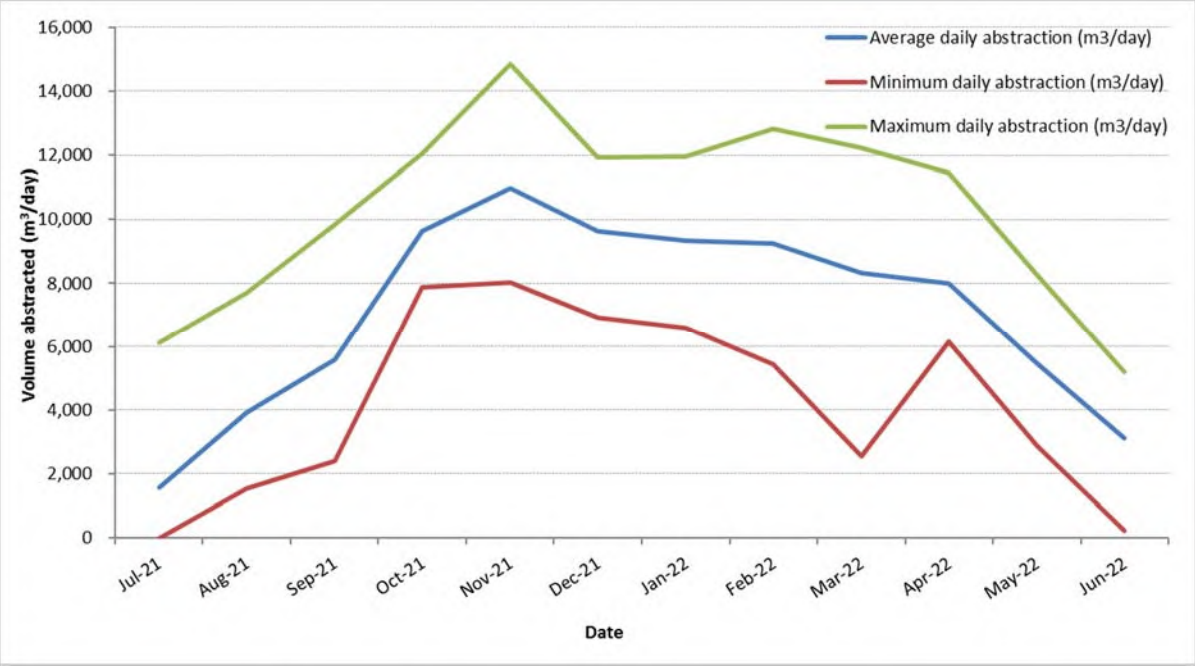

Figure 3 Monthly summary of water abstraction volumes from the Kaupokonui Stream

An approximate total volume of at least 2,545,581 m^3 was abstracted during the 2021-2022 year, noting that the abstraction volumes for July to September inclusive were likely to have been underreported. The abstraction data provided indicates that at least 13% more water was abstracted during the year under

review than the amount taken in 2020-2021, and 5% less than the median annual amount taken during the 2009 to 2021 periods (2,670,184 m^3/year). In terms of attempting to correct for the erroneous data, analysis shows that the monthly discharge volumes are only higher than the abstraction volumes for August and September. If it is assumed that the abstraction volume approximated more closely to the discharge rates for these months, the approximate total volume abstracted during the year under review may have been closer to 2,657,141 m^3. This estimated annual volume is 17% more than the 2002-2021 annual abstraction, and is similar to the historical median.

The daily volume abstracted was maintained well below the 19,500 m^3 daily limit. During 2021-2022, a maximum daily abstraction of 14,832 m^3 was recorded on 7 November 2021, which is 76% of the consent limit.

The changes in the river abstraction volumes since the 2009-2010 year are illustrated in Figure 4, which shows a general trend of decreasing water abstraction at the site since the 2012-2013 year. It is noted that the graph below is based on the data provided in the Company's monthly reports for the 2009-2020 years and the electronic data provided by the Company for the 2020-2021 year onwards.

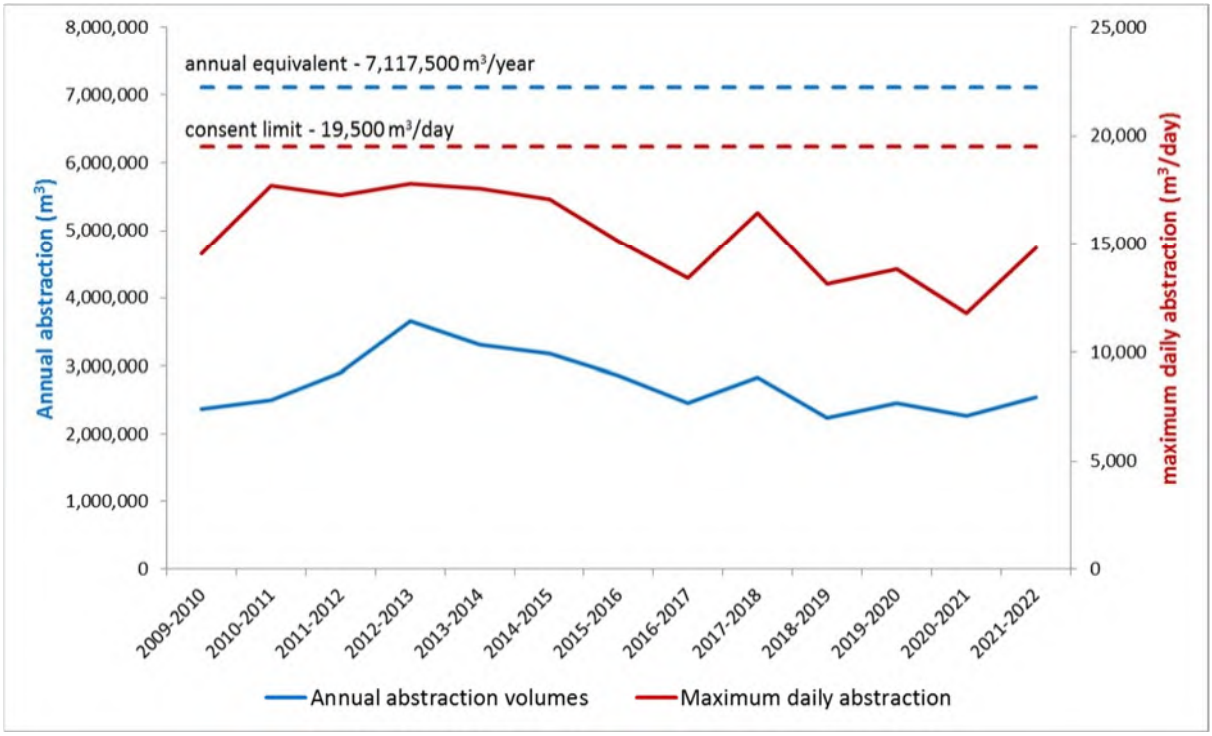

Figure 4 Daily and annual stream abstraction volumes July 2009 to June 2022

The Company's abstraction of water from the Kaupokonui Stream was undertaken in a satisfactory manner and the abstraction rates complied with consent conditions as illustrated in Table 3 and Figure 5. The abstraction rate remained at or below 169 L/s for 99% of the year. Although there was just under 6 days of missing record, this was during the winter shutdown when water usage was very low.

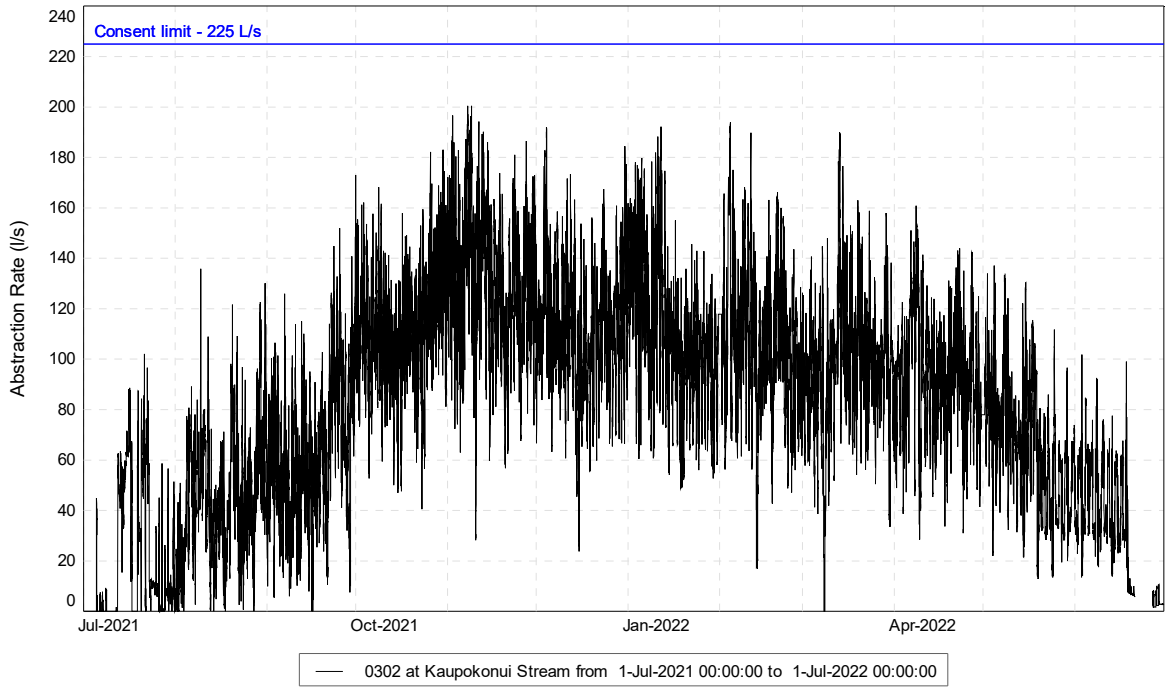

Figure 5 Abstraction rate from the Kaupokonui Stream (consent 0302-3)

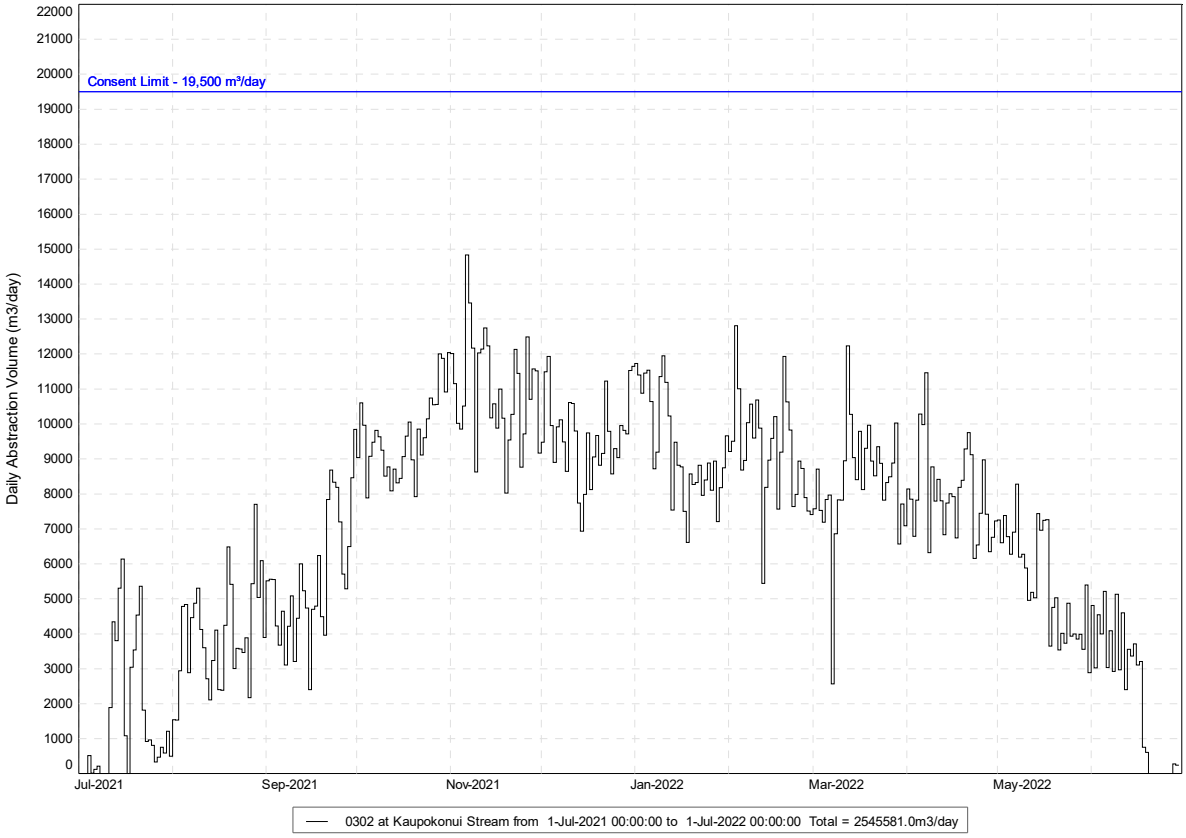

Figure 6 Daily abstraction volumes from the Kaupokonui Stream, electronic record

2.1.1.2 Bore abstraction records

In relation to the exercise of resource consent 0920-3, the Company supplied the Council, on a monthly basis, monitoring data on the daily volume abstracted from the bore in the Kaupokonui catchment.

At an inspection on 20 September 2019 it was noted that the bore had been closed in. During the 2021-2022 monitoring period, the bore was not used, with no further activity reported during the year under review.

2.1.1.3 Cooling water discharge rates

In June 2014, Council invoked the review of consent conditions of consents 0919-3 and 0924-3, which provide for the discharge of the abstracted cooling water back to the Kaupokonui Stream, for water allocation purposes. The notice of review was withdrawn by Council at the Company's request after an agreement was reached that the necessary monitoring information would be provided voluntarily. As condition 1 of these consents require that *"the consent holder shall, in conjunction with the Taranaki Regional Council, undertake such physicochemical and ecological monitoring of the cooling water wastes, and the receiving waters (Kaupokonui Stream) as deemed necessary by the Chief Executive, Taranaki Regional Council, subject to section 35(2)(d) and section 36 of the Resource Management Act 1991"*, this agreed monitoring is within the scope of these conditions.

In summary, the agreement related to the provision of electronic data recording the rate and volume of the cooling water discharges from both outfalls with an accuracy of ± 5%, and this was to be implemented by 31 August 2015. The implementation period was extended to 30 September 2015 following delays associated with the installation of a new cooling tower system.

As previously discussed, the purpose of the review of the consents that were initiated in 2014 were to allow conditions to be put on the consent so that sufficient data could be collected regarding the consumptive use of the abstraction to inform the water allocation decisions that need to be made at the time of the abstraction consent renewal. There were a number of issues in relation to meeting this monitoring requirement that have been discussed in previous reports, with compliance being achieved from 14 September 2019.

The details surrounding these issues are described in the 2019-2020 Annual Report, in which it was also concluded that from the above date the data was sufficiently robust to enable an estimate of the consumptive water use at the site to be determined. However, it must also be borne in mind that further evaporative and/or wind drift losses will occur to varying degrees depending on the weather conditions. In addition to this, during the 2020-2021 and 2021-2022 years, the abstraction and discharge rates may have been impacted to some degree by the Company using abstracted water to leak test tanks. During the periods of time that the Company was filling and then emptying the tanks (between 25 February and 21 April), there was the potential for these activities to result in atypical daily abstraction/discharge volumes. However, the Company advised that the tank was filled and emptied slowly to reduce significant deviation from normal operation, and there were no obvious anomalies.

The abstraction rate record for the year under review is shown in Figure 7. During the year under review, a total of 2,549,826 m^3 (± 5%) was recorded as having discharged from the cooling tower. This is in comparison to the recorded annual abstraction of 2,545,581 m^3 (±5%). These figures indicate that, when considered on annual basis, any usage was within the limits of the accuracy of the measuring devices during the year under review.

Figure 8 shows the differential between the 15 minute data provided by the Company for the discharge and abstraction rates measured during the year under review, with negative values indicating consumptive use and positive values indicating an increase return rate. The maximum permitted error on the differential between the meters is ± 10 %. The error margins, if the abstraction and discharge were approximating to the maximum take rate of 225 L/s, are also shown in Figure 7, although it is noted that the highest average daily abstraction rate was only 172 L/s. For the majority of the year under review, the measured differential in the recorded flow rates was also predominantly within the margin of error of the recording devices.

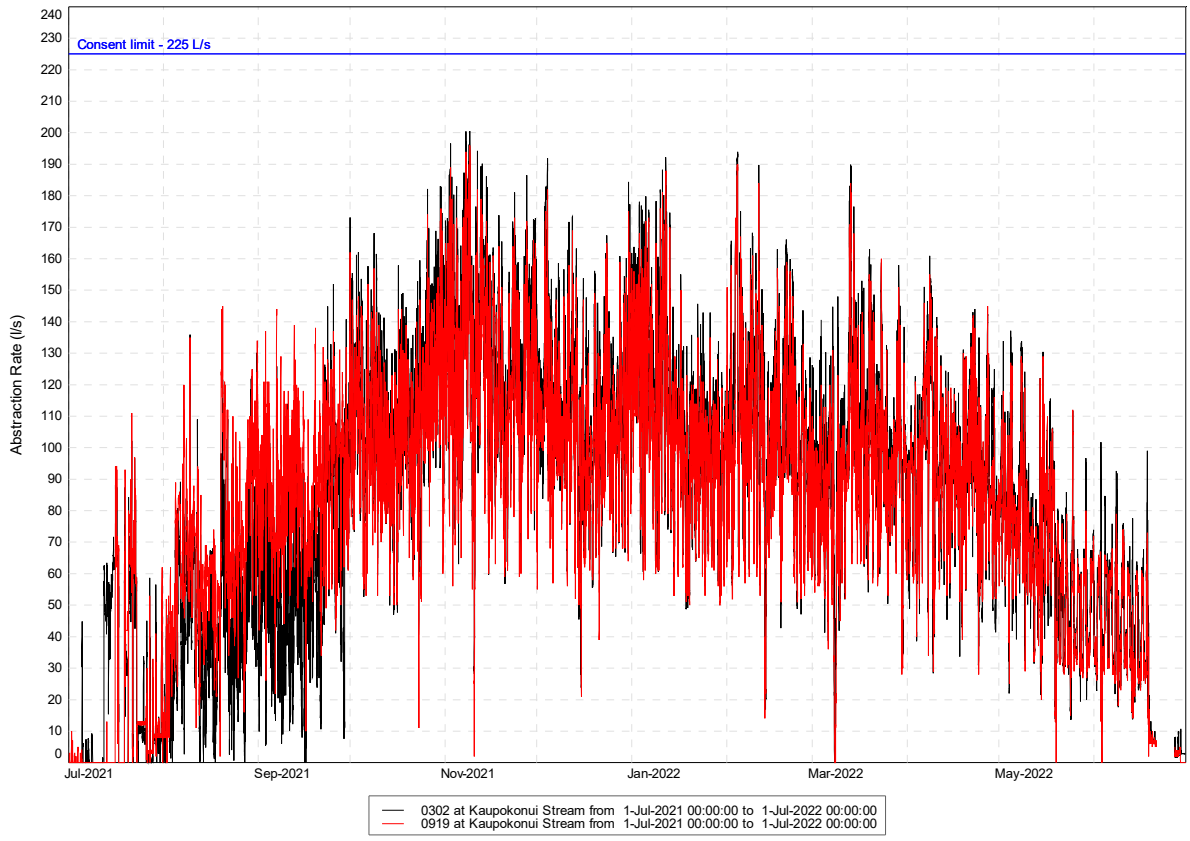

Figure 7 Discharge rates (flow from the cooling tower) for consent 0919-3, along with the abstraction rate for consent 0302-3, electronic record for the year under review

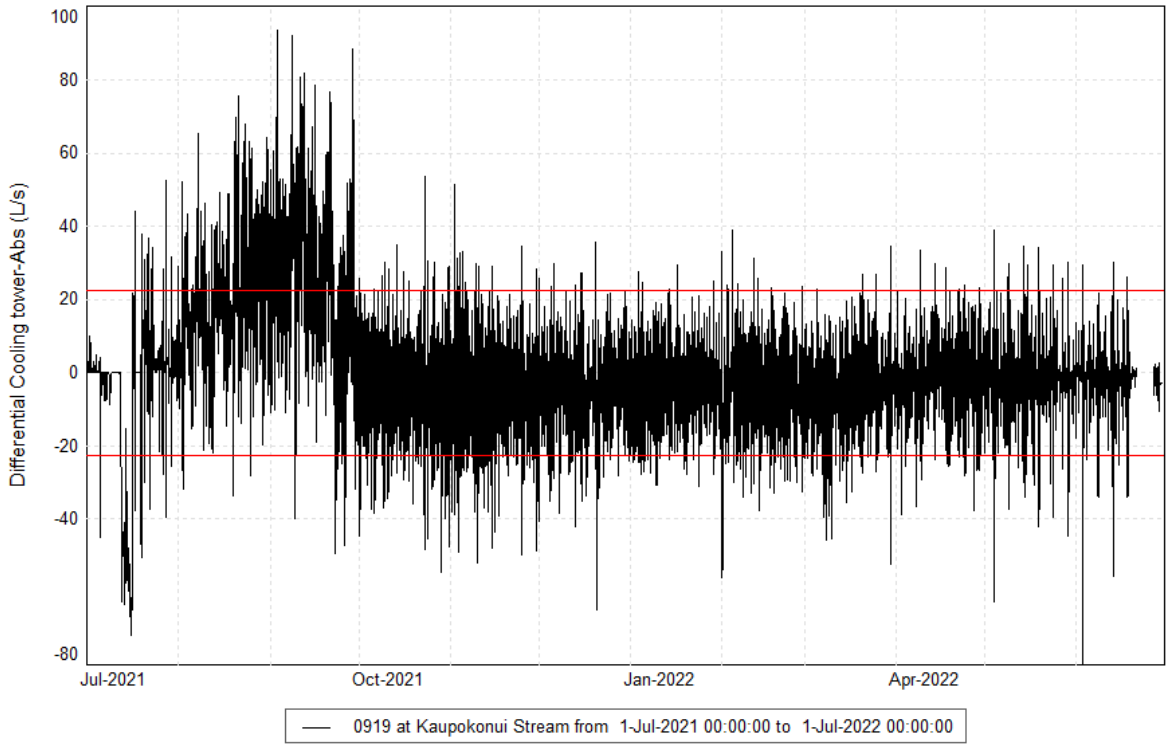

Figure 8 Differential between the rate of discharge from the cooling tower and the abstraction rate

Figure 9 show the percentage of the time that the usage or additional return is at a given rate for the year under review.

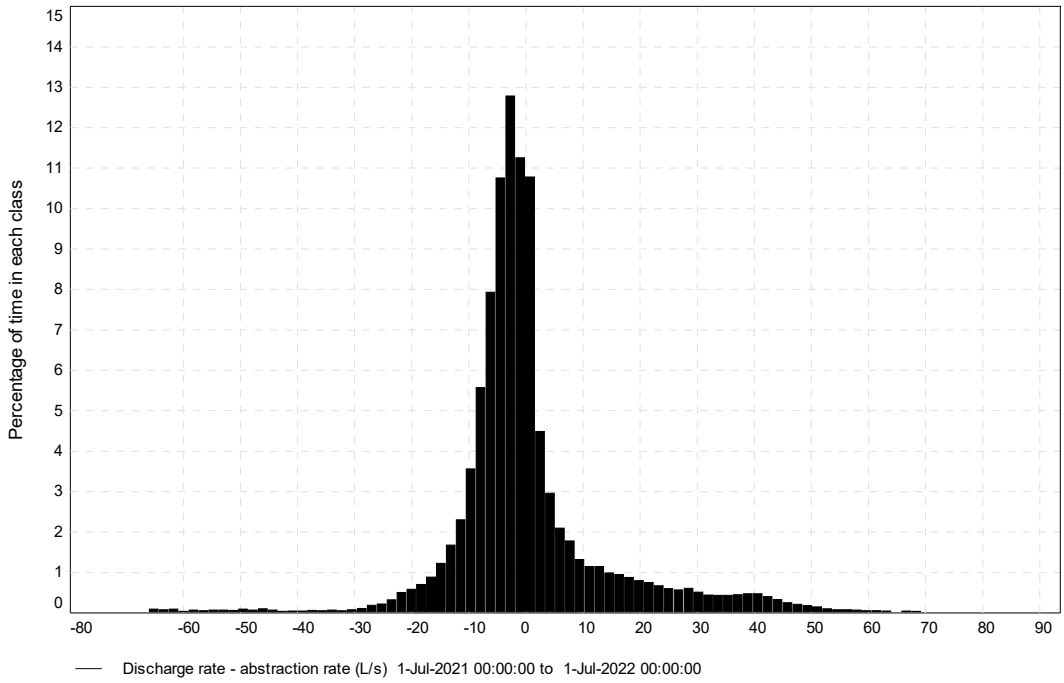

Figure 9 Probability density for the difference between the rate of flow from the cooling tower and the abstraction rate, full year's data

During the year under review, it was found that the maximum 15 minute average for water usage was 94 L/s and the maximum additional return was 80 L/s.

It is noted that the usage profile during August and September is significantly different to the majority of the year under review (Figure 10). During this period of time the differential in data between these two flow rates would suggest that there was a usage of more than 20 L/s (that is, the approximate potential error of metering devices) for 51 % of the time. However this can be accounted for by the under reporting of the abstraction data during this period.

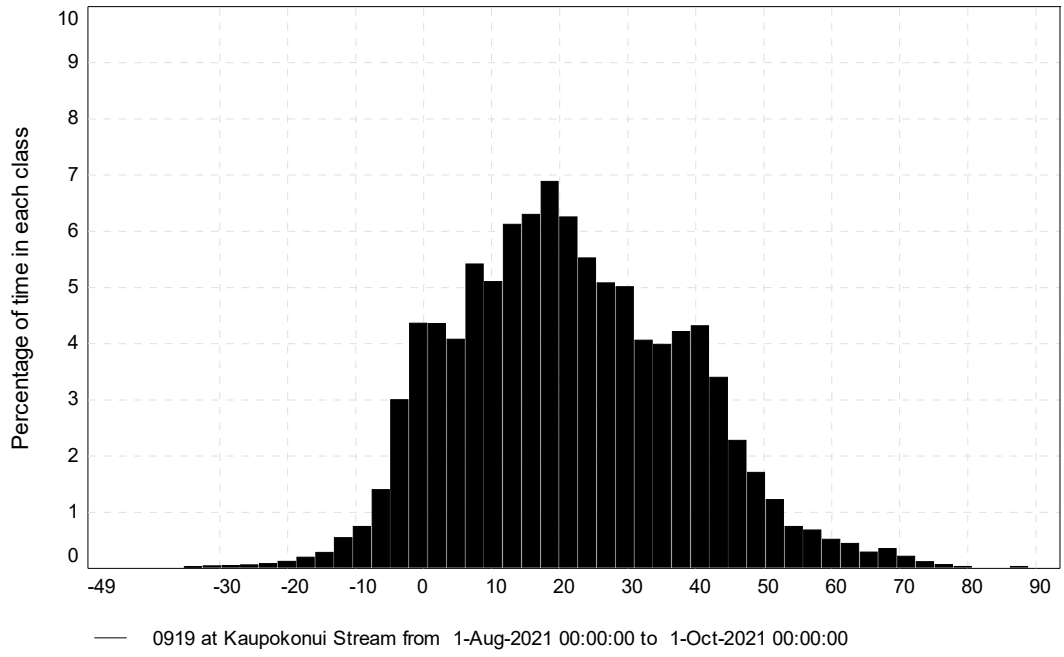

Figure 10 Probability density for the difference between the rate of flow from the cooling tower and the abstraction rate August and September 2021

2.1.1.4 Cooling water discharge temperatures

In addition to providing the new cooling water discharge rate monitoring data, the Company also started to voluntarily monitor the temperature of the cooling water discharged under consent 0919-3 downstream of the cooling tower, upstream of the sprayers. This monitoring is likely to be required by the renewed consent, and in the meantime informs the assessment of effects for the renewal of the consent.

It must also be borne in mind that the discharge method itself (spray discharge) will provide further cooling that is not measured, prior to the cooling water entering into the stream.

The cooling water discharge temperature data has been provided to Council electronically on a 2-hourly basis for the year under review. One minute data is provided by the Company that the Council then processes to provide the 15 minute average temperature so it is comparable to the data used to assess consent compliance in the receiving water as per the conditions of the consent. The median monthly discharge temperatures are given in Table 4.

Table 4 Cooling water temperature monthly statistical summary

Month	Monthly minimum (˚C)	Monthly maximum (˚C)	Monthly median (˚C)	Missing records
Jul 21	2.6	26.2	10.3	no gaps
Aug 21	8.9	38.9	31.0	no gaps
Sep 21	12.5	39.2	31.1	no gaps
Oct 21	17.0	40.8	30.8	no gaps
Nov 21	20.1	41.6	28.0	no gaps
Dec 21	20.7	44.3	36.0	no gaps
Jan 22	23.3	42.8	32.3	11 hr 15 min
Feb 22	16.5	42.9	33.8	16 hr 15 min
Mar 22	16.7	39.4	31.4	no gaps
Apr 22	15.7	39.8	29.3	16 hr 45 min
May 22	13.3	39.3	30.2	14 hr
Jun 22	6.1	37.0	31.0	6 day

As already indicated, this data is not specifically required either by the current consents or the agreement made with the Company in lieu of the consent review. However, it will be useful to compare with the stream temperatures when evaluating potential environmental effects, the Company's implementation of the "best practicable option" to minimise effects, and the requirement that the discharge does not present a thermal barrier to fish passage within the mixing zone. In the assessment of environmental effects for the pending reissue of consent 0919 it was stated that the cooling tower design parameters are such that with fluid entering at 50˚C, and the fans running at 100%, the discharge should be at 33˚C at a wet bulb temperature of 22˚C.

In November 2018, the Company identified that there was a time lag in the control system for the utilisation options available for running the cooling tower efficiently based on the upstream downstream temperature differentials to take effect. The options related to the proportion of cooling water that was passed through the cooling tower, versus passing through a bypass line, and in the operation of the fans on the cooling tower. The time lag was due to the response time between the activation of the change and the time it took for the change to have an effect on the cooling water discharge temperature. The Company has since made a number of operational changes relating to their management of the cooling system. The changes

observed in the cooling water discharge temperature over this period of time are illustrated in Figure 11 to Figure 16. The key changes to the system are summarised in Table 5, along with the impact the changes have had on the measured cooling water discharge temperatures.

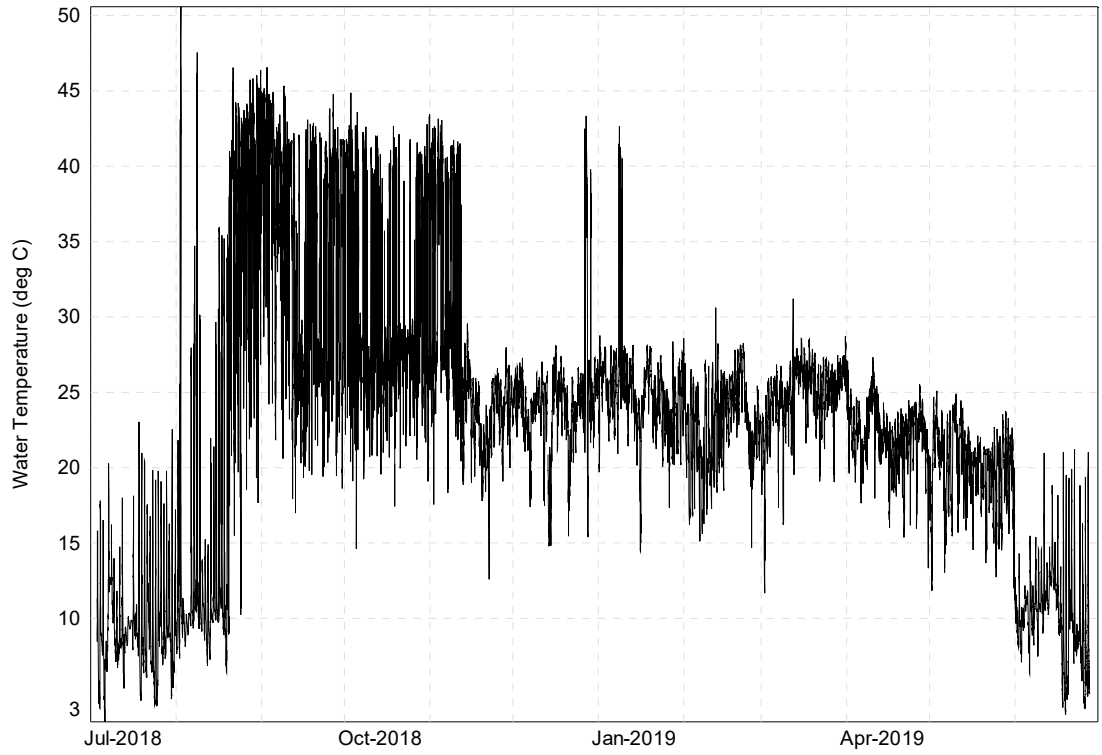

Figure 11 Temperature of the cooling water discharge permitted by consent 0919-3, 2018-2019

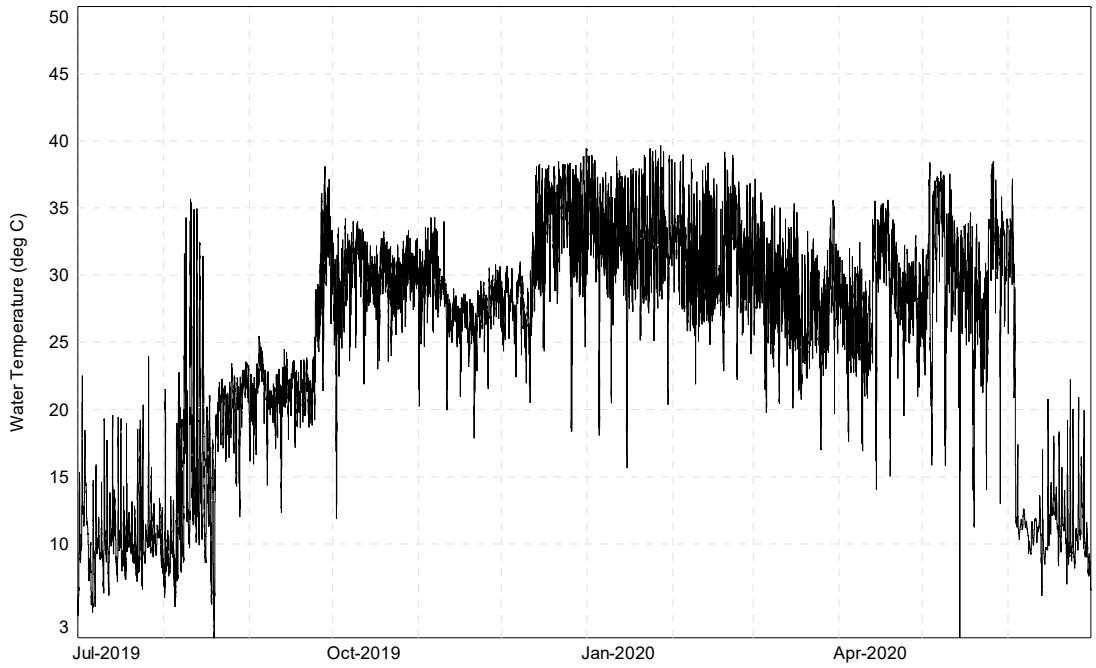

Figure 12 Temperature of the cooling water discharge permitted by consent 0919-3, 2019-2020

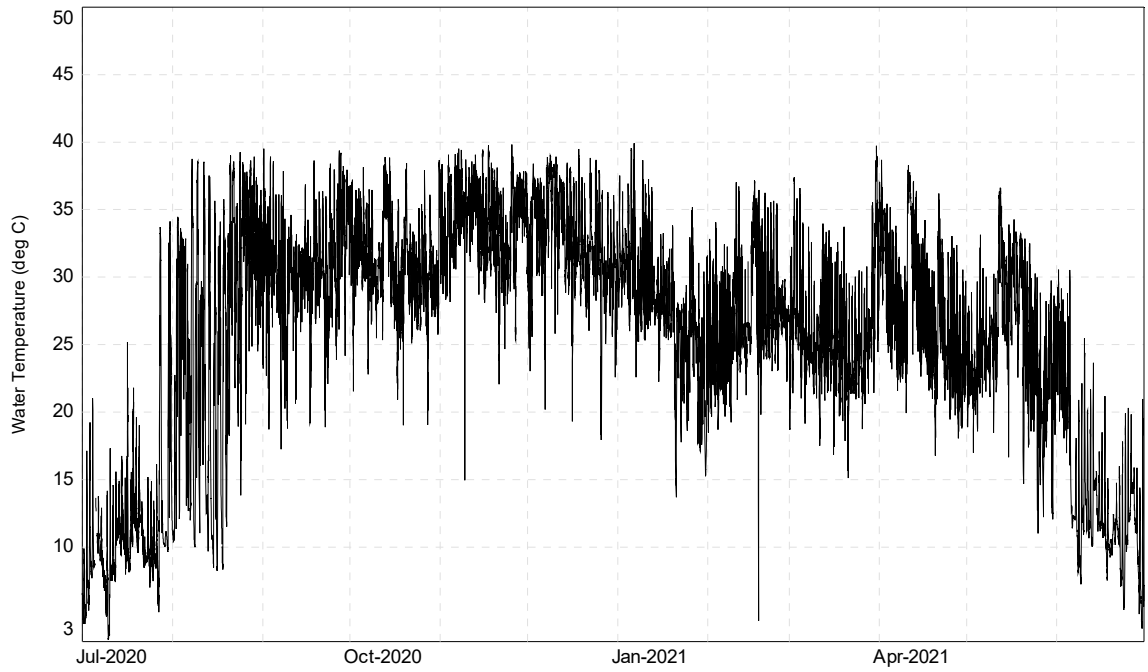

Figure 13 Temperature of the cooling water discharge permitted by consent 0919-3, 2020-2021

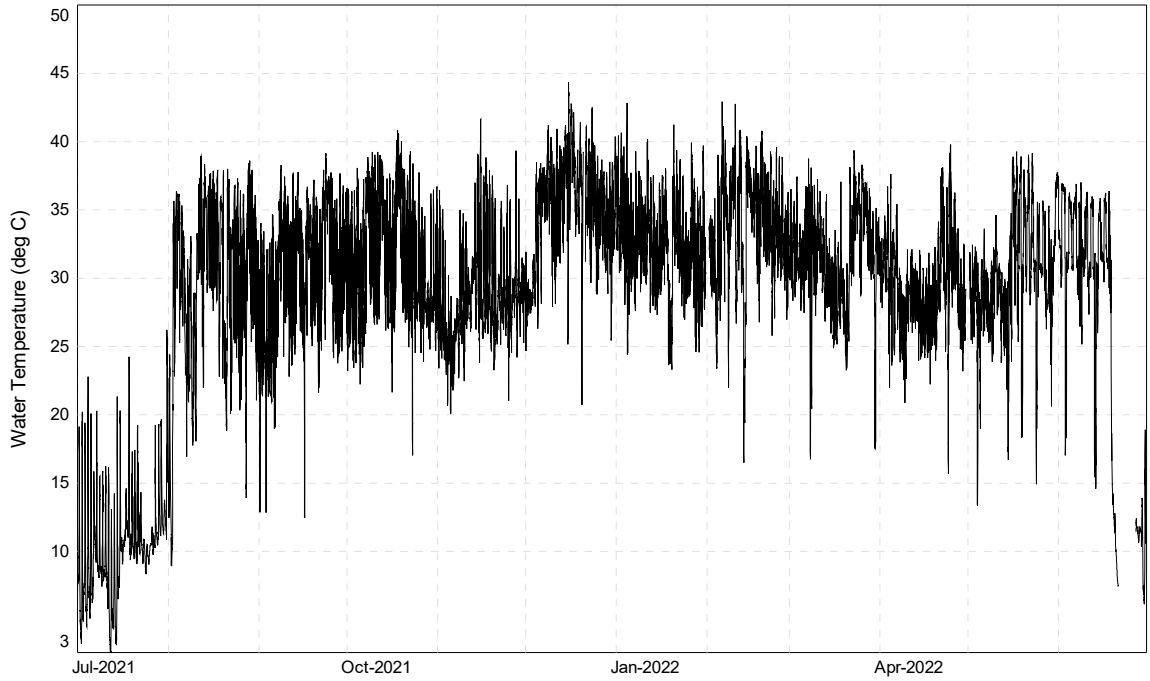

Figure 14 Temperature of the cooling water discharge permitted by consent 0919-3, 2021-2022

Table 5 Summary of cooling tower operational changes and their effects on discharge temperature

Timeframe	Change in operational management of cooling water systems	Observable effects on the monthly median discharge temperatures	Observable effects on the monthly maximum discharge temperatures	Percentage of the time that the cooling water discharge was at or above 35˚C	Percentage of the time that the cooling water discharge was at or above 33˚C during low flow*
Nov 2018-2019	Manual diversion of all flow from the cooling water flows to the cooling tower. Cooling tower operating at maximum cooling conditions at all times	Reduced from 30-37˚C to 23 -25.5˚C	Reduced from 44-54˚C to 27-43˚C	Reduced from 28% to 7%	Reduced from 48% to 1%
2019-2020	Removal of cooling tower bypass line Addition of variable speed pump to control cooling tower residence time Operation of cooling tower fans based on river temperature differential	Increased to 28-33˚C	Increased to 34-40˚C	6%	35%
2020-2021	Commencement of installation of pressure regulating nozzles at the spray discharge booms	25-28˚C	30-40˚C	11%	16%
2021-2022	Completion of installation of pressure regulating nozzles at the spray discharge booms	28-36˚C	26-44˚C	20%	50%

Key *1 December to 31 March

Further analysis and comparison of cooling tower and operational performance is illustrated in Figure 15 and Figure 16. Cumulatively during the year under review the cooling water discharge was at or above 35˚C for approximately 20 % of the time. This is in comparison to 11 % of the time in 2020-2021, 7% of the time in 2019-20, 28% of the time in 2018-2019 prior to the operational changes made in November 2018, 1% of the time between December 2018 and the end of the 2018-2019 monitoring year and 35% of the time in the 2017-2018 year.

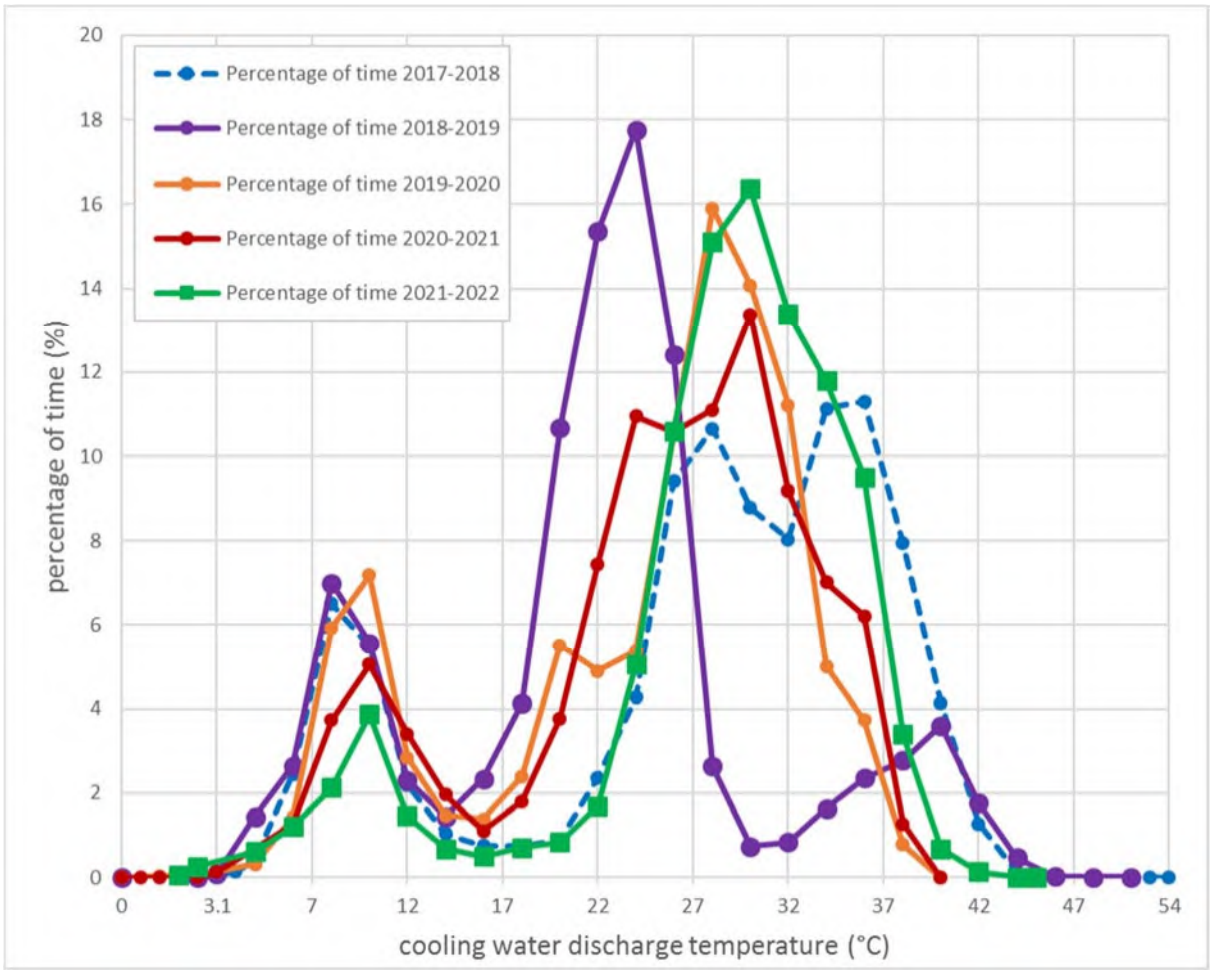

Figure 15 Cooling tower discharge temperature probability density during the 2017 to 2021 years from 1 July-30 June

During the period 1 December to 31 March, the time of year when typically the stream flow is low and the water temperature is higher, the cooling water temperature was at or above 33˚C for 50 % of the time, and above 35˚C for 32% of the time. This in comparison to only 1.3% of the time above both 33 and 35˚C respectively during this period for the 2018-2019 year and 48% and 39% of the time respectively for this period in the 2017-2018 year. Whilst there was a significant reduction in the heat load on the receiving environment as a result of the initial improvements in operational management of the cooling tower in the 2018-2019 year, the reduction in heat load had been lessened by the way in which the cooling water tower was operated in the 2019-2022 years, as illustrated in Figure 16.

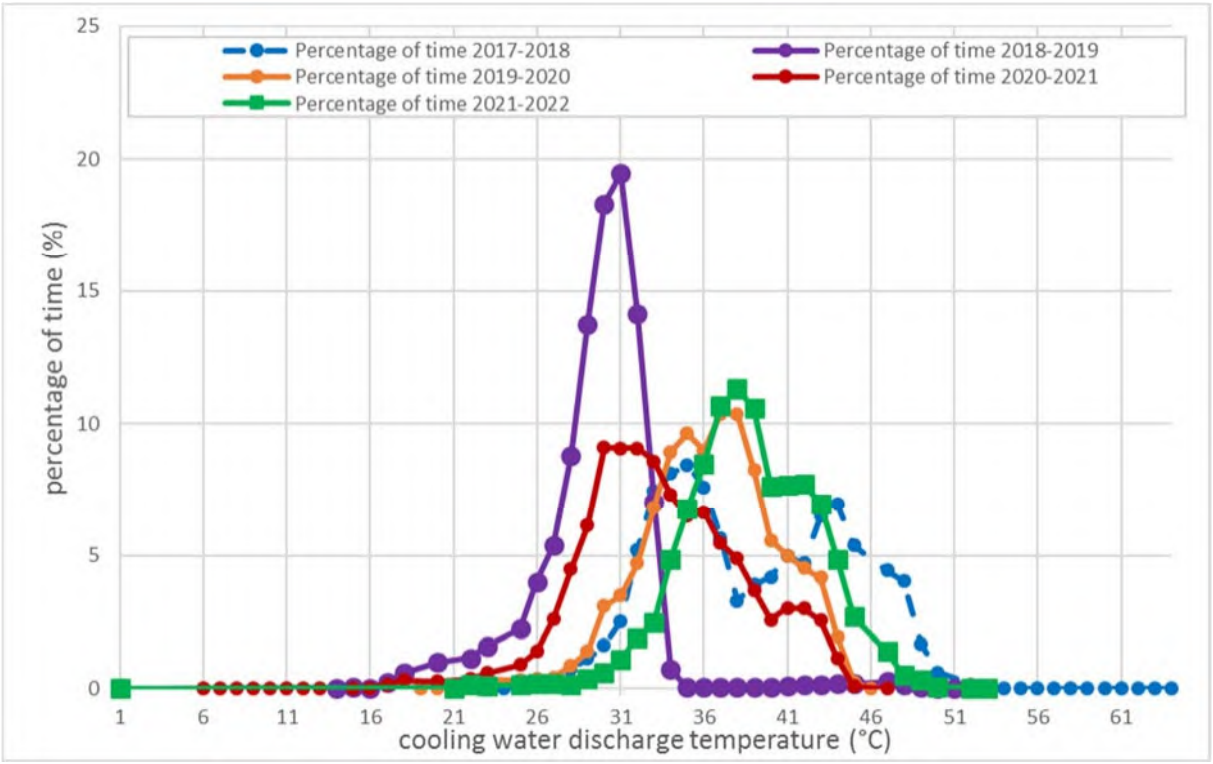

Figure 16 Cooling tower discharge temperature probability density during the 2017 to 2022 years, 1 December-31 March

The effects of the operational changes, as observed in the receiving waters, are discussed in Section 2.1.1.5.2.

2.1.1.5 Receiving water temperatures

The Company maintained continuous records of Kaupokonui Stream water temperatures (upstream of the spray coolant discharge zone and at the downstream end of the designated mixing zone), and water temperature exiting the cooling tower (discussed in section 2.1.1.4). Since 19 March 2014, the upstream and downstream temperature data have been sent directly to Council by telemetry on a daily basis. During the year under review, the data was 1 minute averaged data. As per the consent conditions, compliance will continue to be assessed based on 15 minute averages. The consent holder undertakes regular checking of the recording system to ensure that compliance is achieved in terms of continuity and accuracy of the record, particularly in relation to the 3˚C maximum stream temperature increase permitted by consent conditions, and a requirement for the temperature increase not to exceed 2˚C for more than 10% of the discharge period (on an annual basis).

Calibration was performed at monthly intervals by Company personnel, and checks were made by Council staff during monthly receiving water sampling surveys.

Historically, Council had been advised that the accuracy of the temperature probes was ± 0.1˚C, however, calibration records forwarded to Council for the 2018-2019 year showed off-sets of up to 0.5˚C that were not being corrected for.

From October 2018, the Company introduced a reduced tolerance for allowable deviations from the reference thermometer during verifications. The allowed deviation was reduced from ± 0.5 ˚C to ± 0.2 ˚C. Up

until this point, based on the maximum permitted off-sets given in NEMS[3], there was potential for error up to ± 0.8˚C deviation at each monitoring location (± 0.5˚C, with an additional off-set of ± 0.3˚C allowed for due to errors on the thermometer used to perform the calibration), and a consequent potential error of up to ± 1.6˚C on any calculated temperature differentials overall. Following implementation of the lower deviation tolerance, the potential error was reduced to between ± 0.2˚C and ± 0.5˚C at each monitoring location and therefore a temperature differential accuracy of between ± 0.4˚C and ± 1.0˚C depending on the accuracy of the thermometer used to perform the calibration.

Parallel temperature monitoring was initiated in the 2018-2019 year. This is discussed in Section 2.1.1.5.1, The consent holder provided data presented in section 2.1.1.5.2.

2.1.1.5.1 Parallel temperature monitoring

Where there are cooling water discharges to waterways, it is Council policy to have continuous water temperature monitoring in place to confirm compliance with consent conditions relating to permitted instream temperature changes. The majority of this monitoring is undertaken by the Council with the installation of one upstream site and at least one downstream site. In the case of the lactose plant, this temperature information is required by the Company, as it is used to control cooling water system operating parameters. The Company is responsible for all aspects of the monitoring of the receiving water temperatures immediately upstream and downstream of their site, with any maintenance, validations and calibrations carried out internally.

The data, including any requested calibration records, are provided to the Council. It is therefore considered that the accuracy of the data and consent compliance can be confirmed by periodic parallel temperature monitoring, rather than a full duplication of effort, as would be the case if Council were to undertake monitoring of a similar scale to that which is in place for other consent holders.

The Council's temperature logger was installed alongside the Company's temperature probe at the both the upstream and downstream monitoring sites between 28 April and 23 June 2022, with the comparisons shown in Figure 17 and Figure 18.

Good agreement was observed at both monitoring sites, with the Company's data being no more than 0.1˚C higher than the Council's data at the upstream site and no more than 0.1˚C lower than the Council's data at the downstream site.

[3] A national standard for gathering and processing environmental data

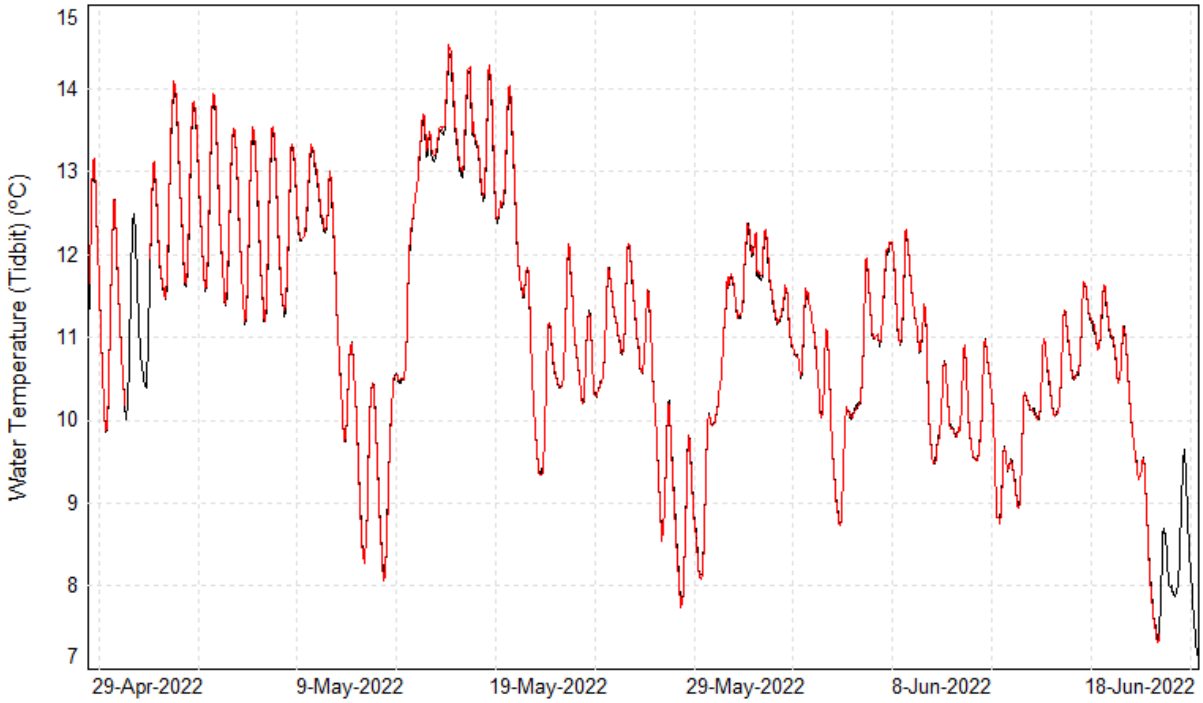

Figure 17 Parallel temperature monitoring upstream of the Company's site

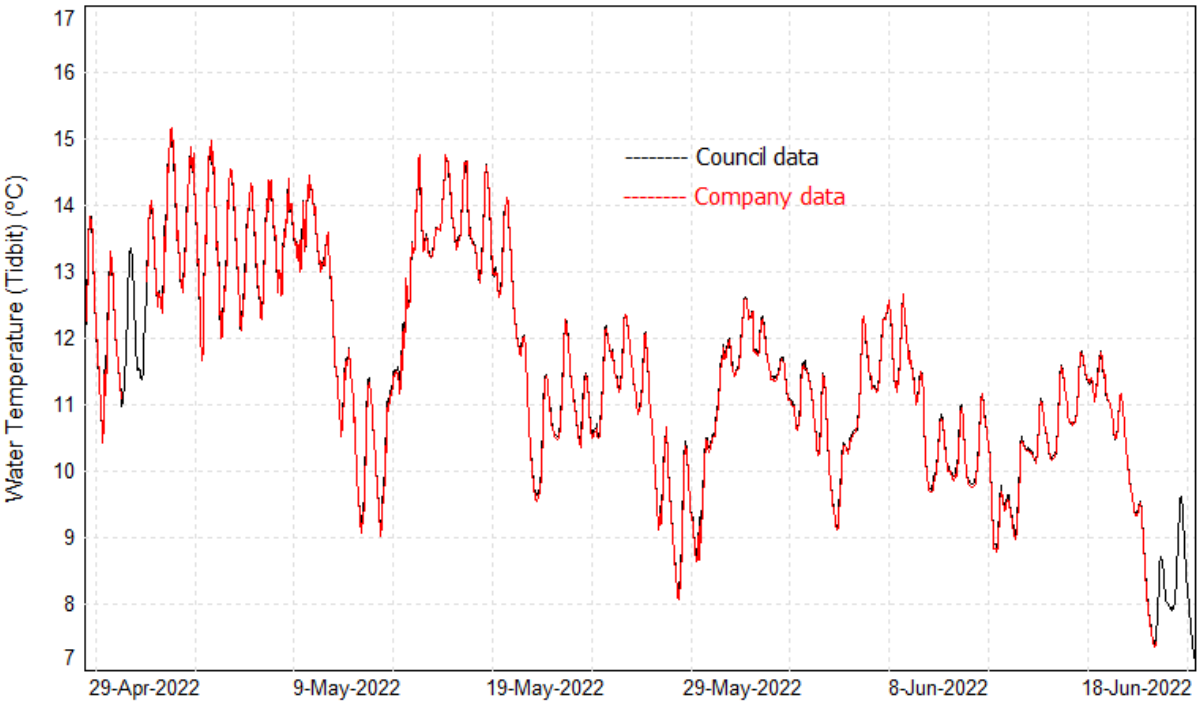

Figure 18 Parallel temperature monitoring downstream of the Company's spray cooling water discharge

2.1.1.5.2 Annual consent holder temperature data

The temperature record over the 2021-2022 reporting period for the Kaupokonui Stream upstream and downstream of the lactose plant discharge is presented in Figure 19 and Figure 20. The change in temperature is given in Figure 21.

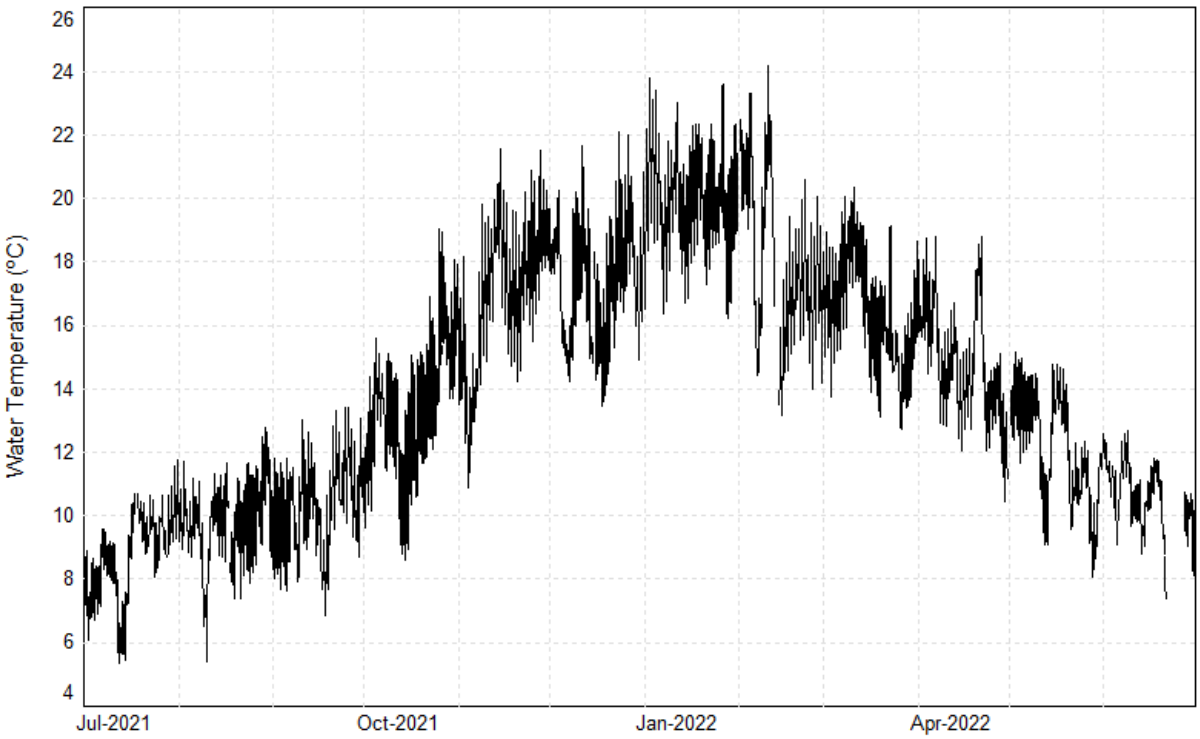

Figure 19 Water temperature (˚C) records for the Kaupokonui Stream upstream of the Lactose plant, electronic data

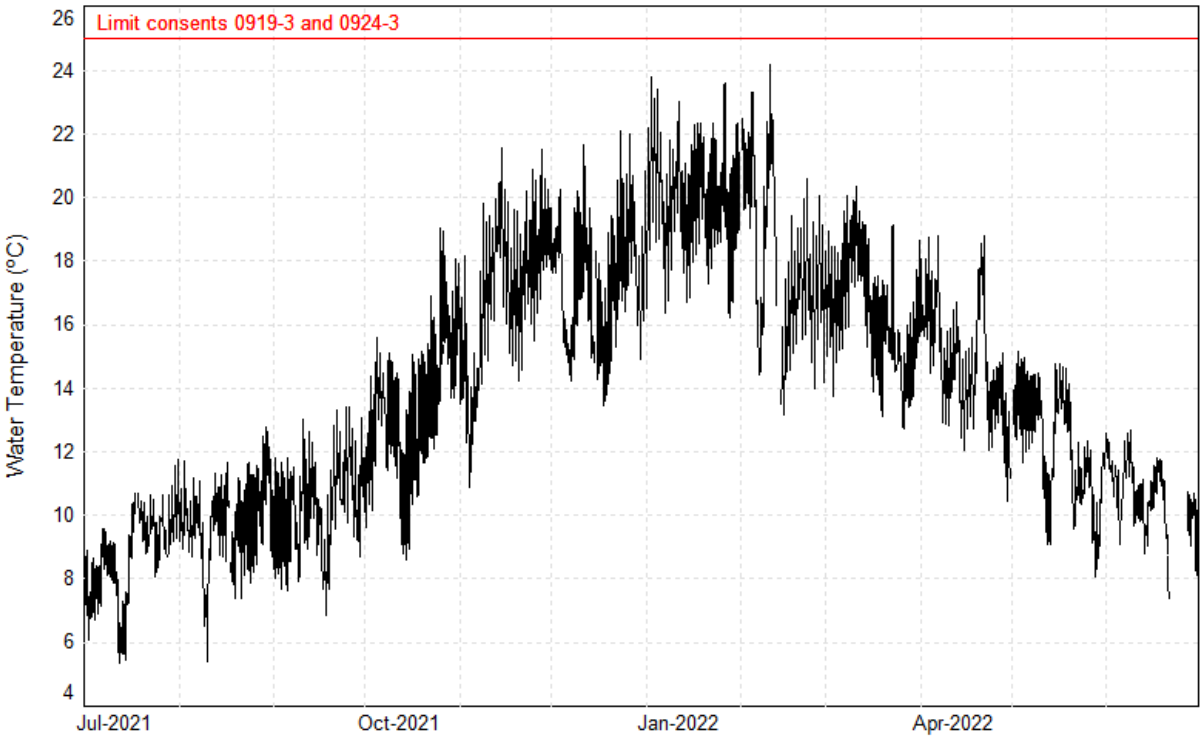

Figure 20 Water temperature (˚C) records for the Kaupokonui Stream downstream of the lactose plant, electronic data

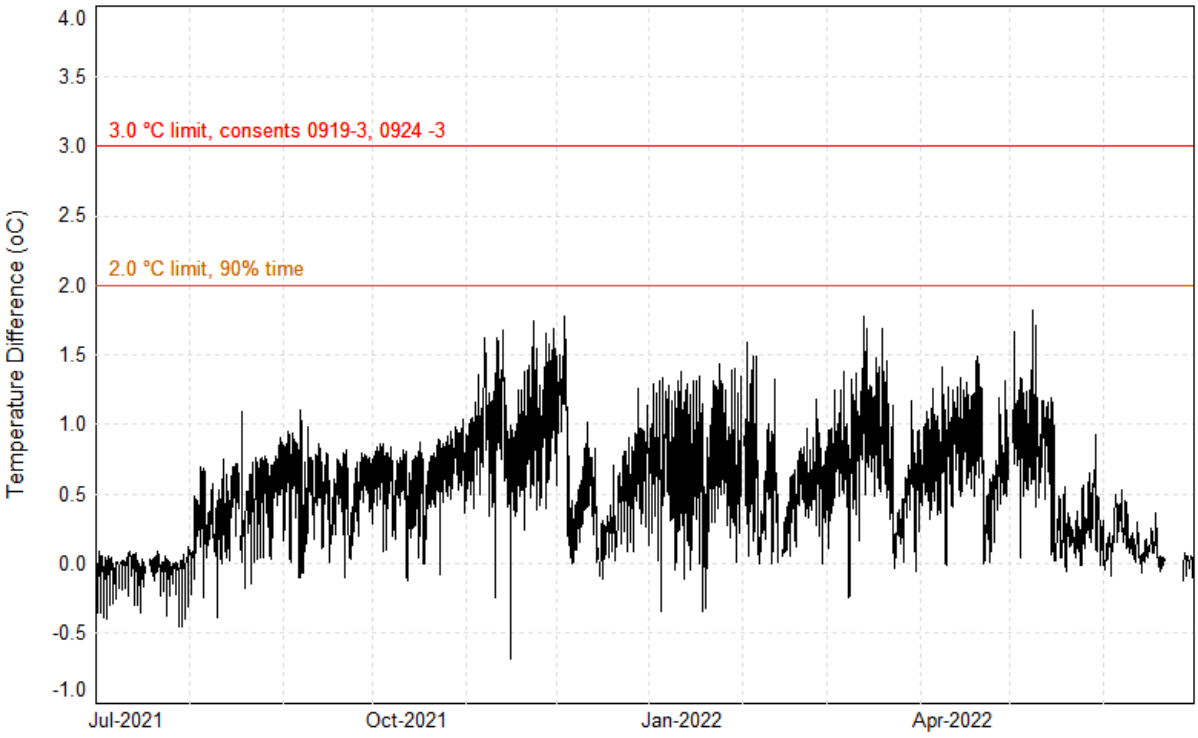

Figure 21 Kaupokonui Stream temperature change below the lactose plant, calculated from electronic data

A summary of the reported temperature change and maximum temperature data for 2021-2022 (15 minute data) is given in Table 6. On a monthly basis, the recorded percentage of time the change was below 0°C, above 2.0°C, 2.5°C and 3.0°C is given, together with the minimum and maximum reported change and the maximum downstream temperature.

Table 6 Summary of Fonterra Ltd's continuous water temperature records (˚C) from two monitoring probes in the Kaupokonui Stream

Month	Temperature change% Time*				Downstream temperature				
	<0˚C	>2˚C	>2.5˚C	>3˚C	Min change (d/s-u/s) (˚C)	Max change (d/s-u/s) (˚C)	Days in excess of 3˚C	Max downstream temp	Days in excess of 25˚C
Jul 21	54	0	0	0	-0.45	0.13	0	11.8	0
Aug 21	17	0	0	0	-0.38	1.1	0	12.8	0
Sep 21	0.8	0	0	0	-0.1	1.1	0	13.4	0
Oct 21	0.4	0	0	0	-0.1	1.04	0	19.1	0
Nov 21	0.2	0	0	0	-0.7	1.75	0	21.6	0
Dec 21	1.5	0	0	0	-0.1	1.78	0	22.1	0
Jan 22	3.6	0	0	0	-0.3	1.43	0	23.8	0
Feb 22	0	0	0	0	0	1.59	0	24.2	0
Mar 22	1.8	0	0	0	-0.24	1.77	0	20.3	0
Apr 22	0.3	0	0	0	-0.01	1.49	0	18.8	0

Month	Temperature change% Time*				Downstream temperature				
	<0˚C	>2˚C	>2.5˚C	>3˚C	Min change (d/s-u/s) (˚C)	Max change (d/s-u/s) (˚C)	Days in excess of 3˚C	Max downstream temp	Days in excess of 25˚C
May 22	1	0	0	0	-0.06	1.82	0	15.2	0
Jun 22	8	0	0	0	-0.12	0.53	0	12.7	0
Totals for 2021-2022*	7	0	0	0	-0.7	1.8	0	24.2	0

Note:* =% of actual record (12 days 13 hrs of missing record)

Condition 4(b) of consent 0919-3 requires that the discharge does not result in an increase of more than 3˚C at any time, and does not alter the temperature of the receiving water by more than 2°C for 90% of the time (on an annual basis). There is an alarm on the system that alerts staff if there is a high differential temperature recorded and periodic testing is performed to ensure that the alarm is functioning.

The Company operates a null switch, which is activated during periods when the temperature probes are pulled out of the water for protection during high flows, or during calibration. This reduces the number and duration of temperature spikes recorded (it should be noted that 0.1% exceedance during any one month's operations equates to a time period of approximately 1 hour). These consent limits were not exceeded during 2021-2022.

Condition 5 of consents 0919-3 requires that the discharge shall not raise the temperature of the receiving water above 25°C at the boundary of the mixing zone. Figure 20 shows that this condition was complied with during the year under review.

The data and summary provided in Figure 21 and Table 6 show that, although the temperature probes comply with the requirements of NEMS standard for the monitoring data, and significant improvements have been made to the calibration processes the Company employs, there still appears to be some occasional issues with the precision of the recording of the temperature differential between the upstream and downstream sites. During the year under review, the data reported indicated that there was a drop in stream temperature between the upstream and downstream sites for 7% of the time. A comparison of the negative temperature differentials is presented in (Table 7).

Table 7 A comparison of the historical data where a decrease in temperature of the Kaupokonui Stream has been recorded

Year	Whole year		During July		
	Percentage of the time that a negative temperature differential is recorded	Maximum negative temperature differential	Percentage of the time that a negative temperature differential is recorded	Percentage of the time that the negative temperature differential is < 0.5°C	Maximum negative temperature differential
2016-2017	23	-1.46	99	0	-0.4
2017-2018	17	-2.24	98	37	-2.24
2018-2019	3	-4.86	0.6	0.5	-3.0
2019-2020	11	-3.77	15	2.1	-2.98
2020-2021	13	-2.26	99	65	-2.14
2021-2022	7	-0.69	52	0	-0.45

The reductions in temperature may be due to the permitted calibration errors of the measuring devices. This continues to support the use of a 2°C temperature change limit on the consent for the majority of the time, and the need for continuation of the parallel temperature monitoring. The temperature differentials during the plant shutdown in July 2020 and July 2021 are shown in Figure 22 and Figure 23.

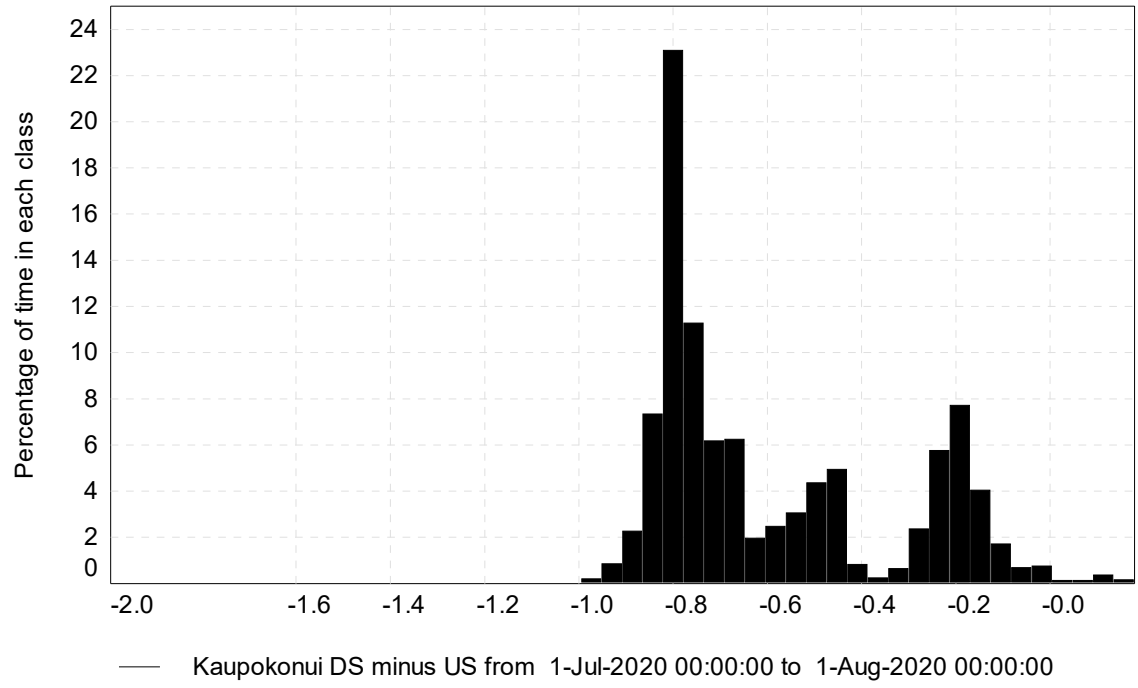

Figure 22 Probability distribution for the Kaupokonui instream temperature differential between the Company's upstream and downstream monitoring sites during July 2020

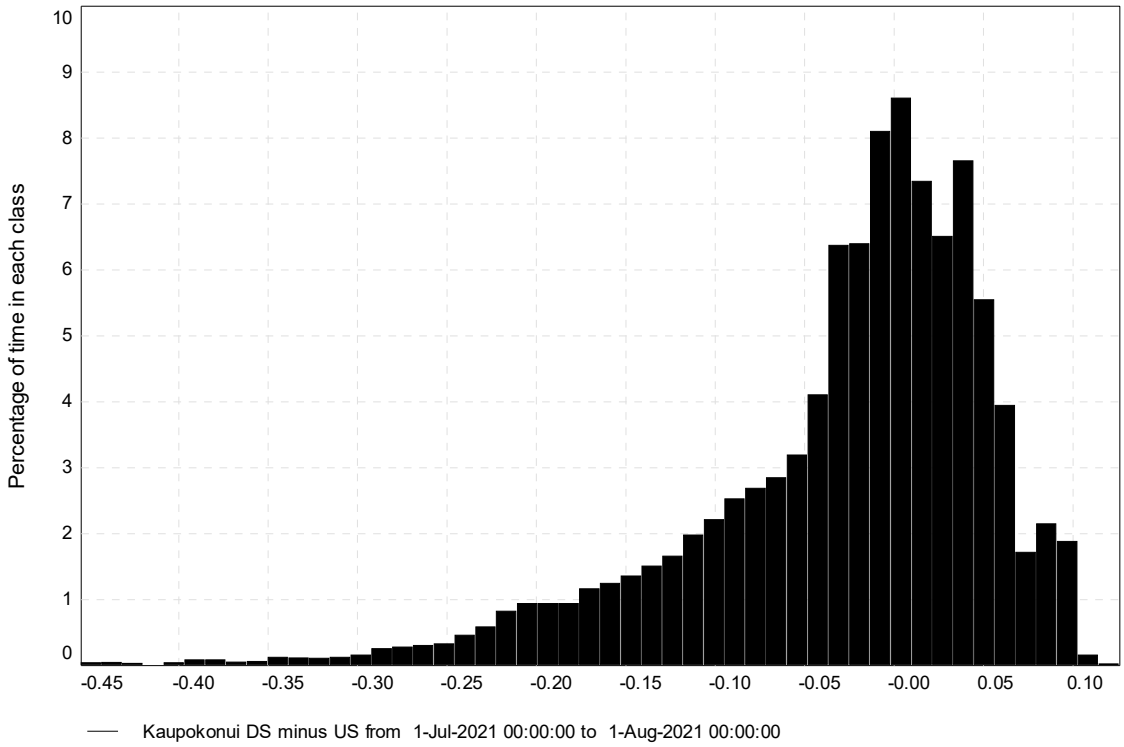

Figure 23 Probability distribution for the Kaupokonui instream temperature differential between the Company's upstream and downstream monitoring sites during July 2021

As discussed in Section 2.1.1.4 operational management of the cooling water discharge system was changed during the 2018-2019 year and again part way through the 2019-2020 year. A summary of the operational changes and the notable observable effects in the receiving water are given in Table 8. The effects of the changes are illustrated in the comparison of the temperature differential probability density curves shown in Figure 24.

Table 8 Summary of cooling water system operational changes and receiving water temperature related outcomes

Timeframe	Change in operational management of cooling tower and associated in-house monitoring	Observable effects on the instream temperature	Comments
2016-2017		Negative upstream-downstream temperature differentials reported for 23% of the electronic record. Maximum negative temp differential reported -1.5°C	Errors within limits permitted by NEMS standards, resulted in potential error of ± 1.6˚C on any calculated temperature differentials. Would need to be considered in relation to the temperature increase permitted on the reissued consent. Discussions commenced on options to improve precision.
2017-2018		Negative upstream-downstream temperature differentials reported for 17% of the electronic record. Maximum negative temp differential reported -2.2°C	Discussions on-going. Council monitoring programme to include period of parallel temperature monitoring for the 2018-2019 year
Oct 2018	Company introduced a reduced tolerance for allowable deviations from the reference thermometer during verifications from ± 0.5 ˚C to ± 0.2 ˚C.	A significant reduction in the amount of time that a negative temperature differential was recorded to only 3.2% of the electronic record.	Time lag identified in the control loop for the utilisation options available for running the cooling tower efficiently based on the upstream downstream temperature differentials to take effect
Nov 2018	Manual diversion of all flow from the cooling water flows to the cooling tower. Cooling tower operating at maximum cooling conditions at all times	A significant reduction in the most common instream temperature differential, from 0.9 to 0.3°C A significant reduction in the percentage of the time that the temperature differential is greater than 1.0°C	

Timeframe	Change in operational management of cooling tower and associated in-house monitoring	Observable effects on the instream temperature	Comments
2019-2020	Removal of cooling tower bypass line Addition of variable speed pump to control cooling tower residence time Operation of cooling tower fans based on river temperature differential	A significant change in the most common instream temperature differentials, with a bimodal pattern evident in the year under review. That is two most common instream temperature differentials of 0.0 and 0.6°C, both at 17% of the time A significant increase in the amount of time that a negative temperature differential is reported (11% of record). A further reduction in the amount of time the temperature differential is above 1.0°C (17%)	Due to permitted errors inherent in any temperature measurements, actual instream temperature differentials may be up to 1.0°C higher than reported measurement. Would need to be considered in relation to the temperature increase permitted by reissued consent.
2020-2021	Commencement of installation of pressure regulating nozzles at the spray discharge booms to produce a finer spray	Most common instream (targeted) temperature differential 0.6°C at 16% of the time Further increase in the amount of time that a negative temperature differential is reported (-0.1 to -1.0°C for 13% of record). A further reduction in the amount of time the temperature differential is above 1.0°C (7%)	Due to permitted errors inherent in any temperature measurements, actual instream temperature differentials may be up to 1.0°C higher than reported measurement. Would need to be considered in relation to the temperature increase permitted by reissued consent.
2021-2022	Completion of installation of pressure regulating nozzles at the spray discharge booms	Most common instream (targeted) temperature differential 0.6°C at 14% of the time. Reduction in the amount of time that a negative temperature differential is reported (-0.1 to -1.0°C for 2% of record). Increase in the amount of time the temperature differential is above 1.0°C (11%)	Due to permitted errors inherent in any temperature measurements, actual instream temperature differentials may be up to 1.0°C higher than reported measurement. Would need to be considered in relation to the temperature increase permitted by reissued consent.

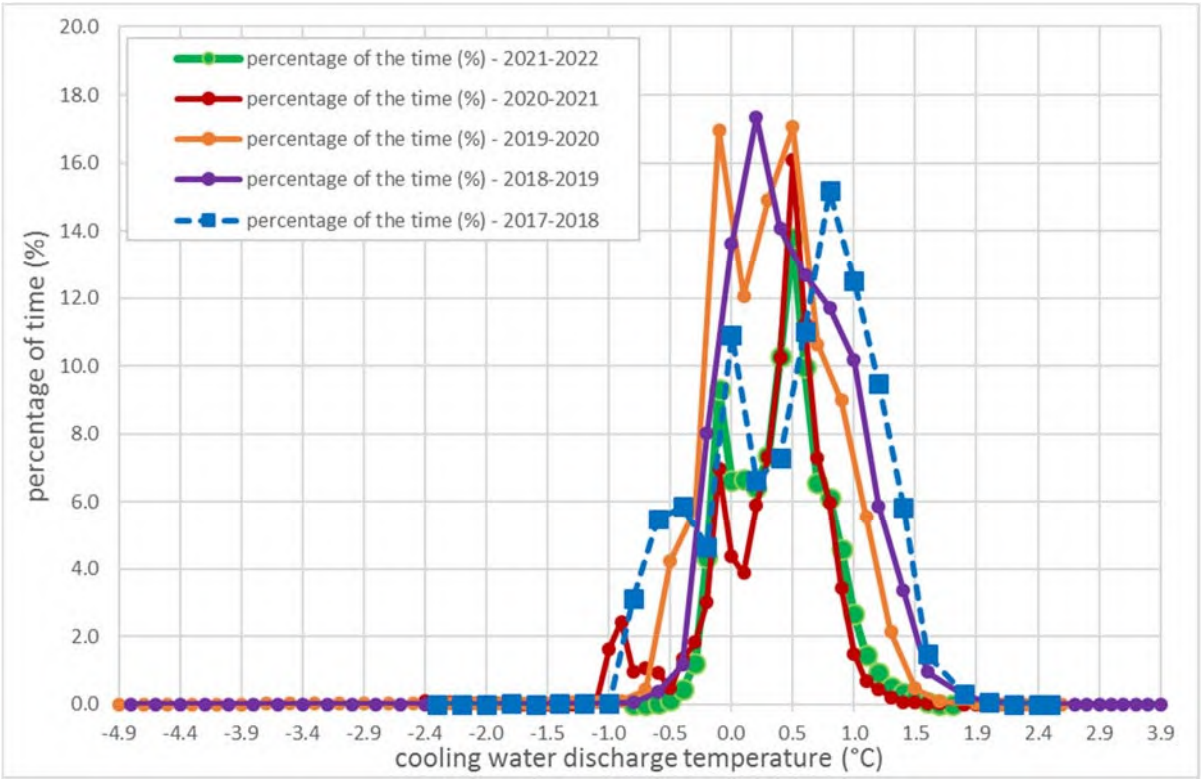

Figure 24 Instream temperature differential probability density during the 2017-2022 years from 1 July-30 June

This demonstrates that the most effective option to minimise temperature effects on the environment was achieved by running the cooling tower at maximum capacity, as was the case in the 2018-2019 year from November onwards. The reduction in the discharge temperatures would have resulted in a significant reduction in the effects occurring within the approximately 200 m discharge and mixing zone. An additional advantage is that it would improve the sustainability of the cooling water discharge system at times when the upstream receiving water temperature peaks during the summer months, whilst still ensuring compliance with the 25°C downstream temperature limit (peak upstream temperature recorded to date, 24.8°C on both 29 and 30 January 2018).

The operational management of the cooling tower in the 2019-2022 years would have resulted in an improvement in the effects occurring within the discharge spray zone when compared to the 2017-2018 year, but some of this improvement would have been lost when compared to the latter part of the 2018-2019 year.

2.1.1.6 Wastewater irrigation

Well managed wastewater irrigation systems have the positive benefits of reducing the requirement for synthetic fertilisers, improving soil condition and improving pasture growth that is limited by dry conditions.

The potential for adverse effects are influenced by the total hydraulic loading (that is, the rainfall and depth of irrigation), the soil moisture at the time of the irrigation event and the contaminant concentrations of the wastewater. All these factors influence the degree of leaching of contaminants that may occur as a result of wastewater irrigation.

The Company's wastewater irrigation consents limit the potential for adverse effects from this activity primarily by:

- Setting irrigation volume limits,
- Prohibiting ponding,

- Requiring that the activity is undertaken in accordance with a management plan that addresses a number of specific matters,
- Requiring specific monitoring, with the data to be provided to Council, and
- Requiring set-back distances from streams and neighbouring properties.

The following sections (Section 2.1.1.6.1 to Section 2.1.1.6.3) contain summaries of the data provided by the Company to assess compliance with the specific consent limits and to assess the data in relation the factors that have the potential to result in adverse environmental effects.

2.1.1.6.1 Wastewater irrigation volumes

Consents 0922 and 0923 permit a maximum volume of 2,630 m^3 (Farm1) and 3,834 m^3 (Farms 2 and 3) of factory wastewater (FWW) and dairy shed effluent (DSE) combined to be spray irrigated per two consecutive days, with a maximum daily volume for DSE of 120 and 168 m^3, respectively. In addition to this, there is a limitation in that DSE can only be irrigated when in combination with factory wastewater.

In relation to the Company's monitoring and data provision for spray irrigation of wastewater onto land (that is, the exercise of 0922-3 and 0923-3) the Company supplied the Council with monitoring data relating to the daily volume of factory and DSE spray irrigated in the form of a monthly report.

It is noted that for the year under review, Fonterra also provided irrigation volumes on a per paddock basis. The data used for the consent compliance assessment and analysis that follows and is based on a summation of this irrigation data for each of the Farms.

Where comparisons with prior years are made, it should be noted that the irrigation data provided to Council was previously based on the volumes of effluent pumped to the farms, and excluded water used to flush the pipes, which is now included in the irrigation volumes provided to Council.

The irrigation data is summarised in Table 9, with the two day totals and the associated consent limits shown in Figure 25 and Figure 26.

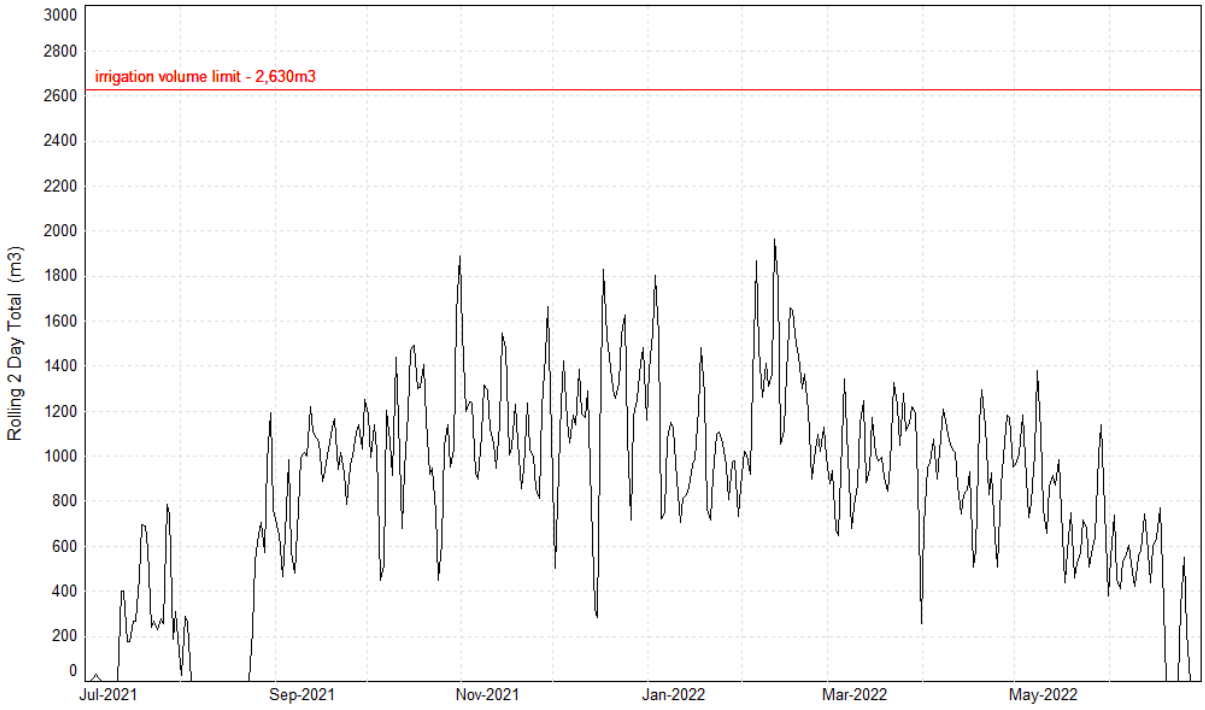

Figure 25 Irrigation volumes for Farm 1, 2 day rolling totals (FWW and DSE)

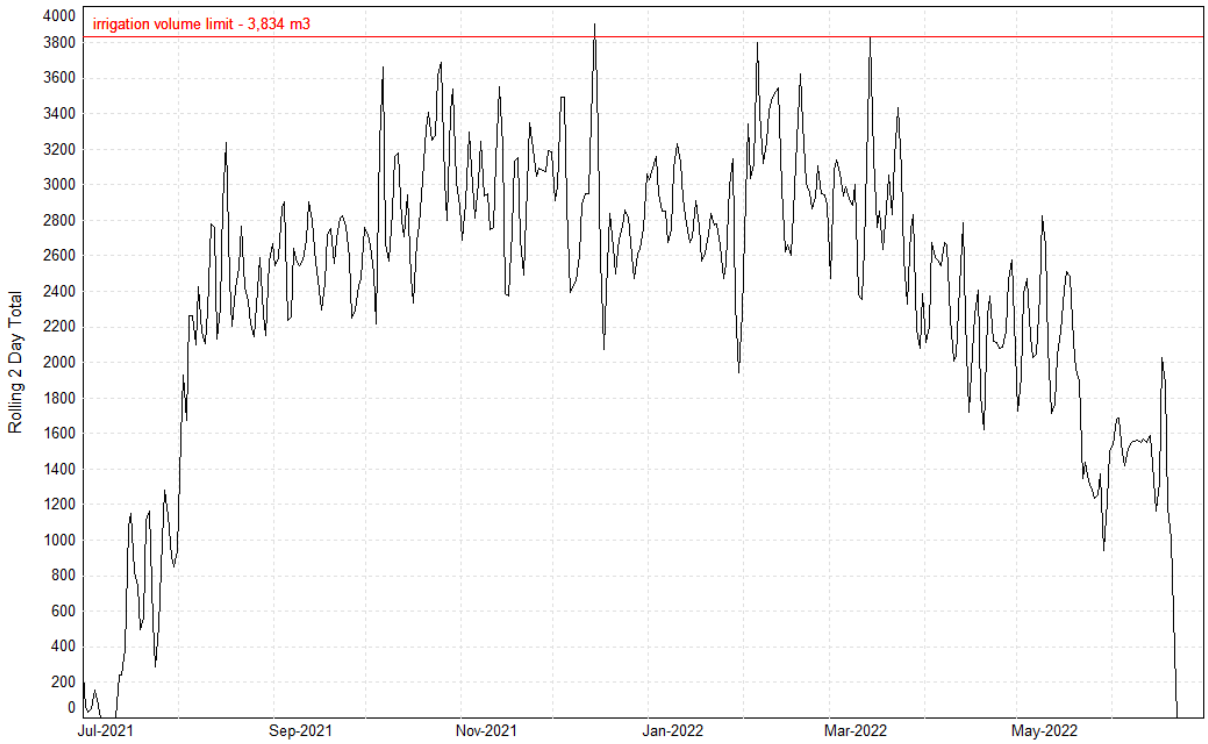

Figure 26 Irrigation volumes for Farms 2 & 3, 2 day rolling totals (FWW and DSE)

Table 9 Waste irrigation records supplied by Fonterra Ltd (volumes)

Month	Kapuni Farm 1						Farms 2 & 3					
	FWW			DSE			FWW			DSE		
	Days	Volume, m^3/d		Days	Volume, m^3/d		Days	Volume, m^3/d		Days	Volume, m^3/d	
		Av.	Max		Av.	Max.		Av.	Max.		Av.	Max.
Jul 21	23	139	333	21	29	82	25	242.3	640.5	13	32	62
Aug 21	11	244	567	11	39	81.5	31	1,145.5	1,620.5	22	47	93.5
Sep 21	30	394	521	30	74	116.5	30	1,231.0	1,378.5	30	66	118
Oct 21	31	459	830.5	31	80	119	31	1,436.3	1,808.0	27	62	115
Nov 21	30	550	832.5	10	77	115.5	30	1,485.0	1,777.0	4	56	74
Dec 21	31	547	854	25	50	83	31	1,398.0	1,952.5	8	59	81
Jan 22	31	463	783.5	24	70	119.5	31	1,305.1	1,559.5	27	95	166
Feb 22	28	580	933.5	26	78	117.5	28	1,458.0	1,900.5	25	114	167
Mar 22	31	465	671	17	54	85	31	1,335.9	1,749.0	26	100	167
Apr 22	30	456	646.5	6	59	90.5	30	1,097.6	1,348.5	12	85	167
May 22	31	393	691	5	40	64	31	946.1	1,412.5	0	0	0
Jun 22	21	269	386	0	0	0	21	528.5	1,013.5	0	0	0
Totals	328	141,893		206	12,930		350	412,643		194	14,907	

Note: Average daily volume irrigated is calculated from days when irrigation occurred

The data provided by the Company showed Company continued to irrigate a large volume of wastewater during the year under review. The data shows that the two day irrigation volume limit was complied with on

Farm 1, with the maximum volume irrigated on Farm 1 in any two consecutive days being a total of 1,963 m^3.

On Farms 2 and 3 the maximum volume irrigated in any two consecutive days was a total of 3,905 m^3. The Company contacted the Council at the time of the event to advise that this had occurred. The apparent exceedance was not recorded as an unauthorised discharge as the volume by which the consent limit had been exceeded was within the accuracy expected by the measuring device (± 5%).

Irrigation of factory effluent occurred almost daily during the monitoring year, with only 15 days when there was no irrigation. These days were during the winter shut down period, which occurs in June and July each year.

A total factory effluent volume of 554,536 m^3 was irrigated during the 2021-2022 year. This was an increase of 8% when compared to the previous year.

The Company's Whole Farm Management Plan (WFMP), which covers the consents requirements for an irrigation management plan, states that an even distribution over the paddocks is ideal, however this needs to be balanced with irrigation requirements, stock rotation and the weather.

During the year under review, the factory wastewater irrigation distribution between the farms during the year under review was 26% on Farm 1, 17% on Farm 2 and 58% on Farm 3. Given that the Farm areas are approximately 30%, 16 % and 54 % respectively, this indicates that there were generally higher application rates of FWW on Farm 3 when compared to Farm 1.

Table 10 FWW volumes 2017-2018 to date

Year		Farm 1	Farm 2	Farm 3	Annual volume (m^3)	Percentage change from previous year
Area irrigated	*ha*	*54.9*	*28.4*	*98.2*	*181.5*	-
	%	*30*	*16*	*54*	-	-
2017-2018	Volume (m^3)	145,382	95,964	334,837	576,183	-
	%	25	17	58	-	
2018-2019	Volume (m^3)	121,376	74,435	273,788	469,461	-18.5
	%	26	16	58	-	
2019-2020	Volume (m^3)	118,402	97,585	277,624	493,611	5
	%	24	20	56	-	
2020-2021	Volume (m^3)	118,037	94,416	299,053	511,506	4
	%	23	18	58	-	
2021-2022	Volume (m^3)	141,893	91,709	320,934	554,536	8.4
	%	26	17	58	-	

Disposal of DSE from the Farm 1 and Farm 3 dairy sheds to land via the factory effluent spray irrigation system was established in 2015-2016, ending the oxidation pond discharges to the Kaupokonui and Motumate Streams.

As with the FWW, the per paddock volumes provided by the Company have been combined to determine the daily volumes of DSE discharged. These are shown in Figure 27 and Figure 28.

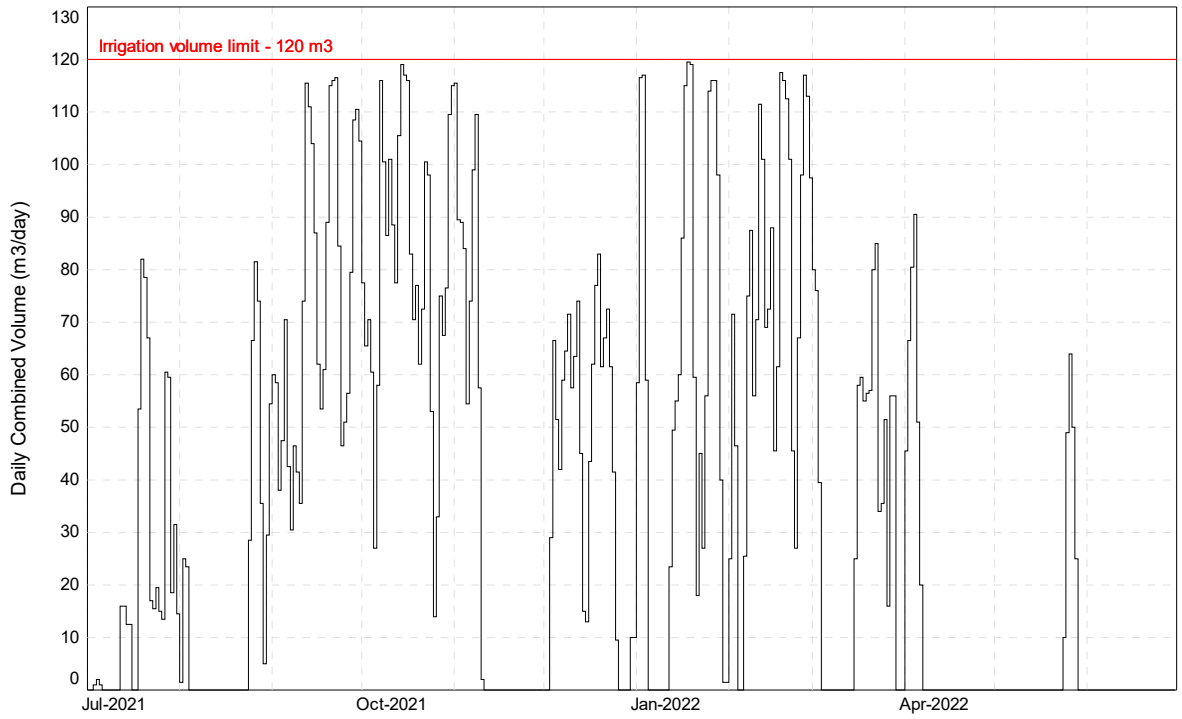

Figure 27 Daily DSE irrigation volumes for Farm1

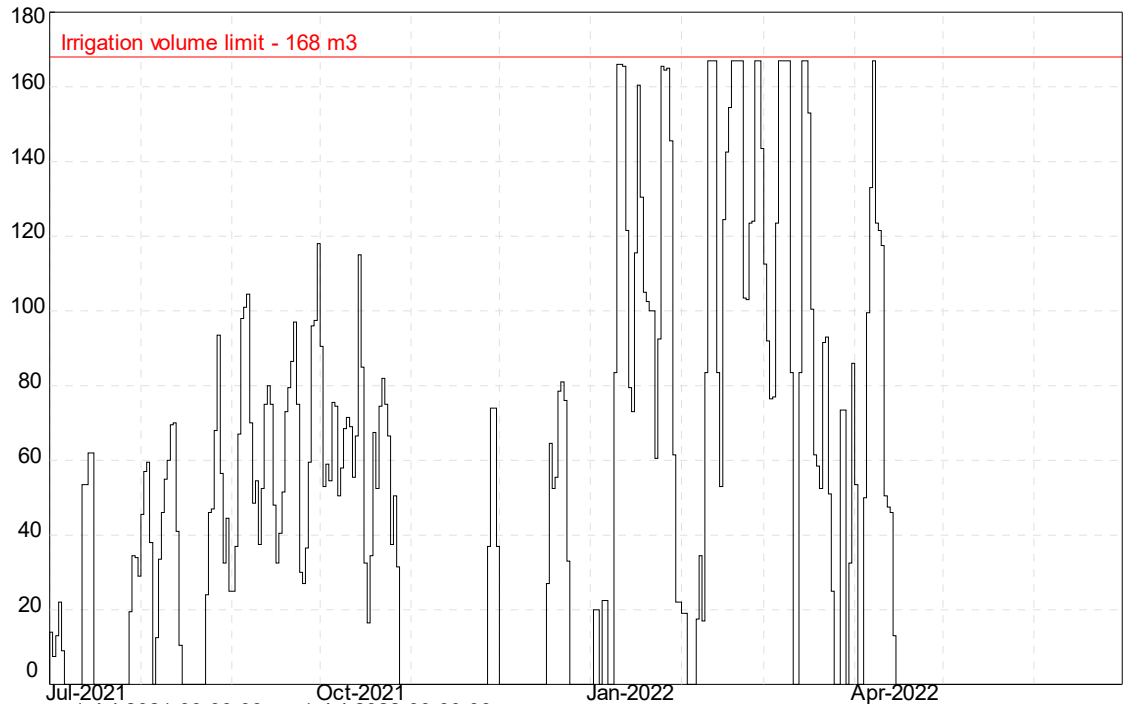

Figure 28 Daily DSE irrigation volumes for Farms 2 and 3

The maximum daily DSE volumes permitted by the Company's consents were complied with during the year under review.

It is noted that on an annual basis, although there was an increase in the FWW volumes irrigated during the year under review (Table 10), there was a decrease in the DSE irrigation volumes (Table 11).

Table 11 Annual DSE volumes 2017-2018 to date

Year	Farm 1 DSE volume (m^3)	Percentage change from previous year	Farm 2 DSE volume (m^3)	Farm 3[a] DSE volume (m^3)	Percentage change from previous year	Annual volume (m^3)	Percentage change from previous year
2017-2018	9,352		-	14,199		23,551	
2018-2019	12,034	29	-	13,276	9	25,310	8
2019-2020	19,229	60	-	13,972	5	33,201	31
2020-2021	18,175	-5	-	20,685	48	38,860	17
2021-2022	12,930	-29	667	14,240	-31	27,837	-28

Key a Prior to the 2021-2022 year, the DSE produced on Farm 3 could only be irrigated on Farm 3.

As outlined, the WFMP states that, with consideration for the stated constraints, the Company is aiming to ensure that the wastewater is distributed as evenly as possible.

Given the varying areas of the paddocks, the total FWW and DSE annual irrigation load as a cumulative depth in mm equivalent have been calculated for each paddock to provide a means of comparing paddock loadings. A statistical summary for each of the farms is given in Table 12, with the individual paddock loadings depicted in Figure 29 (Farm 1) and Figure 31 to Figure 34 (Farms 2 and 3). The locations of the paddocks are shown in Figure 30 (Farm 1) and Figure 33 (Farms 2 and 3).

In the following figures orange bars represent paddocks that the WFMP states should be avoided in wet conditions and the green bar represents a paddock that can become hard in dry conditions, due to the potential for run off to occur.

Table 12 Summary of the annual irrigation on Farms 1, 2 and 3 for the year under review

	Annual application (mm equivalent)		
	Minimum	Maximum	Average
Farm 1	115	394	284
Farm 2	211	372	334
Farm 3	236	404	343

It is noted that there is a large variation in the irrigation ranges both between Farms and within paddocks on each of the Farms.

In the case of Farm 1 the lowest irrigation application rate in mm equivalent discharged during the year under review was on paddock 7 at only 115 mm/year, with the highest load applied to paddock 9 at 394 mm/year. Paddock 2, which received a load of 119 mm equivalent during the year under review is identified in the WFMP as a paddock available for the disposal of solid effluent, however the paddock was not used for this purpose at any time during the year under review.

In the case of Farm 2 lowest irrigation application rate in mm equivalent discharged during the year under review was on paddock 13b at 211 mm/year, with the highest load applied to paddock 16a at 372 mm/year. The lower annual application rate on paddock 13b was in consideration of the elevated nitrogen concentrations that have been found in the bore located in this paddock (GND0638), which were particularly high in the 2020-2021 year.

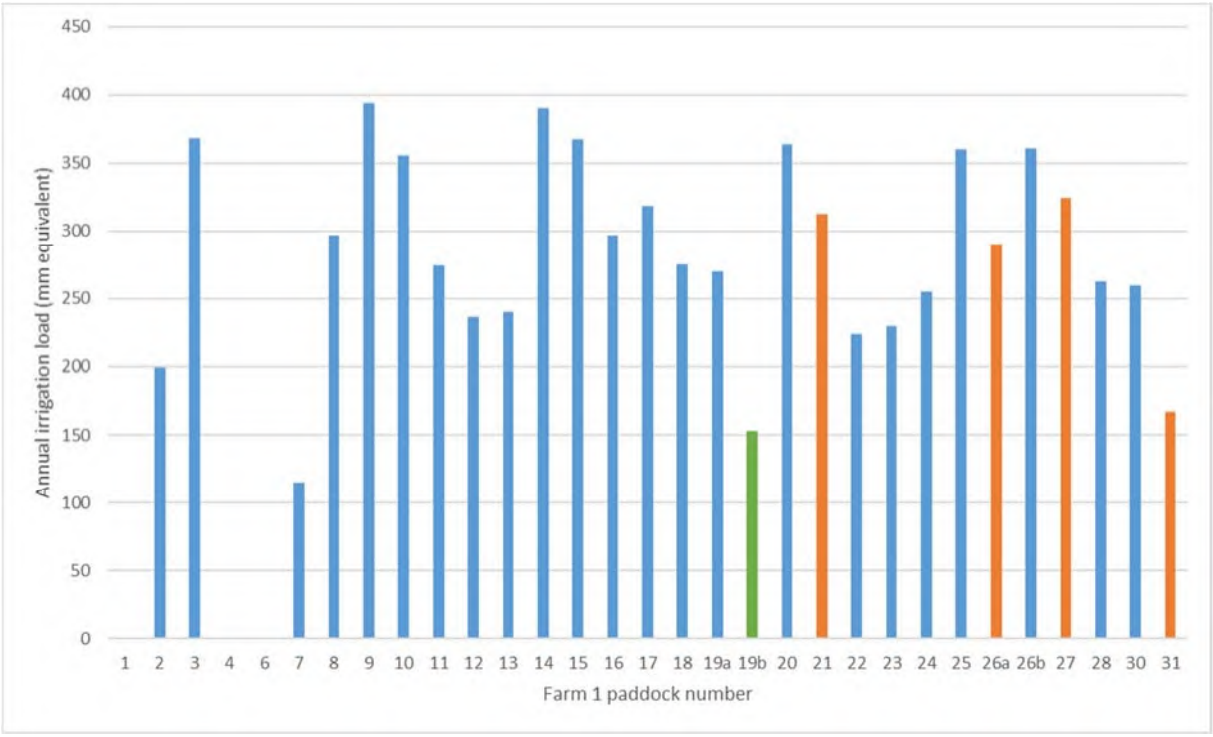

Figure 29 Farm 1 FWW and DSE irrigation load as mm per year equivalent for the year under review.

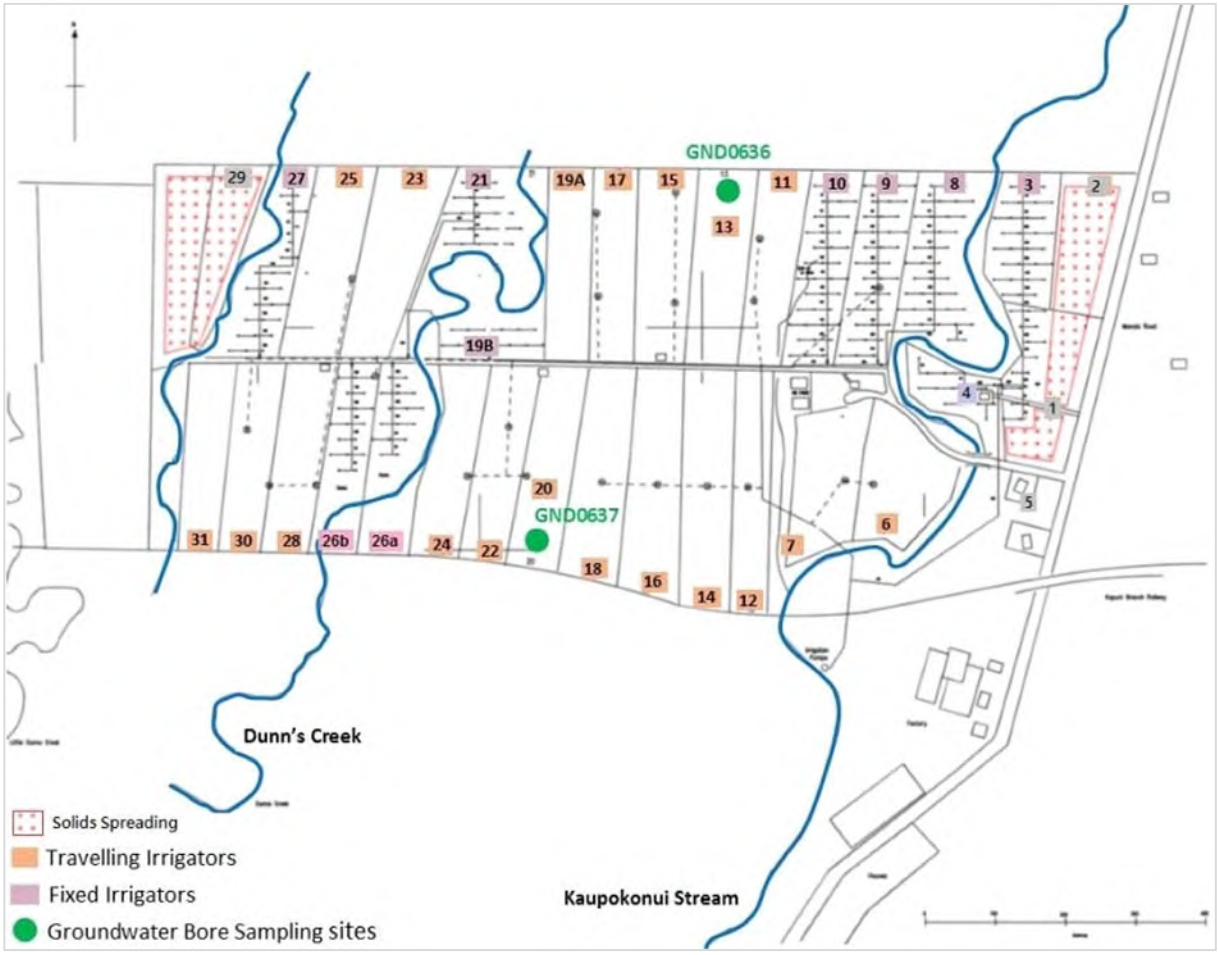

Figure 30 Paddock numbering, Farm 1

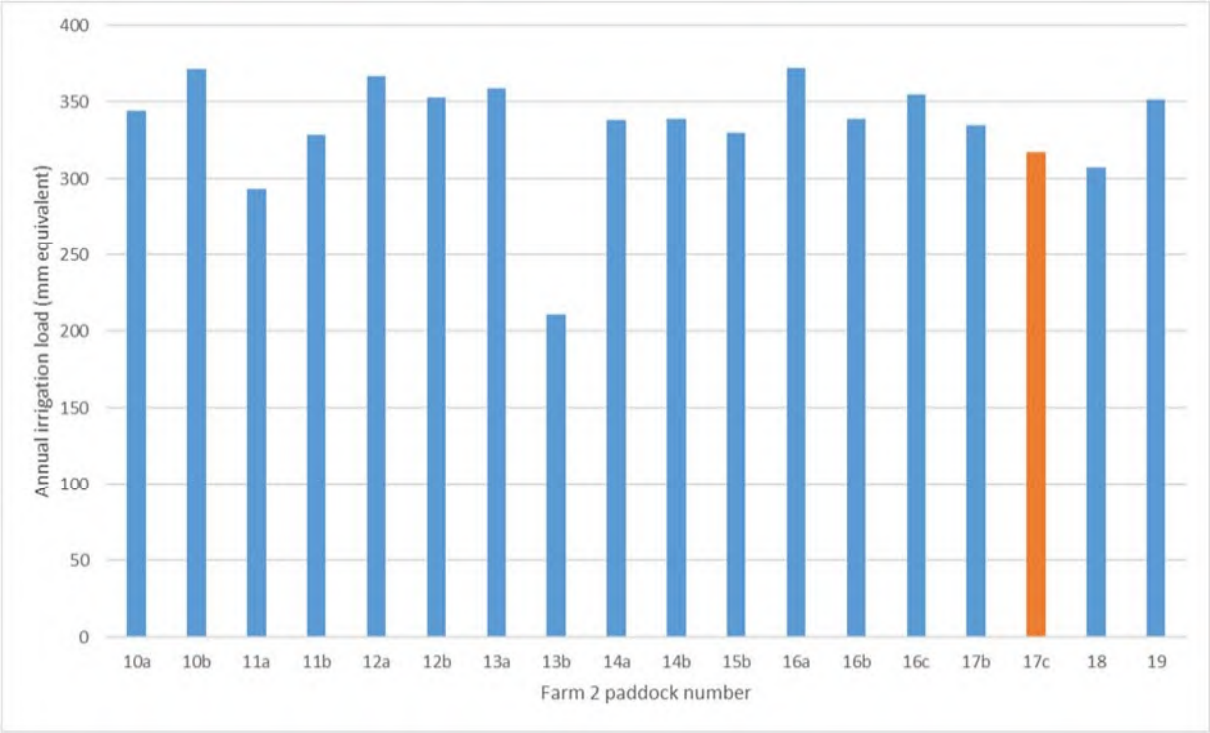

Figure 31 Farm 2 FWW and DSE irrigation load as mm per year equivalent for the year under review.

The application rates in the Farm 3 paddocks that are equipped with fixed in ground irrigators were generally in the range 300-400 mm equivalent. The exception to this was paddock 4. Paddock 4 received the lowest load at 290 mm equivalent.

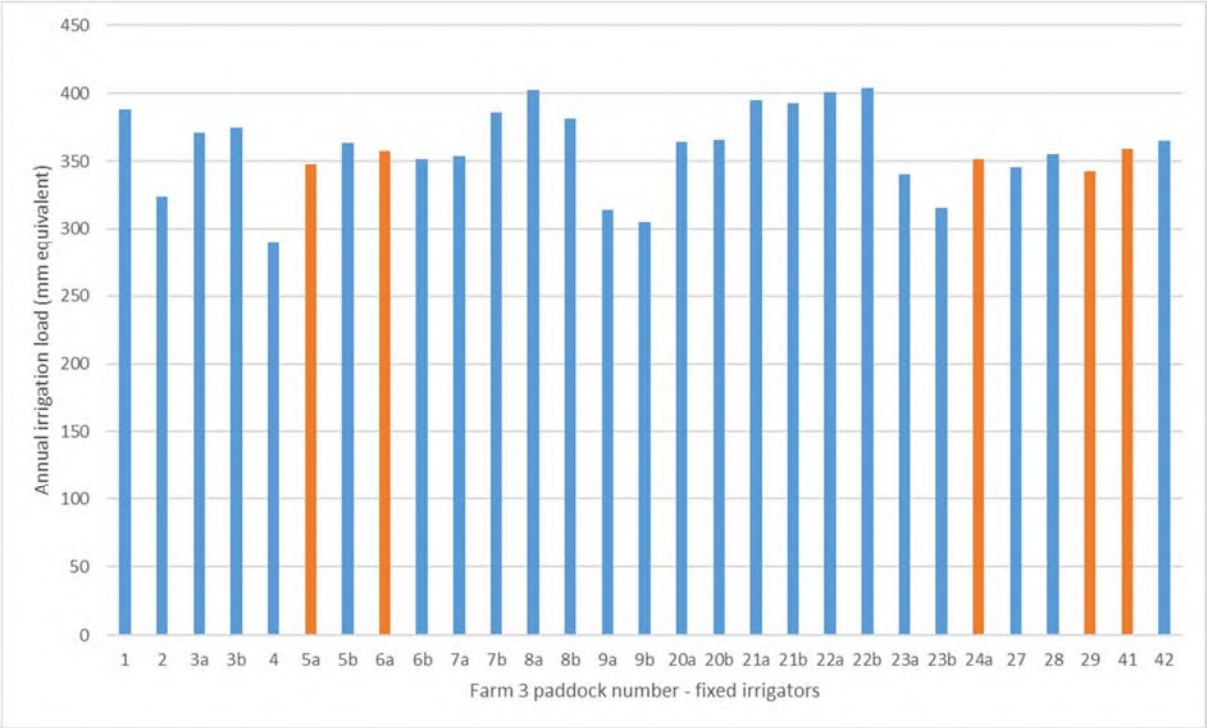

Figure 32 Farm 3 FWW and DSE irrigation load as mm per year equivalent for the year under review, paddocks with fixed irrigators

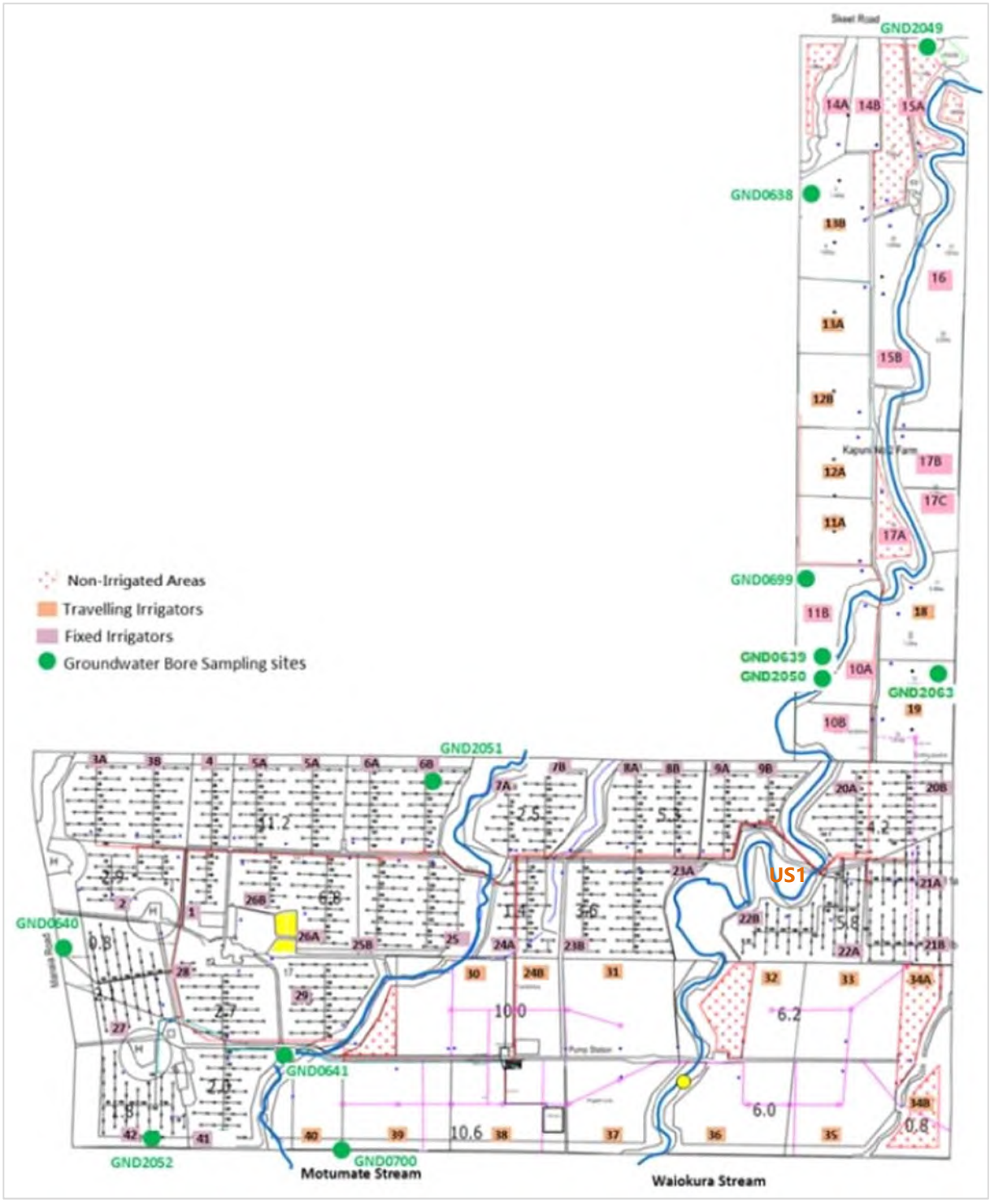

Figure 33 Paddock numbering, Farms 2 and 3

The application rates in the Farm 3 paddocks where travelling irrigators are used were generally slightly lower, being in the range 290 to 350 mm equivalent. Paddock 40, which is identified in the WFMP as a paddock that should be avoided in wet conditions due to there being a swampy area on the west side, received the lowest irrigation load on Farm 3.

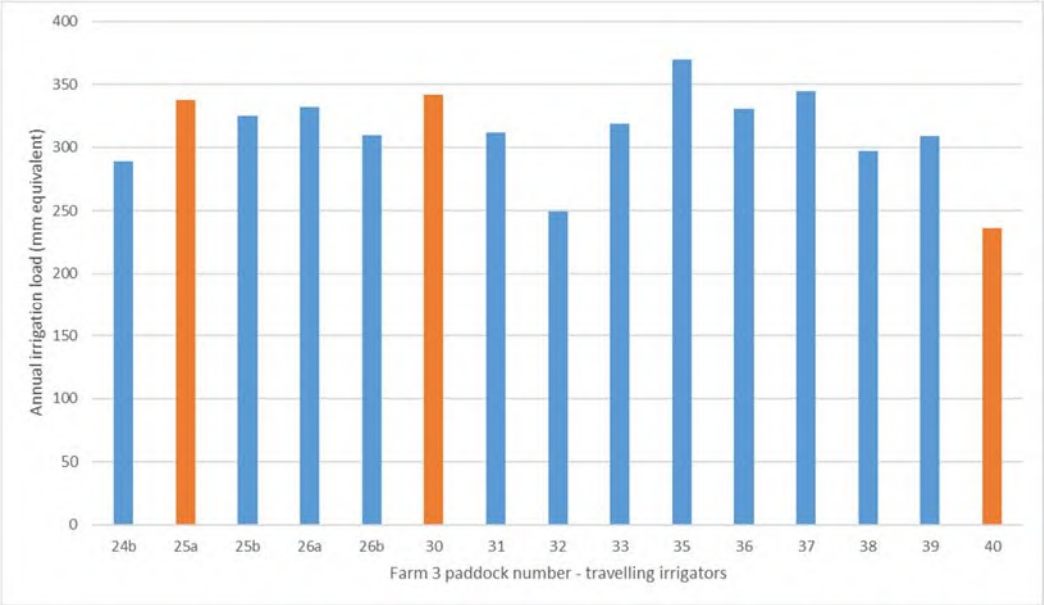

Figure 34 Farm 3 FWW and DSE irrigation load as mm per year equivalent for the year under review, paddocks with travelling irrigators

In general terms, there was an 8 % increase in the volume of wastewater irrigated to the farms and a reduction of 28% in the volume of DSE irrigated.

The Council was informed that this was due to the product being supplied to the site having contained a higher mineral content than in previous years. This resulted in an increase in the amount of "cleaning in place" (CIP) required in the factory equipment. This, along with the inclusion of the volume of water used for the flushing of the wastewater lines, have contributed to the increased amount of factory wastewater irrigated during the year under review that can be seen in Figure 35. The CIP chemical in use at the site is nitric acid and therefore the increases in CIP will have also affected both the nitrogen concentration of the FWW and the contaminant loads applied to the farms, as discussed in the following sections.

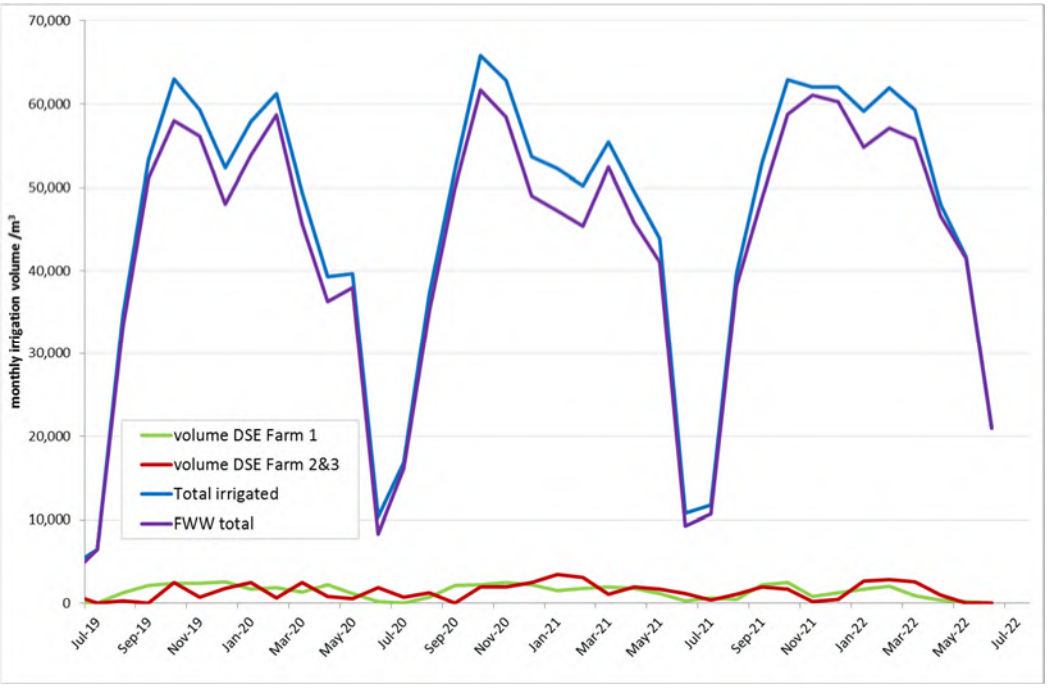

Figure 35 Relative monthly irrigation volumes during the year under review, with previous two years for comparison

2.1.1.6.2 Wastewater composition

Factory wastewater

The Company commenced monthly monitoring of factory wastewater composition in May 2007. This was done at the request of the Council in order to improve calculations of loadings on irrigation areas and to characterise variation in effluent quality. The Company increased the frequency to weekly grab sampling in July 2008. The plant wastewater is now automatically sampled by the Company at the filter on the line from the plant wastewater tank. A grab sample is taken every five minutes when wastewater is being pumped to the farms. The composite of these grab samples is refrigerated and an approximately weekly composite sample is sent to an outside laboratory (Industrial Chemistry Services Ltd) for analysis. In 2021-2022 the pH, organic strength, major mineral components, nutrients (including nitrogen species) and the metals copper and zinc were determined for 46 samples collected between 5 July 2021 and 27 June 2022. It is noted that, although the number of samples collected for analyses had been steadily increasing since the 2017-2018 year, there were a decreased number analysed during the year under review, with the samples being composited over between 3 and 27 days. The results are summarised in Table 13.

Table 13 Results of factory wastewater monitoring by Fonterra Ltd

Parameter	Unit	2021-2022		% change	2020-2021		% change	2019-2020	
		Median N = 46	Range		Median N = 51	Range		Median N=49	Range
pH	pH	4.5	2.7 - 11.6	0.0	4.5	3.8 - 7.4	2	4.4	4.0 – 8.0
Conductivity	µS/cm @25°C	1,886	195 - 2,510	26	1,496	228 - 2,580	-	-	-
Chemical oxygen demand	g/m^3	5,820	46 - 10,160	13	5,140	43 - 8,630	-3	5,300	82 – 9,480
Biochemical oxygen demand	g/m^3	3,200	40 - 5,600	7	3,000	20 - 4,400	-6	3,200	30 – 4,800
Total Nitrogen	g/m^3N	126	5.0 - 171.0	27	99	8.9 - 167	-2	102	5.0 - 166
Nitrate	g/m^3N	84	0.01 - 130	35	62	0.1 - 139	2	61	0.8 - 130
Nitrite	g/m^3N	1.0	0.01 - 29	-36	1.4	0.0 - 20	-42	2.4	0.01 - 30
Total Kjeldahl Nitrogen (TKN)	g/m^3N	26	5 - 116	-28	36	0.8 - 104	44	25	1.0 - 96
Calcium	g/m^3	138	7 - 252	-15	162	12.0 - 276	-11	183	50 - 306
Calcium	meq/L	6.9	0.3 - 12.6	-15	8.1	0.6 - 13.8	-	-	-
Magnesium	g/m^3	17.0	4.3 - 91.0	74	9.8	4.8 - 41	-18	12	4.9 - 46
Magnesium	meq/L	1.4	0.4 - 7.5	75	0.8	0.4 - 3.4	-	-	-
Sodium	g/m^3	196	15 - 289	89	104	15 - 228	-2	107	22 - 2358
Sodium	meq/L	8.5	0.6 - 12.6	90	4.5	0.63 - 9.9	-	-	-
Potassium	g/m^3	48	10 - 170	20	40	13 - 110	-17	48	10 - 265
Total Phosphorus	g/m^3P	80	3 - 141	36	59	0.7 - 161	-31	85	4.2 - 144
Chloride	g/m^3	82	12 - 160	36	60	14 - 234	-	-	-
Ash	g/m^3	1,196	123 - 1,591	33	902	77 - 1,883	-8	976	93 - 1,816
Copper	g/m^3	0.156	0.020 - 0.510	-32	0.230	0.014 - 0.860	-15	0.270	0.042 - 0.850

Parameter	Unit	2021-2022		% change	2020-2021		% change	2019-2020	
		Median N = 46	Range		Median N = 51	Range		Median N=49	Range
Zinc	g/m³	0.390	0.160 - 0.730	15	0.340	0.029 - 0.750	3	0.330	0.028- 0.770
Sodium adsorption ratio		4.2	0.6 - 19.0	89	2.2	0.54 - 4.2	-27	3.0	0.8 – 5.9

The lactose plant wastewater typically has high organic strength and is acidic. A comparison can be made between results for the 2019-2020, 2020-2021 and 2021-2022 monitoring years on the basis of median values, as shown in Table 13. The results of the FWW monitoring during the year under review has shown the effect of the increased mineral concentration of the material received at the site for processing and the increase in the CIP regime. Wastewater organic strength in 2021-2022, was, on the whole similar to or more concentrated when compared with the 2019-2020 and 2020-2022 years, with only the median nitrite, TKN, calcium and copper concentrations being lower than the previous year. Although there was a reduction in the median TKN and nitrite, the total nitrogen median was 27% higher than the previous year. It is noted that the occasional elevation in nitrite concentration that has been observed at times in recent years has continued during the year under review. However, as with previous years, the highest concentrations found in any of the groundwater monitoring bores have remained low. The maximum concentration in the year under review was 0.015 g/m³ in the Farm 1 control bore, which is well below the long term drinking water standard of 0.2 g/m³.

The mineral concentrations in the year under review were generally higher than in the previous two years, with a 75% increase in median magnesium concentration and a 90% increase in the median sodium concentration. The median total phosphorus concentration had decreased between the 2019-2020 and 2020-2021 years, but this increased again during the year under review. The sodium adsorption ratio (SAR) was again elevated on occasion, though well within the safe range for soil stability on all but one occasion. The elevated SAR of the FWW composite sample collected between 5 July and 16 July 2021 was due to an increased use of caustic acid, with the increase in "cleaning in place requirements" and pH stabilisation of the wastewater.

Both the FWW and DSE strengths vary through the season. A comparison of the relative strengths of these different wastewater streams is shown in Figure 36 to Figure 43, following the DSE section.

Dairy shed effluent (DSE)

The Company began weekly analysis of DSE during the 2015-2016 season upon the commencement of spray irrigation of DSE to land, together with FWW. Automatic solenoid samplers, located beside the storage pond pump at each farm, collect composite samples over 24 hours whenever DSE pumping occurs, with an approximately weekly composite being analysed for each farm's DSE. The parameters determined are similar to those for the factory wastewater, with the exception that chemical oxygen demand (COD), copper and zinc are not determined. A total of 27 samples were taken between 16 July 2021 and 2 June 2022 for Farm 1, and 29 samples were taken between 5 July 2021 and 7 Jul 2022 for Farms 2 and 3. The results are summarised in Table 14.

Table 14 Results of dairy shed effluent monitoring by Fonterra Ltd

Parameter	Unit	Farm 1			Farms 2 & 3		
		Median N = 46	Range	2020-2021 median (N=46)	Median N = 37	Range	2020-2021 median (N=37)
pH	pH	7.9	7.3 - 8.2	7.8	8.0	7.6 - 8.2	7.9
Biochemical oxygen demand	g/m^3	300	121 - 480	320	360	120 - 1,400	240
Total Nitrogen	g/m^{3}N	109	73 - 230	163	127	44 - 236	97
Nitrate	g/m^{3}N	0.2	0.0 - 4.4	0.23	0.2	0.0 - 6.6	0.50
Nitrite	g/m^{3}N	0.3	0.0 - 12.0	0.20	0.2	0.1 - 12.0	0.20
Total Kjeldahl Nitrogen (TKN)	g/m^{3}N	107	72 - 229	159	127	42 - 236	96
Calcium	g/m^3	72	42 - 151	99	86	38 - 126	80
Magnesium	g/m^3	21	5 - 89	25	28	5 - 81	19
Sodium	g/m^3	71	29 - 147	72	48	25 - 84	49
Potassium	g/m^3	335	190 - 575	615	345	40 - 730	290
Total Phosphorus	g/m^{3}P	48	26 - 102	61	48	20 - 112	38
Ash	g/m^3	1,027	553 - 2,364	1,417	1,051	349 - 1,771	842

Comparison of contaminant concentrations in the factory wastewater and DSE

The DSE has generally been found to have much lower organic (BOD compared to BOD and COD, Figure 36) and higher mineral strength than factory wastewater (for example potassium, Figure 42), and is slightly alkaline (Figure 37).

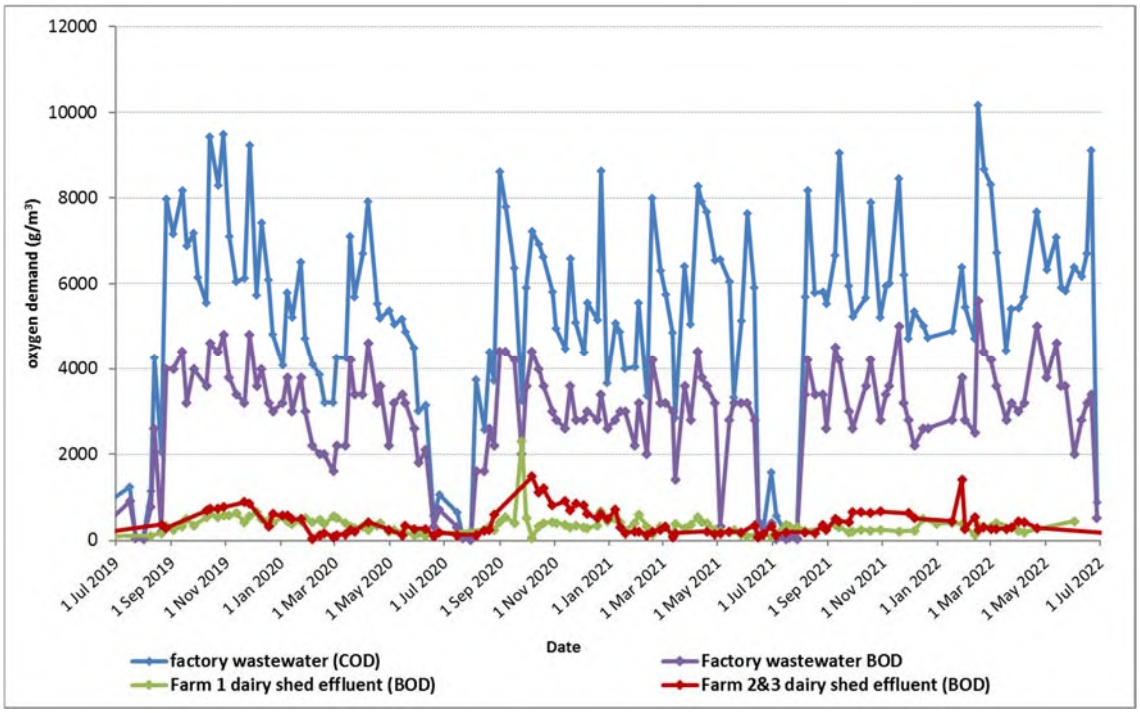

Figure 36 Oxygen demand of the factory wastewater and dairy shed effluents during the year under review, with previous two years for comparison

Figure 37 pH of the factory wastewater and dairy shed effluents during the year under review, with previous two years for comparison

In recent years, the median total nitrogen concentrations of the Farm 1 and Farm 3 DSE have generally been higher than those of the FWW. During the year under review, there was less of a difference between the annual median total nitrogen concentrations of these three wastewater streams.

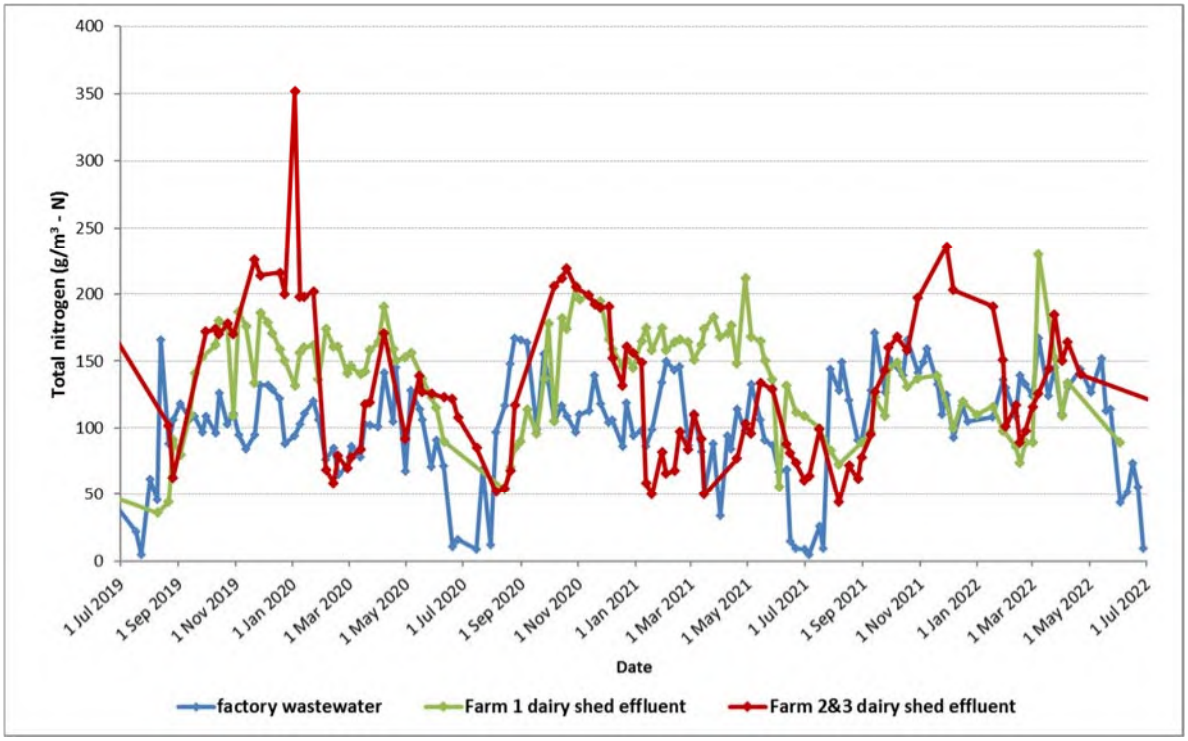

Figure 38 Nitrogen of the factory wastewater and dairy shed effluents during the year under review, with previous two years for comparison

The predominant nitrogen species present in the DSE are generally ammoniacal nitrogen and organically bound nitrogen, whereas the factory wastewater contains much higher concentrations of nitrate and nitrite nitrogen.

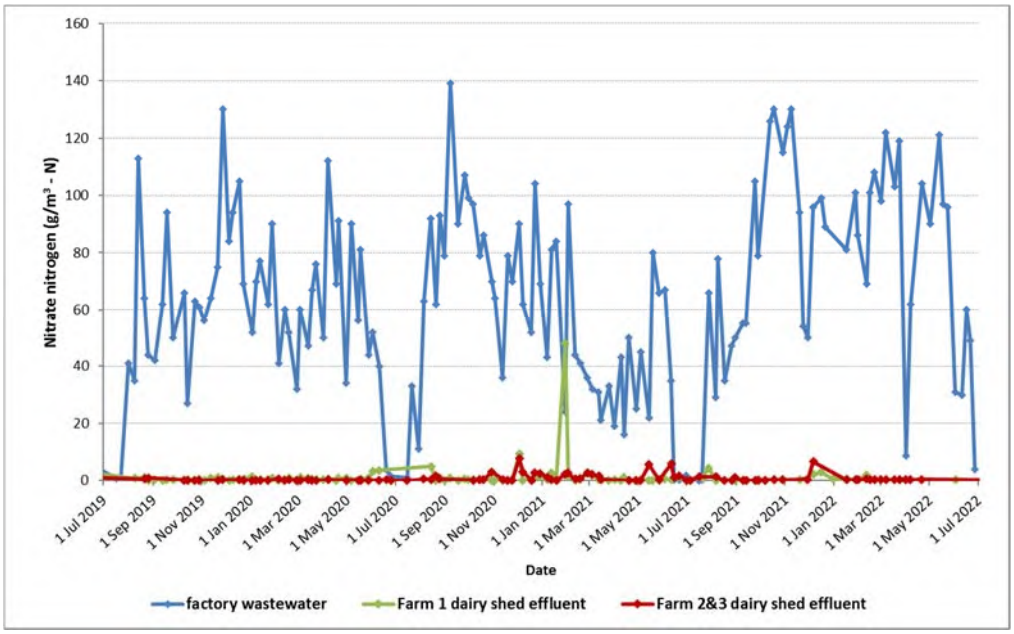

Figure 39 Nitrate nitrogen of the factory wastewater and dairy shed effluents during the year under review, with previous two years for comparison

It is noted that the nitrite concentration of the Farm 3 DSE had reduced, and remained low for the 2018-2020 years. This parameter was elevated to varying degrees on occasion in both the Farm 1 DSE and Farm 3 DSE during the 2020-2021 year, but was elevated in only one of the composite samples for each of the farms year under review. The nitrite concentration of the factory wastewater had been showing a progressive increase in nitrite concentration season on season between the 2017-2020 monitoring years. Although the concentrations had decreased somewhat during the 2020-2021 year, it was again elevated at times in the year under review. (Figure 40).

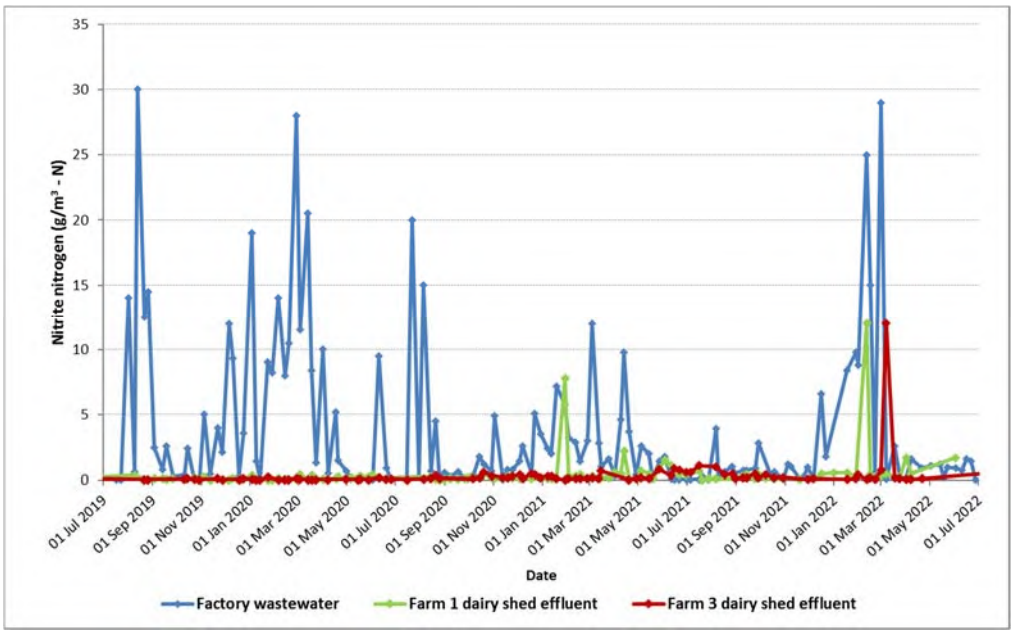

Figure 40 Nitrite nitrogen of the factory wastewater and dairy shed effluents during the year under review, with previous three years for comparison

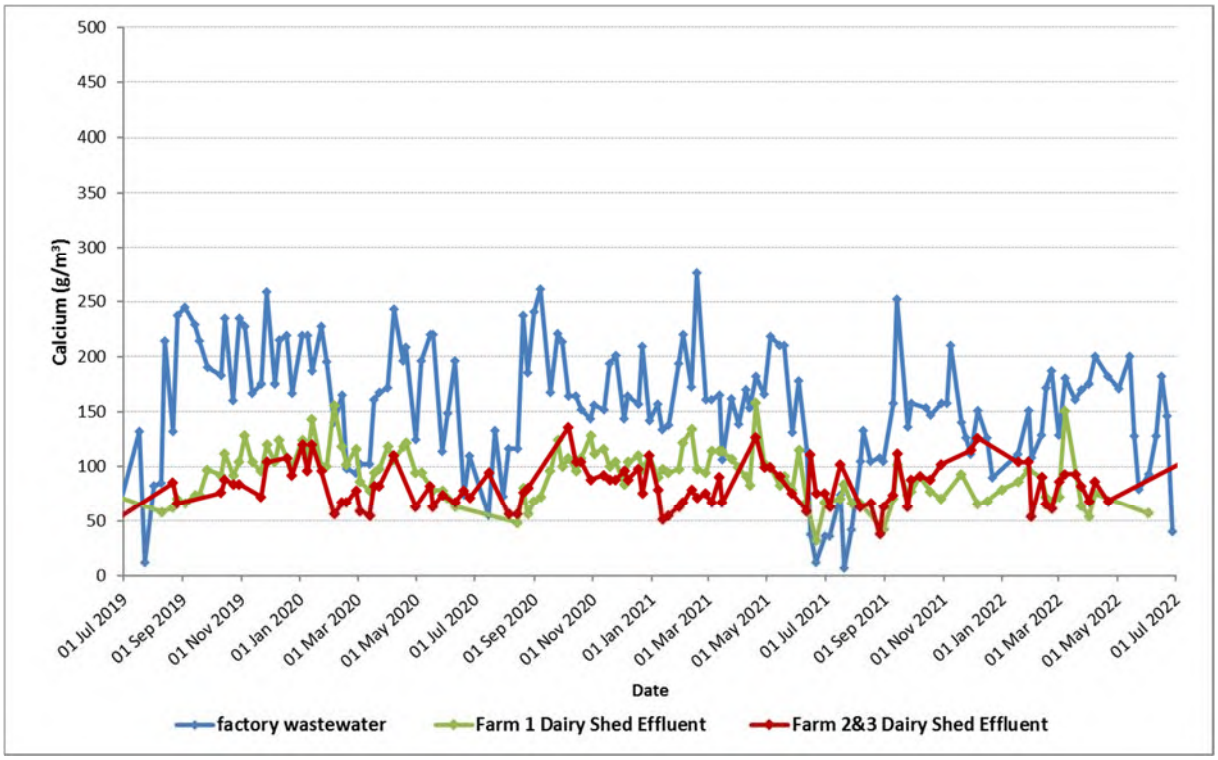

Figure 41 Calcium concentration of the factory wastewater and dairy shed effluents during the year under review, with previous two years for comparison

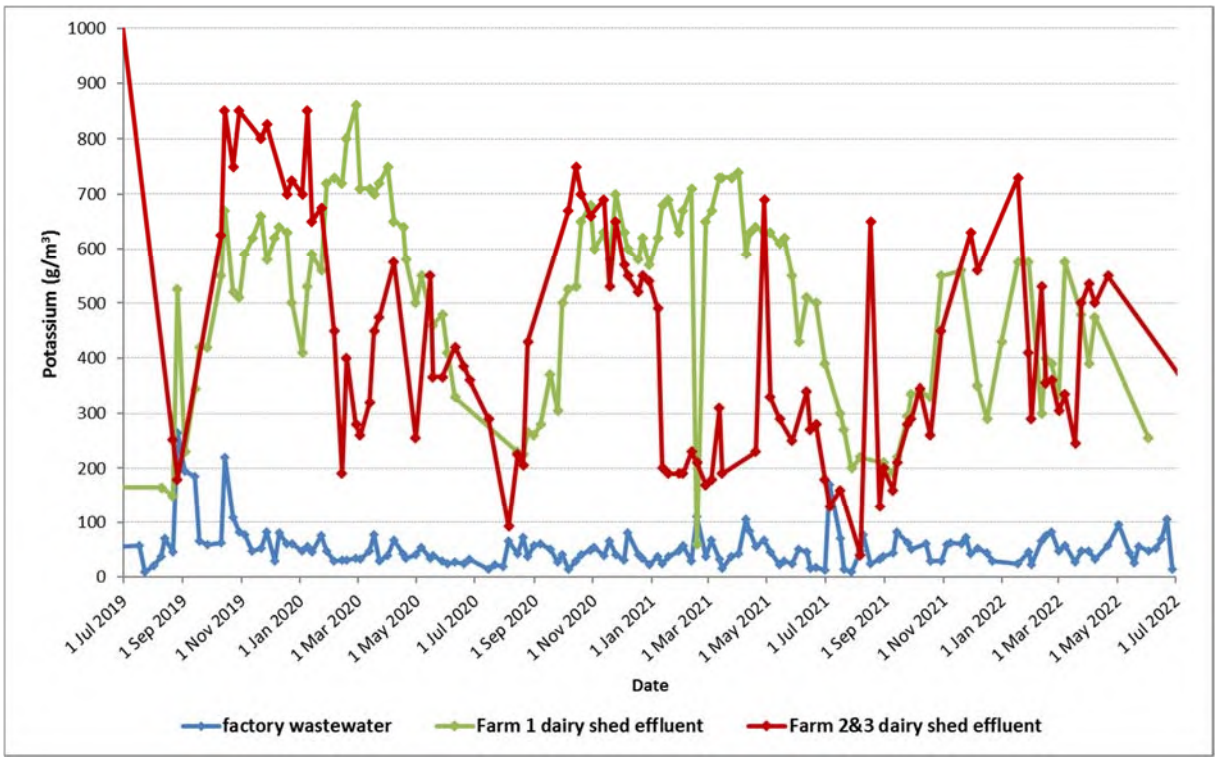

Figure 42 Potassium concentration of the factory wastewater and dairy shed effluents during the year under review, with previous two years for comparison

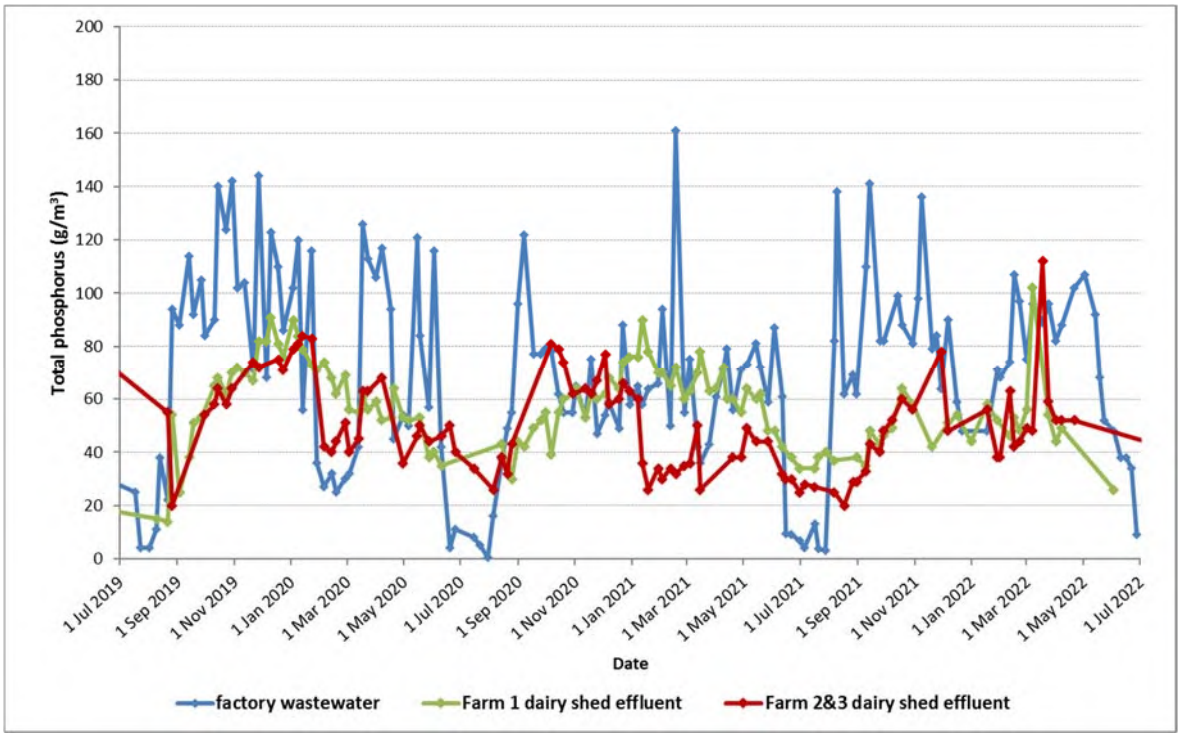

Figure 43 Phosphorus concentration of the factory wastewater and dairy shed effluents during the year under review, with previous two years for comparison

Interlaboratory comparison

The interlaboratory comparison exercise was carried out on 21 December 2021. The samples collected were a split subsample of the weekly composite of the 24-hour composite samples taken of factory wastewater and farms DSE by the Company. The results are given in Table 15.

Table 15 Results of interlaboratory comparison on factory and dairy effluents, 21 December 2021

Parameter	Unit	Factory wastewater		Dairy shed effluent (Farm 1)		Dairy shed effluent (Farms 2 & 3)	
		Fonterra (ICS)	TRC	Fonterra (ICS)	TRC	Fonterra (ICS)	TRC
Sum of anions	meq/L	-	11	-	21	-	29
Sum of cations[a]	meq/L	-	18.3/17.7	-	24/23	-	31/29
% Difference in Ion Balance	%	-	25	-	6.9	-	3.9
Alkalinity, total to pH 4.5	g/m³ $CaCO_3$	-	84	-	710	-	1020
Biochemical oxygen demand (BOD)	g/m³	2600	2100	440	81	640	240
Chloride	g/m³	84	83	-	210	-	290
Chemical oxygen demand (COD)	g/m³	4730	4200	-	-	-	-
Dissolved Calcium	g/m³	-	87	-	44	-	62
Total Calcium	mS/m	90	89	75	58	90	89
Dissolved Magnesium	g/m³	-	12.3	-	28	-	46
Total Magnesium	g/m³	13	11.8	15	31	13	55
Dissolved Potassium	g/m³	-	64	-	330	-	450

Parameter	Unit	Factory wastewater		Dairy shed effluent (Farm 1)		Dairy shed effluent (Farms 2 & 3)	
		Fonterra (ICS)	TRC	Fonterra (ICS)	TRC	Fonterra (ICS)	TRC
Total Potassium	g/m^3	29	65	270	330	490	470
Potassium adsorption ratio	-	-	1	-	5	-	6
Dissolved Sodium	g/m^3	-	250		68	-	55
Total Sodium	g/m^3	280	260	80	66	66	56
Sodium adsorption ratio	-	-	6.8	-	1.7	-	1.2
Ammoniacal nitrogen	g/m^{3}N	-	0.104	-	98	-	109
Nitrate	g/m^{3}N	89	87	0.2	0.37	<0.2	< 0.10
Nitrite	g/m^{3}N	1.8	1.27	<0.2	0.62	0.05	< 0.10
Nitrate + nitrite	g/m^3	91	88	-	0.24	-	< 0.10
Conductivity, 25°C	mS/m	177	166	-	222	-	297
Oil and grease	g/m^3	-	< 9	-	18	-	57
pH	pH	4.7	4.7	7.9	8	8	8.1
Suspended solids	g/m^3	-	340	-	340	-	710
Total Kjeldahl Nitrogen (TKN)	g/m^{3}N	14	31	92	103	166	194
Total Nitrogen	g/m^{3}N	105	119	92	104	166	195
Total Phosphorus	g/m^{3}P	48	50	16	51	66	57
Ash	g/m^3	989	-	1062	-	1430	-
Copper	g/m^3	0.25	-	-	-	-	-
Zinc	g/m^3	0.3	-	-	-	-	-

Key: a Duplicate results reported

In the 2015-2016 year, agreement between laboratories was poor, apart from on pH, which led to a revision of the methods of sample compositing, splitting and identification. During the year under review, the only parameters that were found to have good agreement (within ± 5%) for all three effluent sources was pH. Getting good agreement for the effluents can be particularly problematic due to the nature of the waste (that is they contain high concentrations of suspended solids that settle quickly during the splitting of the composite samples). The first area of focus continues to be in attempting to ensure that the samples are split in an effective manner, although it is acknowledged that this is difficult to achieve.

In terms of total nitrogen, there was underestimation of 12%, in the total nitrogen results for the FWW, and Farm 1 DSE, and a 15% underestimation of the total nitrogen results for the Farm 3 DSE result reported by the Company.

In terms of total phosphorus, there was good agreement between the results obtained for the FWW, particularly poor agreement in the Farm 1 DSE results and relatively poor agreement for the Farm 3 DSE results.

The discrepancy between the sum of anions and sum of cations, and conductivity in the factory wastewater indicates the presence of other anions (potentially from organic acids or dissolved phosphorus) that have not been quantified in the parameters determined. It is recommended that the Company investigate the potential environmental significance of the presence of these unidentified anions in the irrigated

wastewater. Council may request that the Company have the suspended solids concentration of their sample determined as an indicator of the effectiveness of the sample splitting.

2.1.1.6.3 Nitrogen and phosphorus contaminant loadings

Using data from sections 2.1.1.6.1 and 2.1.1.6.2 the approximate contaminant loadings can be estimated both in terms of the per paddock loadings and as monthly and annual totals. Prior to the year under review, only approximate per farm monthly and annual totals were able to be calculated based on the monthly irrigation volumes on each of the farms and the average monthly nitrogen and phosphorus concentrations for each of the three wastewater streams.

A summary of the mass of nitrogen applied to the farms from the various waste streams since the assessment of environmental effects was submitted to Council in support of the application for the re-issue of the discharge to land consents is provided in Table 16. The cumulative total monthly mass of nitrogen irrigated during the year under review is summarised in Figure 44, with the loads from each waste stream applied to each of the farms also illustrated.

Table 16 Summary of the annual mass of nitrogen applied, 2016 to date

Year	Farm 1 DSE (kgN)	Farm 1 FWW (kgN)	Farm 2 DSE (kgN)	Farm 2 FWW (kgN)	Farm 3 DSE (kgN)	Farm 3 FWW (kgN)	DSE total (kgN)	FWW total (kgN)	Total applied (kgN)
2016-2017	1,624	13,072	-	9,285	3,761	29,781	5,384	52,138	57,522
2017-2018	809	10,909	-	7,564	3,177	26,170	3,986	44,644	48,630
2018-2019	1,078	11,070	-	6,750	3,273	24,245	4,352	42,066	46,417
2019-2020	2,829	11,858	-	9,555	2,243	27,392	5,072	48,805	53,877
2020-2021	2,910	13,057	-	9,957	2,416	32,224	5,326	55,238	60,564
2021-2022	1,479	17,556	108	11,515	1,925	39,673	3,512	68,744	72,256

It can be seen from Figure 44 that the relative contributions to the total nitrogen mass irrigated reflects the lower mass of nitrogen applied from the much lower volumes of DSE, and the differences in the area of land available for irrigation at each of the farms.

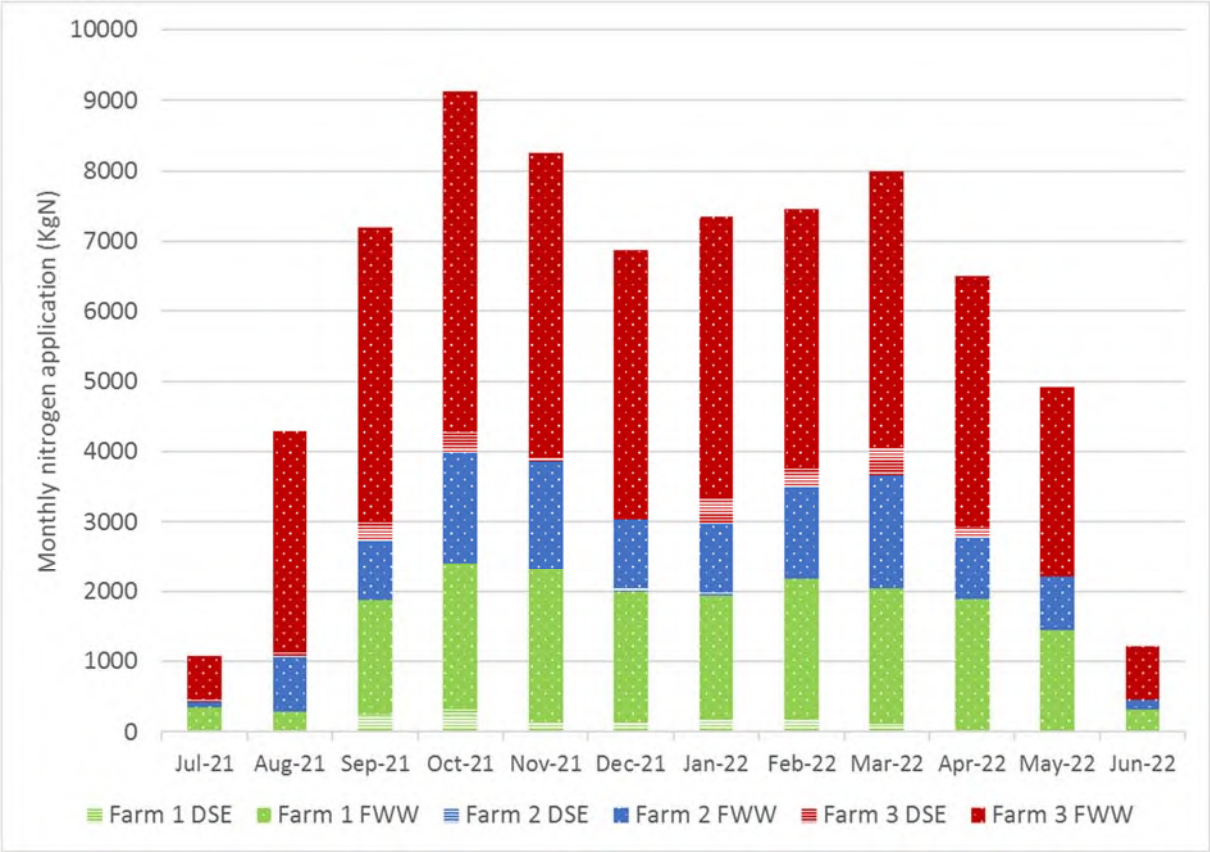

Figure 44 Cumulative monthly mass of nitrogen discharged to each farm for the year under review

The annual volume of FWW produced since 2009-2010, together with the annual mass of factory nitrogen irrigated, is presented in Figure 45. With respect to the mass discharge rate of wastewater components, FWW volume had generally changed little between the 2011-2012 and 2016-2017 years. Therefore, during this period, the estimated mass discharge rate of the wastewater components increased or reduced by about the same proportion as their respective concentrations. However, since the 2017-2018 year there has been much more variability in the annual volume discharged and/or the concentration of the components in the discharge. This has resulted in what was, in the 2017-2018 year, a maximum volume discharged, with a minimum total nitrogen mass discharge. A further reduction in the mass discharge rate of total nitrogen was achieved in the 2018-2019 year. There has been a steady increase in both the volumes and total nitrogen mass of the FWW since that time. Initially, these changes were as a result of an increase Food Safety and Quality requirements that have required an increase in the "cleaning in place" (CIP) of the factory equipment, for which nitric acid is used. In the 2021-2022 year, there was an additional 13,506 kg of nitrogen discharged in the FWW when compared to the 2020-2021 year, taking the nitrogen mass from this wastewater stream to over 68,000 kg. As previously outlined, this additional mass of nitrogen was due to an increase in the nitric acid CIP's being undertaken as a result of the high mineral content of the raw material being received at the site.

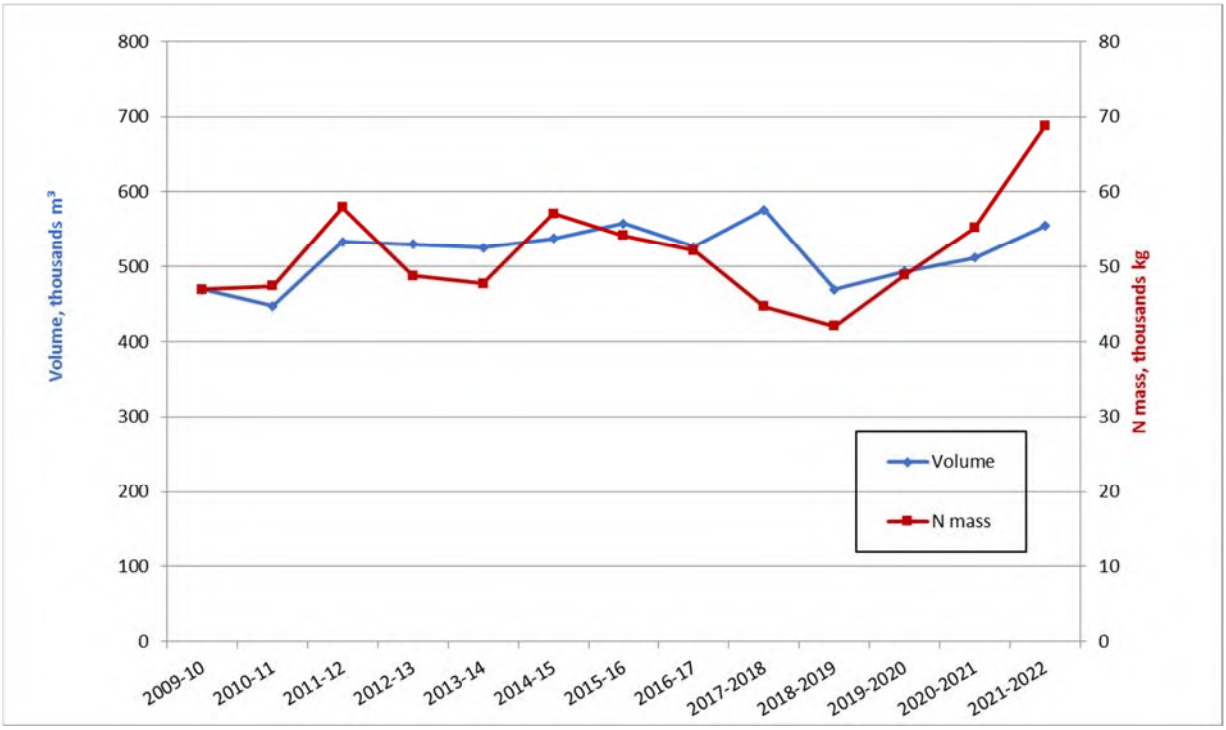

Figure 45 Annual volume of factory wastewater and estimated factory nitrogen mass irrigated, 2009-2022

In terms of the additional nitrogen load being discharged on the farms in the form of the DSE, this had represented approximately 8 or 9% of the total nitrogen mass between the 2016-2017 and 2020-2021 years, although the variation in the contribution that the Farm 1 DSE made to the total mass of nitrogen discharged on Farm 1 has varied quite considerably. The variation has been between 7 and 24% of the total mass of nitrogen discharged on this farm. During the year under review, 8% of the total nitrogen mass was from the Farm 1 DSE. In the case of the discharges to Farms 2 and 3 there has been less variation between monitoring years, with the DSE contributing between 6 to 11% of the total mass of nitrogen applied to these farms. During the year under review, only 4% of the total nitrogen applied on these farms was from the Farm 3 DSE.

In order to make reasonable comparisons of the amount of nitrogen being discharged under consents 0922-3.2 and 0923-3.3 and any potential or actual environmental effects, the nitrogen application rates need to be evaluated in kg/ha/year. A comparison of the estimated application rates are presented in Table 17. During the year under review, the approximate application rates for each paddock have been calculated, with the minimum, maximum and average application rates presented. Prior data has been estimated assuming that the effluent has been evenly distributed across the available irrigation area on each of the three farms. The data provided for the year under review has shown that this is not the case (Table 17, and Figure 46 to Figure 49).

Prior to the 2007-2008 year, the estimated annual nitrogen application rates were in the region of 523 kgN/ha/y. An expansion of the irrigation area of 49 ha in the 2007-2008 year was predicted to reduce the nitrogen load to about 371 kgN/ha/y. This increase in irrigation area was facilitated by the purchase of an additional 60 ha of land that lay between the original Farm 2 and Farm 3 areas.

On the whole, between the 2012-2013 and 2020-2021 years the nitrogen application rates, when averaged out across each of the farms, have been below or similar to this predicted application rate. During the year under review, the average nitrogen application rate was higher than in the previous nine years but remained just below that predicted following the expansion of the total available irrigation area. The average nitrogen application rates on Farms 2 and 3 was approximately 70 kgN/ha/y higher than on Farm 1 and approximately 50 kgN/ha/y higher than the predicted annual application rate.

It is noted that the nitrogen loads have been consistently lower on Farm 1 than on Farms 2 and 3. However, there is a large variation in the annual application rates of the individual paddocks.

Table 17 Farm nitrogen application rates

Monitoring year	Farm 1 nitrogen application rate (kg/ha/y)	Farms 2 and 3 nitrogen application rate (kg/ha/y)		Comments
		Farm 2	Farm 3	
2021-2022	151-509 (350)	282-465 (423)	290-489 (425)	Ranges and averages based on paddock by paddock irrigation data. Includes DSE and FWW. Irrigation area for DSE expanded to some paddocks on Farm 2.
2020-2021	290	356	377	This and earlier years are an average application rate, based on average monthly nitrogen concentration and monthly irrigation volumes. Includes DSE and FWW
2019-2020	267	341	322	Includes DSE and FWW
2018-2019	221	241	299	Includes DSE and FWW
2017-2018	230	326		Includes DSE and FWW
2016-2017	288	379		Factory wastewater and DSE fully implemented at Farms 1 & 3
2015-2016	283	353		Factory wastewater plus DSE (2 months only Farm 1) (9 months Farms 2 & 3)
2014-2015	270	382		Factory wastewater only, no DSE
2013-2014	259	309		Factory wastewater only, no DSE
2012-2013	244	321		Factory wastewater only, no DSE

The calculated nitrogen mass and annual loadings still need to be treated with caution. Although the data no longer relies on the assumption that the wastewater has been irrigated uniformly across all paddocks, there can be:

- significant discrepancies in the agreement between nitrogen concentrations in the interlaboratory wastewater samples; and
- the use of composite samples, which may cover periods of time when there has been variation in the nitrogen concentration of the wastewater streams.

The approximate per paddock nitrogen application rates for Farm 1 for the year under review are shown in Figure 46.

The paddocks receiving both the highest and lowest irrigation volumes (paddocks 9a and 7 respectively) also had the highest and lowest nitrogen application rates. The application rate on paddock 9a was 358 kgN/ha/y higher than the application rate on paddock 7.

It is noted that, at the time of irrigation, the nitrogen concentration of the wastewater in not known given that the composite sample is likely to be analysed up to several days after a given irrigation event. Although paddocks 28 and 30 received similar wastewater irrigation loads of approximately 260 mm equivalent during the year under review, approximately 280 kgN/ha/y was applied to paddock 28 and 310 kgN/ha/y was applied to paddock 30.

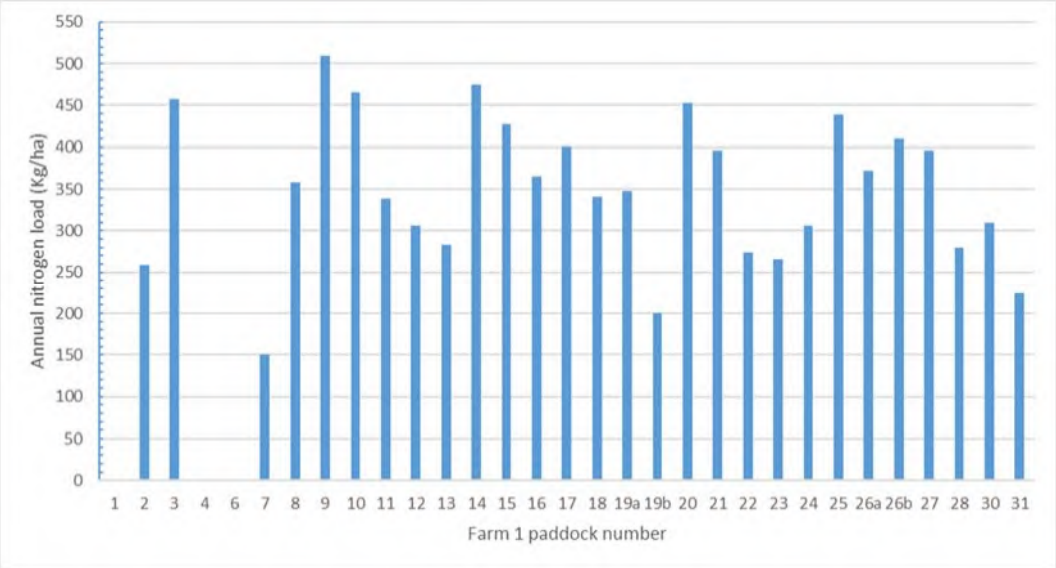

Figure 46 Paddock annual nitrogen application rates for Farm 1

It is noted that the Company also holds consent 10232-1.0 for the discharge of dairy shed pond wastes on this Farm. This consent specifies that in any 12 month period the total nitrogen applied to any hectare of land that is used for the spreading of the dairy pond sludge shall not exceed 200 kg. Although the annual nitrogen load for paddock 2 exceeded 200 kgN/ha/y, there was no disposal of waste from the dairy shed pond spread on this paddock during the year under review.

The approximate per paddock nitrogen application rates for Farm 2 for the year under review are shown in Figure 47.

Paddock 13b received the lowest annual nitrogen load on Farm 2 as an active mitigation that the Company has in place to allow the nitrogen concentrations of the groundwater in the vicinity of GND0638 to reduce from the elevated concentrations found in the 2021-2022 year.

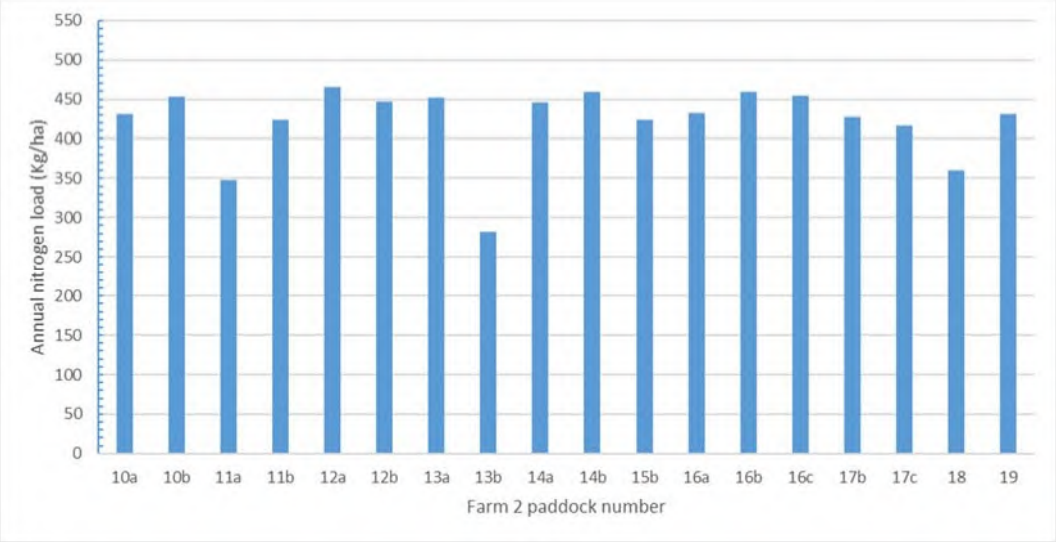

Figure 47 Paddock annual nitrogen application rates for Farm 2

The approximate per paddock nitrogen application rates for Farm 3 for the year under review are shown in Figure 48 and Figure 49.

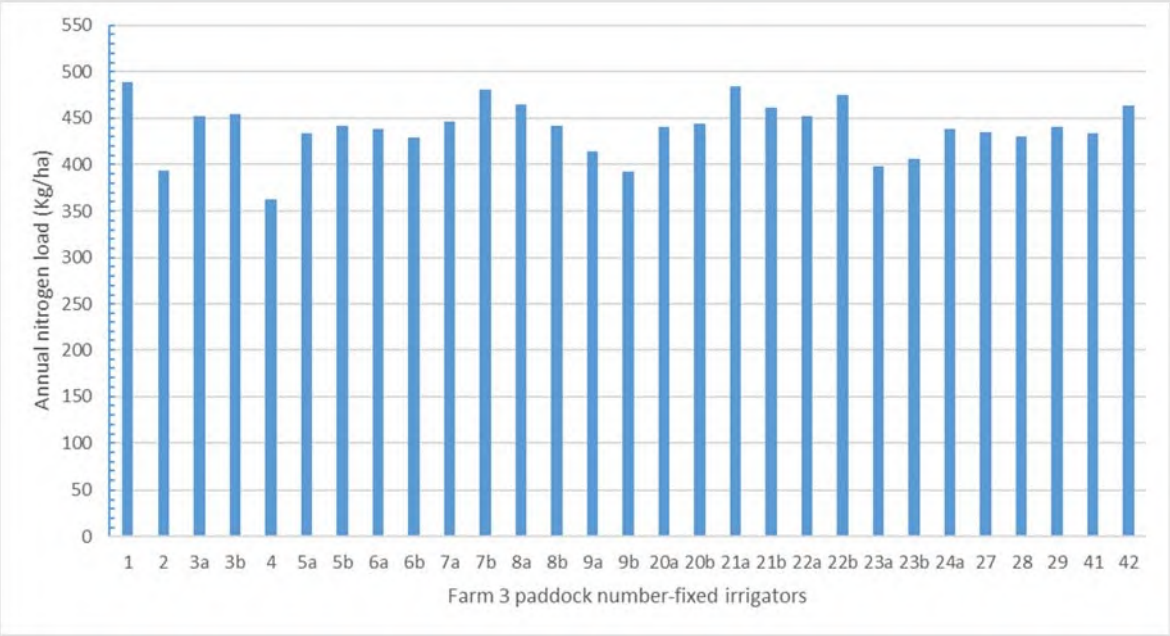

Figure 48 Paddock annual nitrogen application rates for Farm 3, fixed irrigator network

On Farm 3 the lowest nitrogen load was applied to paddock 40 at 290 kgN/ha/y. It is noted that the groundwater monitoring bore GND0700 is located on the the southern boundary of the Farm close to the fenceline between paddocks 39 and 40.

Paddocks served by the fixed irrigator system received, on average, a higher nitrogen application rate than those irrigated using travelling irrigtors. The average application rate in the paddocks with fixed irrigators was 439 kgN/ha/y, whilst the average application rate in paddocks irrigated with traveling irrigators was 396 kgN/ha/yr. With the exception of paddock 35, all the paddocks where travelling irrigators are used had nitrogen application rates at or below the overall Farm 3 average application rate.

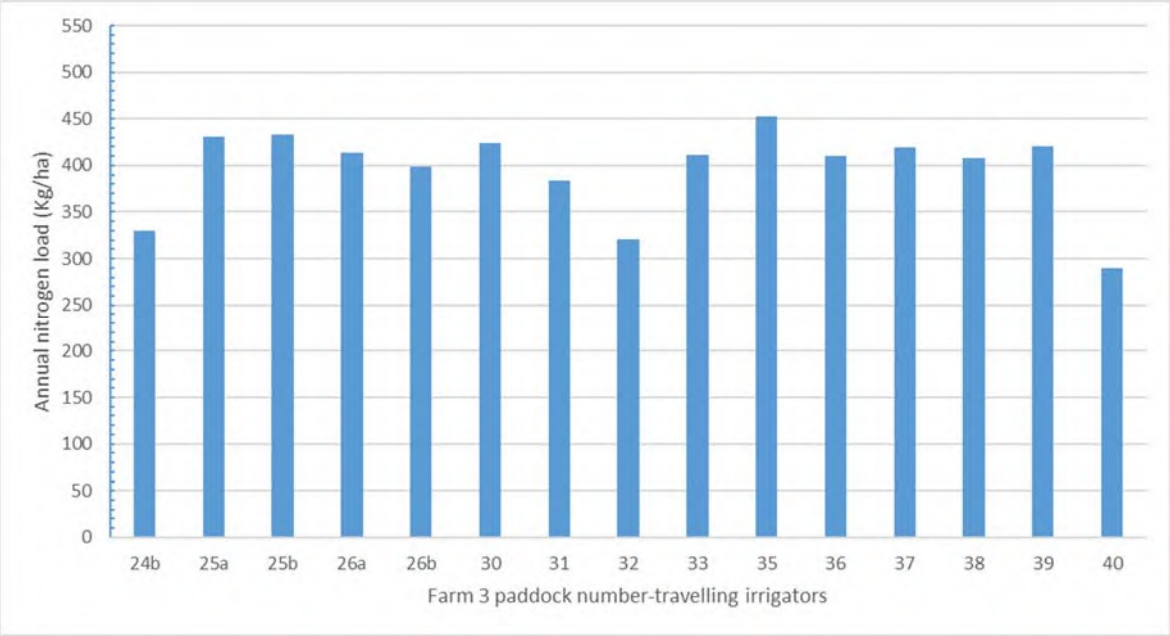

Figure 49 Paddock annual nitrogen application rates for Farm 3, travelling irrigators

The Company's WFMP states that an even distribution over the paddocks is ideal, however this needs to be balanced with irrigation requirements, stock rotation and the weather. It is clear that these, or other factors, have a greater impact on the Company's ability to evenly distribute the wastewater nitrogen application rates on Farm 1 than they do on Farms 2 and 3.

As outlined previously, in addition to the contaminant application rates, factors such as rainfall and soil moisture at the time of irrigation influence the potential for leachate to enter ground and/or surface water. These factors affect the leaching from the application of both of the main contaminants of concern, namely nitrogen and phosphorus.

Currently the Company's WFMP states that the potential for the wastewater irrigation to discharge to the streams flowing through the farms during rainfall events is mitigated by avoiding irrigation on paddocks adjacent to water ways. The mitigation measures to counter the potential for adverse effects when soil moistures are high are to shorten the irrigation event or to take the paddock out of the irrigation rotation for a period of time. This may mean that the paddocks that have been affected in this way receive a higher irrigation volume during the dryer months of the year to balance this out. There are currently no formal methods used by the Company for measuring the soil moisture of the paddocks before or after irrigation events. This is assessed visually by the irrigation operators.

The estimated monthly nitrogen and phosphorus loads irrigated onto the farms are shown in Figure 50 and Figure 52 respectively. During the year under review, a total of approximately 72,256 kg of nitrogen and approximately 46,403 kg of phosphorus were irrigated on to the farms. These were increases in the approximate annual mass of nitrogen and phosphorus of 19% and 34% respectively over the 2020-2021 year. The maximum monthly mass of nitrogen irrigated onto the farms during the year under review was approximately 9,118 kg in October 21, with over 7,000 kg of nitrogen per month discharged in September to November 2021 and January to March 2022. The maximum monthly mass of phosphorus irrigated during the year under review was approximately 5,679 kg in November 2021, with over 5,000 kg of phosphorus discharged in each of September to November 2021 and February and March 2022. Figure 51 shows the total monthly rainfall totals and the mean daily soil moisture from the closest Council monitoring site, which is at the Glenn Road site. The Company operates a weather station located on Farm 3, and commenced providing the daily rainfall information to Council in November 2020. The monthly rainfall totals from this location are also shown in Figure 51.

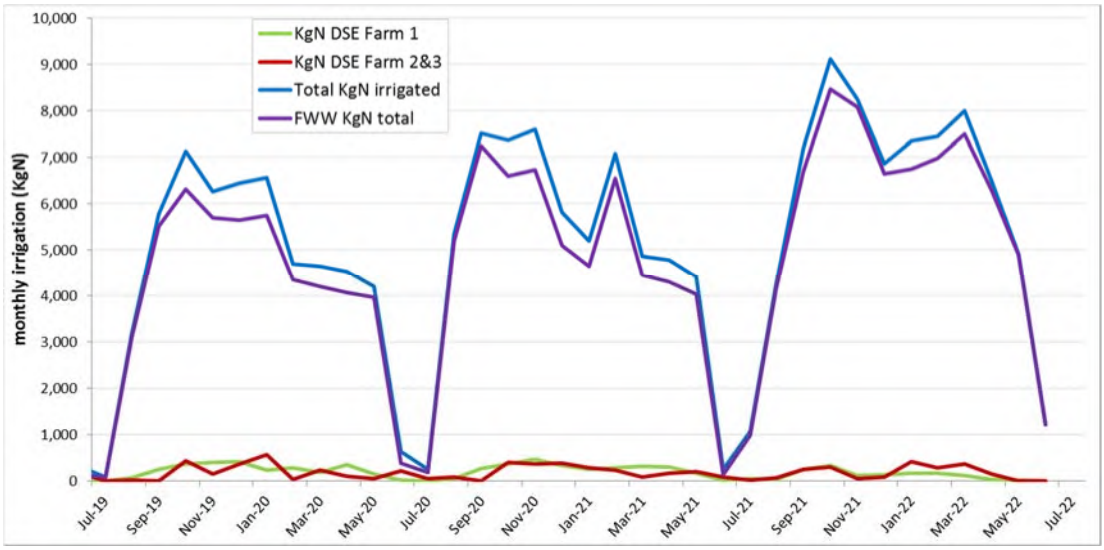

Figure 50 Monthly mass of nitrogen irrigated

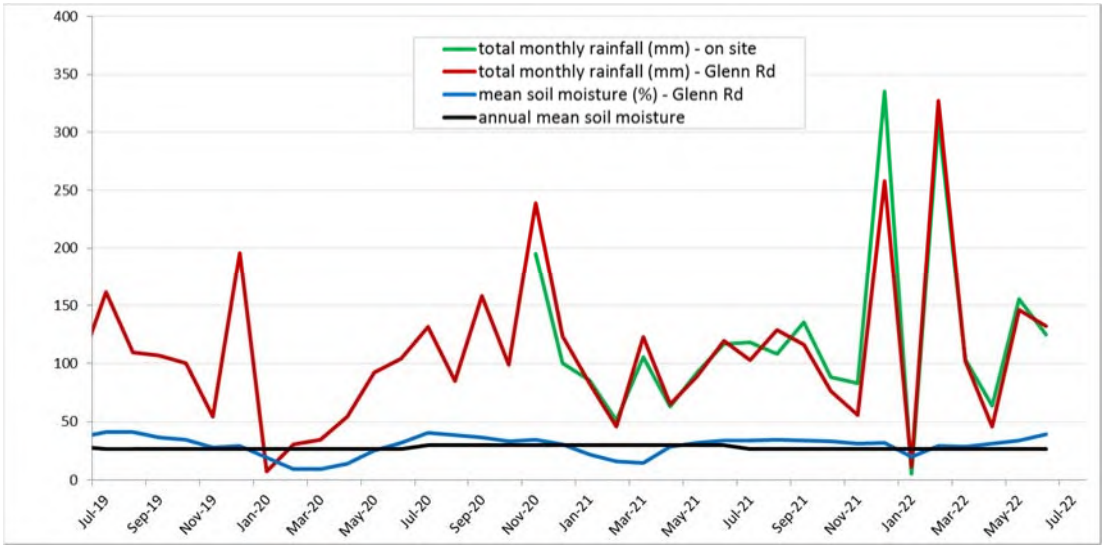

Figure 51 Monthly rainfall totals and median soil moistures

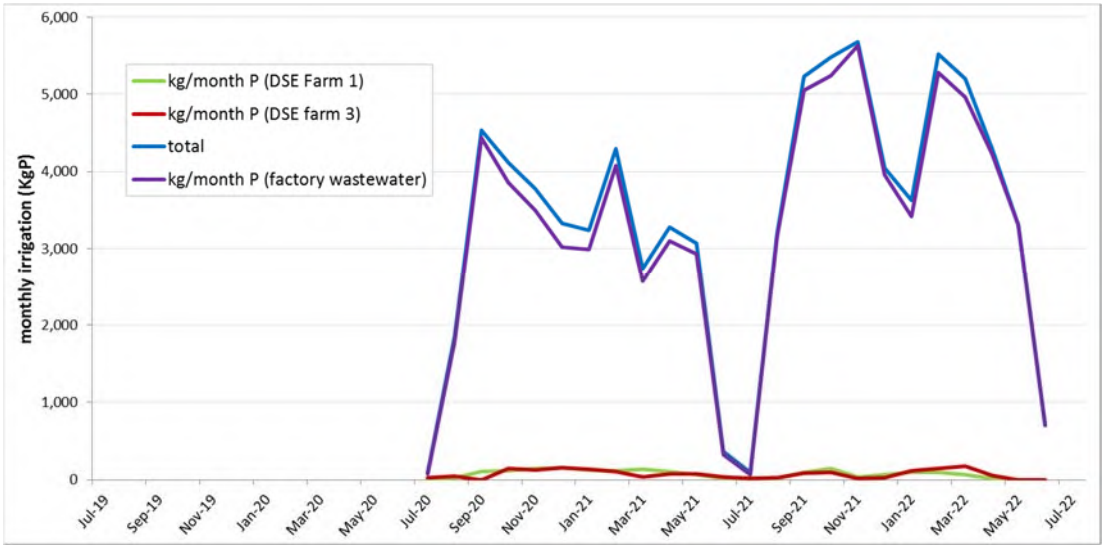

Figure 52 Estimated monthly mass of phosphorus irrigated

2.1.1.7 Soil sampling

Soil sampling and analysis was commissioned by the Company in June 2022 and a copy of the soil report was provided to Council. The depth of soil sampled was 0-75 millimetres, with 20-25 soil cores being collected along a transect through each paddock. Selected parameters from the Farm 1 results are presented in Table 18, the Farm 2 results are presented in Table 19, and the Farm 3 results are presented in Table 20. A comparison of the total nitrogen content of the soils in the various paddocks sampled is shown in Figure 53 and a comparison of the Olsen phosphorus concentrations is shown in Figure 54. The paddock numbering for Farm 1 is shown in Figure 30 and Figure 33 shows the paddock numbering for Farms 2 and 3.

Table 18 Soil sampling results Farm 1, June 2022

Paddock Number	pH	Sodium	Potassium	Magnesium	Calcium	Olsen Phosphorus	Sulphate Sulphur	Anion Storage Capacity	Exchangeable sodium percentage	Extractable Organic Sulphur	Total Nitrogen	Total Carbon	C/N ratio
	pH	MAF	MAF	MAF	MAF	mg/L	mg/kg	%	%	mg/kg	%	%	
13	7.0	19	28	53	26	348	86	32	1.6	<2	1.42	14.1	9.9
14	7.0	12	27	59	26	394	22	36	1.0	10	1.24	11.9	9.6
17	6.9	12	17	46	23	279	57	36	1.2	9	1.29	12.7	9.9
18	7.0	16	24	49	25	319	28	34	1.5	3	1.44	13.8	9.6
21	6.8	13	27	58	28	359	18	53	1.1	10	1.44	13.7	9.5
29 (control)	6.4	7	8	29	29	52	57	76	0.9	13	0.83	8.8	10.7
30	6.9	14	23	55	55	362	42	46	1.2	10	1.20	11.7	9.7

Table 19 Soil sampling results Farm 2, June 2022

Paddock Number	pH	Sodium	Potassium	Magnesium	Calcium	Olsen Phosphorus	Sulphate Sulphur	Anion Storage Capacity	Exchangeable sodium percentage	Extractable Organic Sulphur	Total Nitrogen	Total Carbon	C/N ratio
	pH	MAF	MAF	MAF	MAF	mg/L	mg/kg	%	%	mg/kg	%	%	
12A	6.7	20	26	43	13	321	21	46	1.1	1.37	12.8	9.3	6.7
17A (control)	6.8	22	30	56	14	366	17	41	1.1	1.4	12.6	9.0	6.8
17B	6.9	29	25	49	17	310	17	33	1.5	1.59	15.1	9.5	6.9
18	6.7	20	26	43	13	321	21	46	1.1	1.37	12.8	9.3	6.7

Table 20 Soil sampling results Farm 3, June 2022

Paddock Number	pH	Sodium	Potassium	Magnesium	Calcium	Olsen Phosphorus	Sulphate Sulphur	Anion Storage Capacity	Exchangeable sodium percentage	Extractable Organic Sulphur	Total Nitrogen	Total Carbon	C/N ratio
	pH	MAF	MAF	MAF	MAF	mg/L	mg/kg	%	%	mg/kg	%	%	
4	6.9	23	25	61	14	328	59	52	1.2	1.15	10.5	9.1	6.9
21A	7.0	31	25	57	25	328	60	68	2	1.1	10.1	9.2	7.0
25A	7.1	26	27	71	20	360	45	67	1.7	1.1	9.9	9.0	7.1
31	6.8	28	25	51	18	323	29	60	1.6	1.19	10.4	8.8	6.8
US1 (control)	6.1	18	8	44	12	27	11	77	1.5	0.93	10.8	11.6	6.1
38	6.7	21	22	48	13	315	11	61	1.2	1.13	9.8	8.7	6.7
34B (control)	6.4	10	13	27	7	43	119	78	0.9	0.59	5.9	9.9	6.4

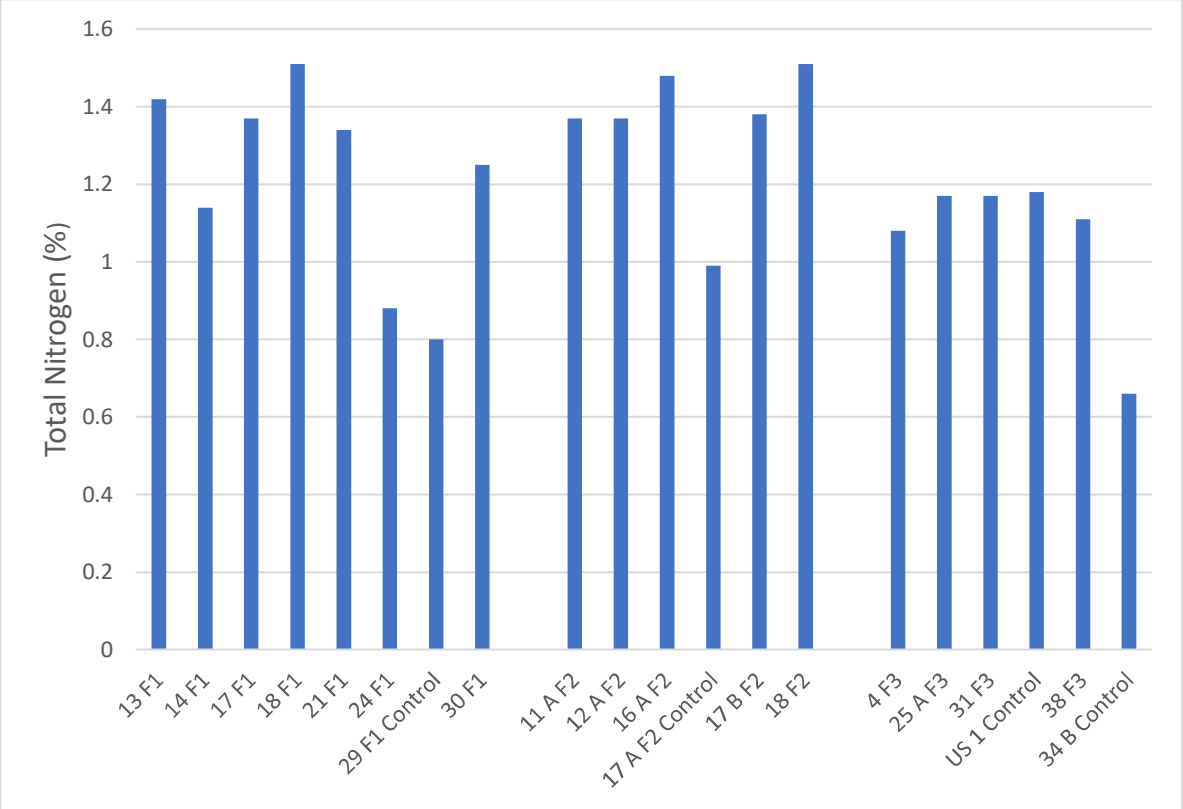

Figure 53 Total nitrogen concentration of soil samples taken from the Company's irrigation areas, June 2022

It can be seen that the nitrogen concentration of the soil is between 50 and 100% higher than the control paddocks. The Olsen phosphorus concentration is up to 15 times higher than the controls.

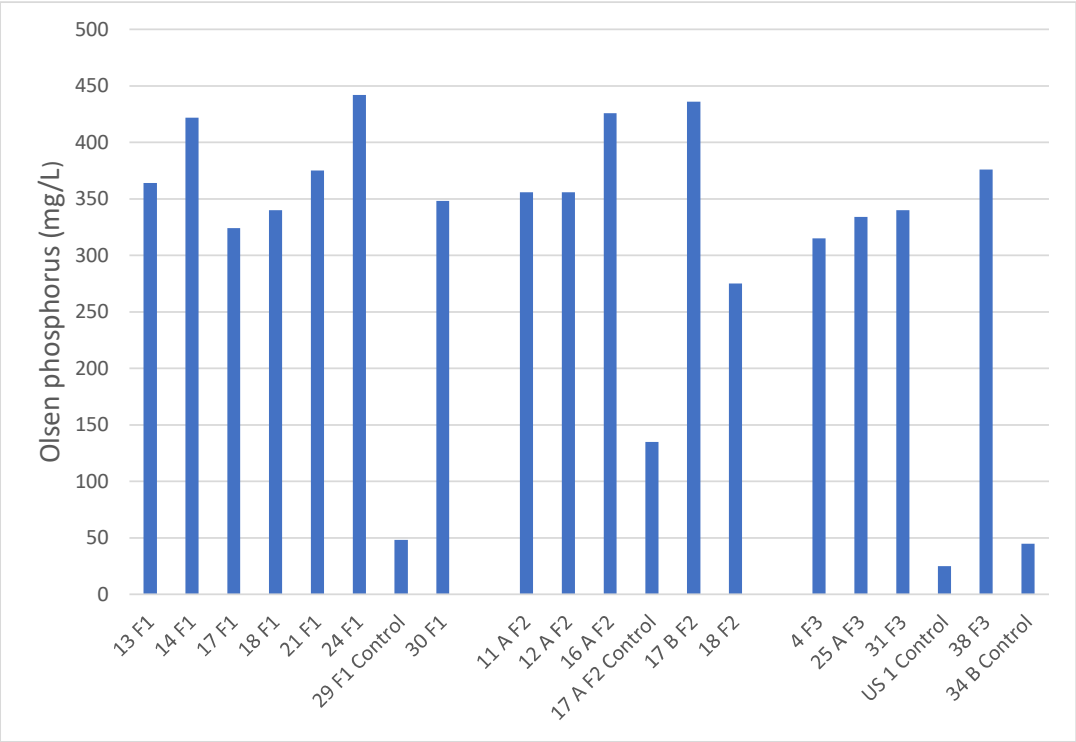

Figure 54 Olsen phosphorus of soil samples taken from the Company's irrigation areas, June 2022

In the soil report it was noted that:

- Soil pHs were higher (more alkaline) than the agronomic optimum on the irrigated paddocks. This is unlikely to be due to the irrigation activities as the pH of the wastewater is more acidic than the pH of the soils samples that were analysed.
- Irrigated paddocks continued to have high phosphorus levels (Olsen-P) which is usual for dairy factory wastewater farms. Trends in soil chemistry since records began at the farm show that the accumulation rate of phosphorus appears to be stable and not increasing. This likely indicates that the topsoil is saturated with Olsen-P and it is now moving deeper into the soil. Some transfer of nutrients (by stock) from irrigated to non-irrigated areas appear to be occurring as Olsen-P levels are slightly above the optimum agronomic range (35-45 mg/L) in several control paddocks.

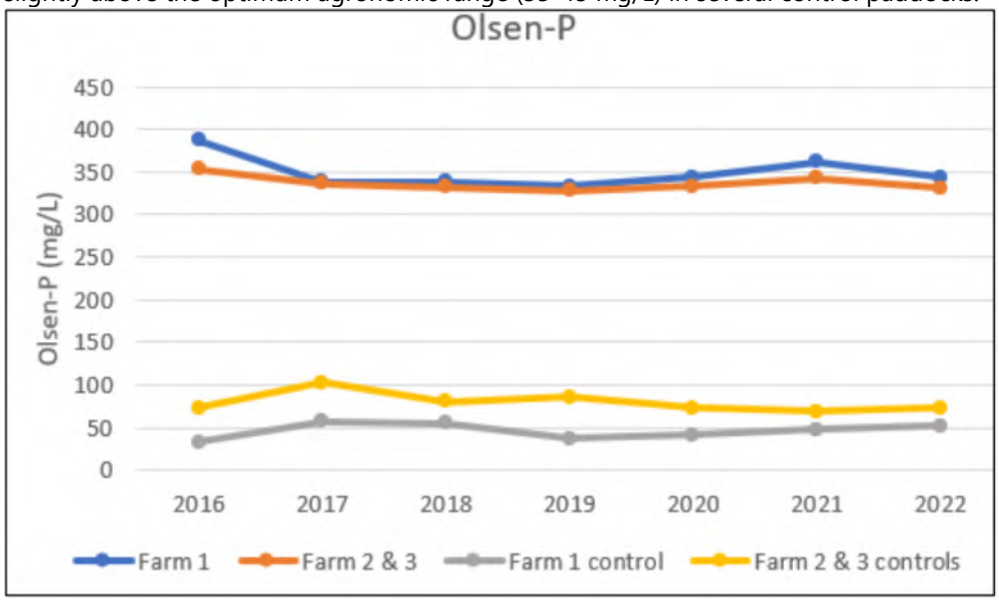

Figure 55 Trend in Olsen-P over time

- It was noted that the investigation undertaken by Lowe Environmental to support the application for the re-issue of the consents covering the discharge of wastewaters to land indicated that, due to the allophane clay in the soils, there was still capacity in the soil to retain phosphorus in the order or 9 to 15 tonnes/ha in the top soil. In an assessment of the long term impact of the phosphorus loadings undertaken by McDowell (2021) balancing P inputs with P outputs and reducing P loadings to achieve a topsoil Olsen-P of 300 mg/L or less and an eventual Olsen-P of 50 mg/L was recommended.
- Exchangeable sodium percentages levels (ESP's) levels showed there was no threat of soil structure collapse from any excessive build-up of salt from wastewater.
- The exchangeable bases of potassium and calcium on the irrigated blocks were all higher than the agronomic optimum. However, these levels are unlikely to cause any issues with plant or animal health and are satisfactory.
- The soil in irrigated paddocks had all, or nearly all, of the exchange sites filled with cations. Calcium was the dominant ion. Further addition of calcium will have no impact on the soil because the soils exchange sites are already full.
- The total carbon and carbon:nitrogen ratios were satisfactory and within the optimal range for pasture soil quality. The total nitrogen was higher than optimum (classified as very high in the irrigated paddocks) but the levels were similar to the previous year.
- The soil visual assessment scores were all classified as good and the pasture soil tests have shown there are no deficiencies in the pasture.
- Recommendations were made relating to aeration of the paddocks to combat surface sealing of the soil that is caused by hoof pressing and pugging. The recommendations related to annual aeration programme that should routinely occur on one third of the farm area each year, along with any damaged paddocks being aerated as required.

A copy of the full soil report is available on request.

2.1.2 Council monitoring

2.1.2.1 General inspections of factory premises

Six scheduled inspections of the premises, treatment system and Kaupokonui Stream were performed during the 2021-2022 period. A standard pattern was followed by the officer of the Council with all areas of discharges and potential spillage sites inspected. The inspections were made at approximately monthly intervals. Company staff met with the Council officer and provided an update on the Company's performance on each inspection occasion. The Company also communicates regularly with the Council regarding matters at the site that relate to their in-house monitoring, environmental performance and initiatives. Additional inspections were also undertaken following notifications relating to the cleaning of the site effluent tank and desilting of the water intake area.

2.1.2.1.1 General site

The six inspections revealed no major problems with the general factory site. Generally the site was clean, tidy and orderly.

Improvements in the 2021-2022 year that were discussed at the site inspections or otherwise communicated to Council included:

- Completion of the replacement of the wastewater PVC pipe crossings with stainless steel.
- Review of wastewater transfer system alarms.
- Re-introduction of the ability to transfer the wastewater to multiple farms,

- Introduction of real time monitoring of powder emissions from each dryer.
- Update to the Air Management Plan for the site.
- Continued improvements in the Company's tracking of the nitrogen loadings applied to the irrigation areas.

Projects planned for the 2022-2023 year included:

- reviewing practices to improve the management of nutrients at the site,
- ensuring that the site would receive raw materials of an improved quality from the other Fonterra sites to reduce the CIP requirements,
- investigating options such as changes in CIP chemicals, recovery of the CIP material, and available technologies to treat the wastewater from the site to reduce the nutrient content of the irrigated factory wastewater
- replacement of site formed bends in the wastewater transfer lines to reduce the potential for leaks.
- Continuation of the work programmes associated with the consent renewal applications.

2.1.2.1.2 Intake from the Kaupokonui Stream

The inspections showed that both the Company's weir and intake system worked well during the period under review. The intake screens were in place and cleaned regularly during the year under review. The water intake is also cleaned regularly and compliance with permitted activity Rule 53 of the Regional Freshwater Plan is checked. Two inspections were undertaken during the year under review that were limited to these cleaning operations

A site inspection was undertaken on 8 October 2021. It was noted that any disturbed sediment as a result of the cleaning by a digger was dissipating after approximately 20 m. The sand removed was placed on stable ground where it was unlikely to remobilize to water. Overall, at the time of inspection, there was no breach of Rule 53 of the Regional Fresh Water Plan for Taranaki.

Further work was carried out on 18 January 2022. Inspection of the works to clear the sediment from around the river water intake found that there was no obvious difference noted in the clarity of the steam upstream and downstream of the extraction site. The extracted sediment was being placed in a holding area located near the northern stormwater pond, and from there was pumped out back to the river. Before the drainage water entered the Stream it was allowed to run overland to naturally filter the particulates out. This appeared to be working to good effect. No compliance issues were found.

Works were undertaken by the Company to repair erosion that had occurred at the side of the weir on the true right bank. The Company provided details of the works to be undertaken to Council, and it was confirmed that the work could be carried out under the requirements of consent 4623 without any additional authorisations being required.

The fish pass installed by the Company under the guidance of the Council in March 2004, contained an adequate level of water and were unobstructed during all inspections. Trout were observed above the weir at the time of four of the inspections. Juvenile trout and an eel were also observed above the weir at the time of some of these inspections.

At the time of three of the 2020-2021 inspections a juvenile fish was sighted in the water intake. Although there are no intake fish protection requirements on the Company's current abstraction consent, the AEE supplied with the application for the replacement of the consent considered that the design of the fish intake was such that it was adequate to avoid effects. It is expected the standard conditions that ensure the intake is screened to avoid fish (in all stages of their life-cycle) entering the intake or being trapped against the screen will be included in the renewed consent. No juvenile trout were observed in the intake during the year under review.

2.1.2.1.3 Spray cooling water discharges to the Kaupokonui Stream

New cooling towers were constructed and commissioned in August and September 2015, designed to achieve an improved performance. Flow and temperature meters were installed on the inflow line to the towers, along with a temperature sensor on the outflow from the cooling tower that is used to provide the cooling water discharge temperature to Council. A flow meter had been placed on the line through which combined recovery condenser cooling water and stormwater was discharged directly to the stream under consent 0924-3. This was removed during the 2017-2018 year with the diversion of the cooling water to the cooling towers and stormwater to the northern stormwater pond. The installation of telemetry for the monitoring data from these meters had been delayed until December 2015, while landscaping around the towers was carried out. Accurate cooling water discharge flow monitoring commenced in September 2019.

Historically, there had been issues relating to missing data due to a third party server going off line temporarily, which then did not accept data until the link was reset. Alerts were put in place so that the link can be re-established by Fonterra staff in a more timely fashion. This has continued to work well during the year under review. The only remaining missing data tends to be when the probes have been removed during flood conditions, the null switch has been activated during calibrations, or rarely there are faults or electrical problems at the site. The missing data rate has been at or below about 3% for the 2017-2022 years.

Air actuated pressure regulating valves have been installed on the first nozzle of each discharge leg to ensure that all nozzles have a good spray discharge to maximise cooling. The Company is be able to open/close valves individually to ensure optimum spray discharge is achieved. The system was fully commissioned in December 2021.

During the year under review the cooling water discharge arms were in operation at all inspections between October 2021 and May 2022. It was found that the upstream versus downstream temperature difference was within the consented parameters. No issues were noted in relation to spray drift indicating that the well grown riparian vegetation continued to be effective at preventing spray drift of cooling water beyond the property boundary. At the time of the January inspection it was noted that there was a significantly increased flow at the sprayers compared to the previous inspection. The inspecting officer was informed that there had recently been upgrades to the system. It was reported that the Company had noticed an increase in efficiency due to the upgrades and an associated decrease in the effect the cooling water discharge was having on the stream temperatures.

2.1.2.1.4 Other discharges to the Kaupokonui Stream

During October 2017 works to combine and relocate the DFE plant and factory extension stormwater pipes had occurred and for a period, the stormwater discharged via the new outfall without any treatment as the stormwater pond was yet to be completed, however a shut off valve had been installed and was functional during this period (Photo 1). All discharges from the norther area of the site occurred from this new combined outfall following this, with the first discharge from the northern pond logged by the Company as being 8 March 2018.

The Company actively manages discharges from the ponds and has the ability to divert the contents to the wastewater system, and/or to divert various parts of the stormwater catchment directly to the wastewater treatment system in the event that activities like site wash downs are occurring. Prior to discharge the quality of the water is assessed and checks are made to ensure that there are no visible effects occurring in the stream during the discharge. The stormwater discharges, receiving water checks and quality assessment information is logged along with whether the pond has been discharged to the stream or to the effluent system for irrigation onto land at the farms. A copy of the log is provided to Council on a monthly basis and is available for checking at inspection.

Photo 1 Northern stormwater pond, stop valves and outfall to the Kaupokonui Stream

In the 2018-2019 year it was noted that the groundwater discharge from the southern pond was to be addressed in near future by contractors following the finding that low flow rate discharges were occurring periodically from the southern pond outfall. It has subsequently been identified that there is some groundwater infiltration occurring into the discharge pipe. Discharges of this nature were noted to be occurring on occasion during the year under review. No adverse effects were found in the Kaupokonui Stream as a result of these discharges.

On a number of occasions it was found that the contents of the stormwater ponds were being used to cool the wastewater or were diverted due to quality issues identified during the assessment process, thereby reducing the number of discharges that occurred to the stream.

The Company began planning to plant low growing natives around both stormwater ponds to avoid the need to spray weeds, and also minimising the potential for overland flow of sediment and debris from the pine trees into the ponds during heavy rainfall events. The planting of shrubs around both stormwater was completed in June 2020.

At each inspection it was noted that the stormwater catchments were clear of spills, the drains appeared clear of contaminants, and hazardous material storage was secure. It was also generally found that both of the stormwater ponds contained a small volumes of liquid which were free of visible hydrocarbons.

It is noted that the southern stormwater pond was cleaned out in April 2022.

2.1.2.1.5 Water bore in the Kaupokonui Catchment

The Company ceased using its groundwater bore in mid-March 2013, when an upgrade of the York Chiller removed the need for additional cooling during periods of warmer temperatures in Kaupokonui Stream. Groundwater level in the bore was last measured on 25 September 2014, at 6.17 m below the top of the upstand. The Council was advised during the 2017-2018 year that the Company intended to decommission this bore and withdraw the application to renew this consent at some point. The withdrawal application was not received by Council during the year under review. However, it was noted at the inspection on 20 September 2019 that the bore had been closed in. No abstraction occurred during the year under review.

2.1.2.1.6 Discharges to the Motumate Stream

There is no longer any discharge of heat-elevated cooling water to the unnamed tributary of the Motumate Stream, previously used by the Kapuni School to heat its swimming pool. The school is now closed and no longer has a need for this service.

Bore water, when used, was also discharged back to the Motumate catchment via a tributary immediately opposite the factory across Manaia Road. The Council was advised by the Company that, as the

groundwater cooling water system has not been utilised for a number of years, the Company also intend to withdraw the application to renew this consent at some point. No discharge occurred during the year under review.

2.1.2.1.7 Spray irrigation of wastewater

In general, the inspections showed a good level of compliance in relation to the irrigation of wastewater.

The wastewater from the factory is conveyed to the Farms by transfer lines that are shown in the Company's Whole Farm Management Plan. At the time of the inspection undertaken on 19 November 2021 a wet area was found at the factory site near the southern stormwater pond on the gravel driveway. The inspecting officer was informed that this was from the wastewater transfer to Farms 2&3 that was leaking slightly, and that this would be repaired that day. The contractors were already on site to undertake the repairs.

Spray irrigation at the farms involves the use of both travelling irrigators and in-ground spray irrigators. Prior to mid-2007, approximately 95 ha was irrigated using travelling irrigators, while a further 25 ha was irrigated using in-ground irrigators. Works commenced in January 2007 on extension of the in-ground irrigation system, mainly on a parcel of land between Farm 2 and Farm 3 that had been purchased by the Company.

This extension increased the irrigated area during the 2007-2008 dairy season by 49 ha to 169 ha, of which approximately 44 ha is reticulated with in-ground irrigators. During the year under review, the total area used for irrigation was 181.5 ha. The total area farmed is 244 ha.

Care is required while irrigating near watercourses particularly during wet and/or windy conditions. Spraying is not to occur within 20 m of the streambank of a watercourse (condition 6 of consent 0923). A weather station with telemetry to the pump station on Farms 2 and 3 was installed in August 2015, allowing faster response to changes in wind direction. No spray drift across streams was observed at the time of the compliance monitoring inspections or groundwater sampling surveys during the year under review.

In previous monitoring periods some browning of grass, overland flow and minor ponding has been noted. Fonterra Research Centre was engaged to investigate the ponding/run-off issues. Subsequently, annual aeration was conducted for several years from the 2002-2003 monitoring period over a significant area of the Company's farms, which improved the capacity of these areas to receive and assimilate the irrigated wastewater. Testing undertaken in May 2010 indicated that aeration is no longer required, unless there are visible signs of ponding or damage to the pasture from pugging by stock. Some additional aeration was undertaken in February 2016, with aeration also undertaken in the 2018–2022 years.

On the whole, the wastewater irrigation was found to be generally well managed. The pasture receiving irrigation appeared to be healthy, with no ponding, grass burn, or run-off observed during most of the inspections. Buffer distances were being adhered to at the time of all but one monthly inspection.

At the time of the groundwater sampling survey carried out on 10 August 2021 it was found that, due to the wet weather that preceded this survey, some paddocks showed hoof damage from the strip grazing by the cattle. A bailer was used for sampling on two of the bores as the paddocks had been cut up as a result of the winter grazing. The Council Officer requested that a fence be constructed around GND0638. This bore head was found to be on a slight lean, which has possibly been caused by cattle rubbing on it. Irrigation was occurring at Farm 2 in a paddock east of GND0700. No ponding was occurring from this irrigator. All of the couplings appeared to fully sealed showing no evidence of leakage

During the 2020-2021 year, work began on replacing PVC pipe crossings carrying the wastewater across the Kaupokonui, Waiokura and Motumate Streams following a risk assessment undertaken by the Company. The risk assessment of all stream crossings was prompted by the minor leakage that was discovered at the Farm 1 Kaupokonui Stream pipe crossing in the 2018-2019 year. The last pipe was replaced in the 2021-2022 year.

2.1.2.1.8 Riparian planting

The riparian planting on the left bank of the Kaupokonui Stream adjacent to and downstream of the cooling sprays continues to provide secondary filtering of windblown spray cooling water drift as well as aesthetically benefiting the site. New planting was undertaken on the riverbank upstream of the factory in the 2001-2002 monitoring period. The gully areas in the vicinity of the Farm 1 cowshed to the downstream farm boundary, which were planted during the 1997 and 1998 winter periods, continued to be maintained during the 2021-2021 monitoring period. During the 2020-2022 years, some small areas of the riparian planting were removed to allow access for the replacement of the PVC wastewater pipes over the stream during their replacement with lower risk stainless steel pipes. The extent of this was still to be assessed, but it would be minimised and replanted.

The Company has continued to invest in planting and fencing of waterways around the factory and Company farms. This also includes an annual (index linked) donation of $3,000 to the Taranaki Tree Trust in accordance with condition 10 (b) of consent 0919. The Taranaki Tree Trust was dissolved in 2016 after which time the donations were paid directly to the Council. To 30 June 2022, a total of approximately $79,240 had been donated under the requirements of consent 0919. The financial contributions are paid upon invoicing by the Council. The invoicing due in the 2021-2022 year was delayed and occurred in August 2022. Council was awaiting payment of this invoice at the time of writing this report.

At the end of the 2021-2022 year, the Council had prepared 164 Riparian Management Plans (RMP's) fully or partially located in the Kaupokonui Stream catchment (an increase of four plans). Of these, 20 plans cover the 31 km of streambank that was originally identified as requiring improvement and met the criteria for funding given in condition 10 of consent 0919-3 (that is, are located in the Kaupokonui Stream catchment above the Company's cooling water discharge). Both the plan numbers and streambank measurements are subject to change due to events such as a farms being split, improvements in mapping, reclassification of drains to streams, changes in riparian standards over time and the like.

Taking into account the riparian planting that was already existing at the time the plans were developed and changes such as those given above, the progress towards full implementation of the additional planting required is shown in Table 21 and is illustrated in Figure 56.

Subject to confirmation by audit, the riparian plantings recommended in the plans that had received funding to the end of June 2022 (12 plans) covered a total stream bank distance of 48 km, of which seven (58%) were 100% completed.

This compares to 29 plans covering a total of 33.8 km, of which four (14%) were 100% completed in the Kaupokonui Stream catchment downstream of the plant, and 164 plans covering a total of 786 km, of which 34 (21%) were 100% completed in the wider Kaupokonui parent catchment. The riparian planting progress for the Kaupokonui catchment as a whole is illustrated in Figure 57.

During the 2021-2022 year no farms received rebates under this scheme, as there was an alternative funding scheme available during the year under review (Jobs for Nature Fund). It is expected that uptake of the funding available under consent 0919 will resume in the 2022-2023 year.

Table 21 Comparison of riparian plan progress in the Kaupokonui Stream catchment and Kaupokonui catchment (subject to confirmation by audit)

	Kaupokonui Stream				Kaupokonui Catchment total
	Upstream Fonterra	Plans that have received funding	Upstream of Fonterra no funding	Downstream Fonterra	
Total length of streambank, km	96.1	48.0	48.1	33.8	786
Additional recommended planting, km	35.4	23.6	11.8	16.7	367
Planting implemented, km	23.6	19.9	3.7	9.8	250
Planting percentage implemented,%	66.7	84.3	31.3	74.9	68.0
Fencing implemented, km	88.6	44.9	43.7	-	-
Percentage of steam bank fenced, %	92.2	93.5	90.9	-	-

During the year under review, data gathered during farm visits and, improvements in data analysis tools have resulted in increases in some of the measurements for some of the total lengths of streambank and/or additional recommended planting. Significant rainfall events have also resulted in some replacement planting being necessary. This combination of factors has resulted in some apparent decreases in the reported percentage implementation rates in some instances when compared to the previous year.

It can be seen that the current data indicates that whilst there is still a moderate implementation rate of 68% in the catchment as a whole (63.1% at June 2021), there is a similar implementation rate upstream of the plant to 66.7% (down slightly from 69.5% at June 2021). As would be expected, there is a higher implementation rate on those farms that have received funding, which have reached an implementation rate of 84.3% (again down slightly from 96.7% at June 2021), when compared to those that have not. The implementation rate for these plan holders was at 31.3 % compared to 28.8% at June 2021.

It is important to note that, due to the fact that the Kaupokonui Stream catchment upstream of the plant has an extensive network of tributaries, there is a longer distance of stream bank above the plant than there is below it. There was also only half the amount of new planting originally recommended below the plant. This means any increases in the number of kilometres planted will have a much larger effect on the percentage completion downstream of the plant than it will upstream of the plant.

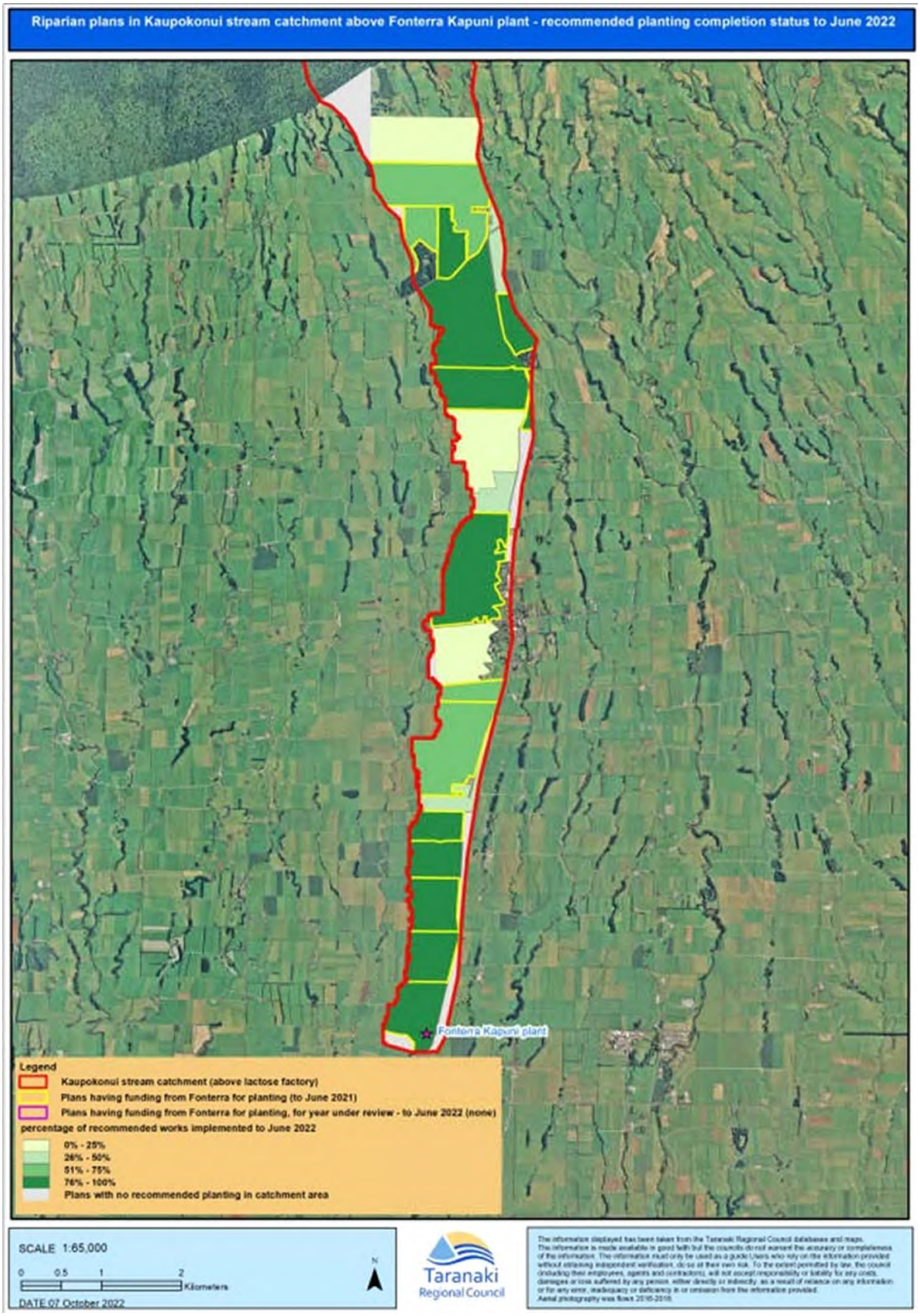

Figure 56 Riparian planting progress in the Kaupokonui Stream catchment above the lactose plant

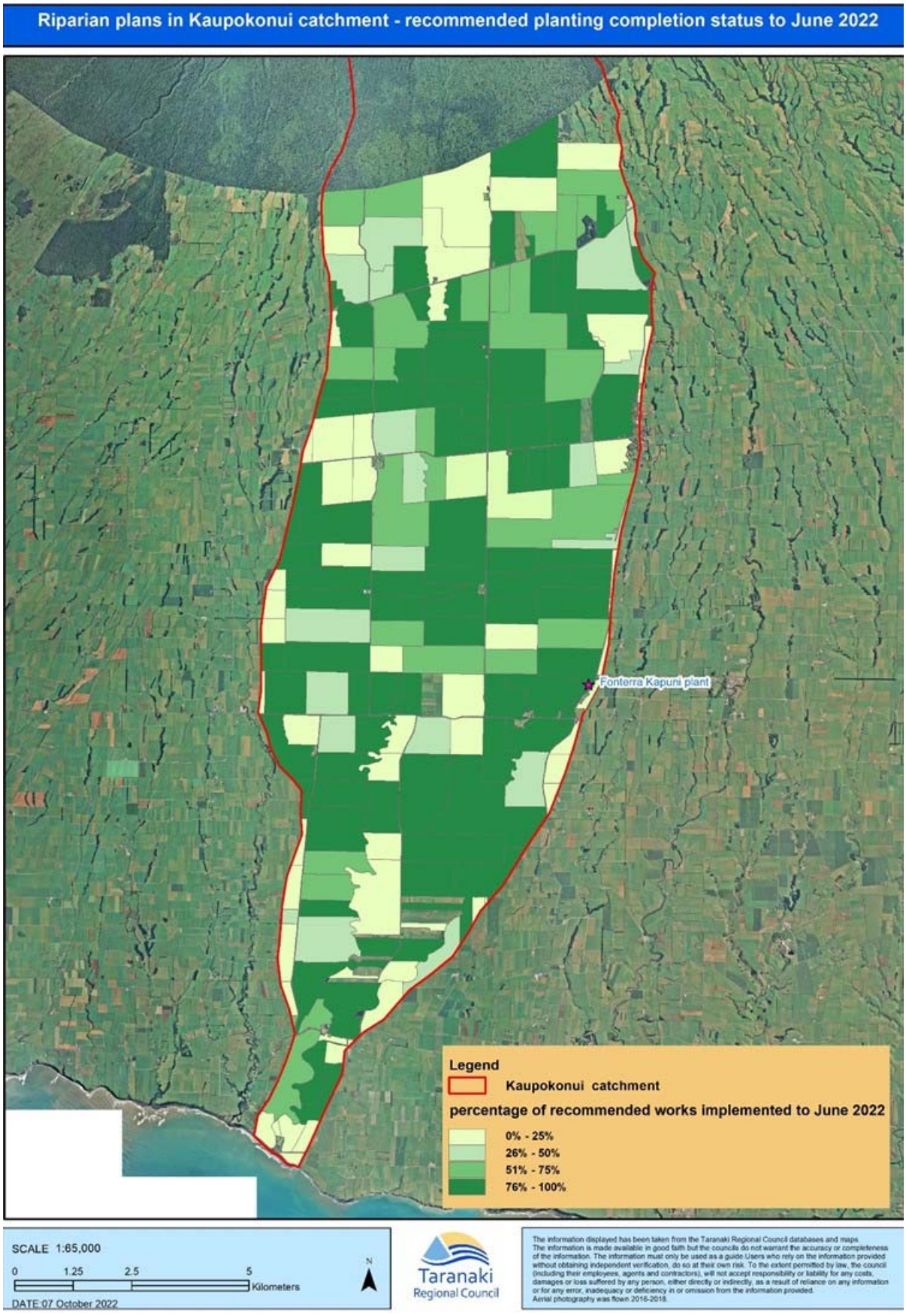

Figure 57 Riparian planting progress in the Kaupokonui Stream catchment

An example of riparian planting is given in Photo 2, taken along the Waiokura Stream on Farm 2, and about 1.1 km south of Skeet Road (Riparian Management Plan RMP1425). Groundwater monitoring bore GND2050 is situated down gradient of the fixed-in-place irrigators and up-gradient of the riparian plantings.

In a separate project initiated by the Company in September 2009, the Manaia Road boundaries of Farm 1 and Farm 3 were planted with native species for screening of the adjacent irrigation areas. A total of 2,142 plants were planted, over a total distance of 1,071 m, at a cost of $6,224. The roadside plantings provide visual screening and amenity value, protection of neighbours and road users from spray drift, and shelter for livestock and pasture. In addition, the Manaia Road boundary adjacent to the storm pond on the lactose plant site was planted in winter 2010. In November 2011, approximately 1,600 more plants were planted on the Manaia Road boundary of the Farm 1 run-off. Replanting was undertaken where a new crossing was installed over Waiokura Stream between Farm 2 and Farm 3 in June 2013. In June 2017, the Company purchased 4,000 native plants at a cost of $14,387. The Company supplied these to 11 upstream properties, all but one of which has a Riparian Management Plan. The Company also liaised with farmers regarding the planting. Additional fencing and planting was undertaken by the Company on Farm 3 during the 2018-2019 year, retiring some marginal farmland to a wetland.

The riparian planning along the stream running through the farms is now well established. All Fonterra plantings were maintained in the 2021-2022 year. Although some small sections needed to be removed to allow the replacement of the wastewater pipe crossings, the plantings were replaced as soon as possible following completion of the work.

Photo 2 Riparian plantings along Waiokura Stream, Farms 2 with fixed irrigators in operation

During the 2020-2021 year the Council was informed that the Company was intending to remove some of the large pine trees on the stream bank next to the northern pond to prevent the possibility of them falling

into the stream or onto the wastewater pipe crossing the stream. The trees would then be replaced promptly with native trees. Some trees have been removed from this area.

2.1.2.1.9 Disposal of factory solid wastes

Solid wastes from annual cleaning of the waste effluent tank and lime silo had been disposed of by burial on Farms 2 and 3 during the winter maintenance shut-down for a number of years, ending in 2018. This activity was permitted under Rule 29 of the Regional Freshwater Plan, which covers the discharge of contaminants from industrial and trade wastes premises onto and into land subject to certain conditions, including minimum distance from water courses and water supply bores. A record was kept of the volumes discharged and of the burial site locations. The disposal sites are monitored during the routine monthly inspection of the farms by Council. Compliance with the conditions of the Rule has been found on each monitoring occasion.

During the 2016-2017 year a Trommel (solids separator) was installed on site to separate the solids (diatomaceous earth and activated carbon) out of the waste stream from the filtration of the whey permeate. Following this, the solids were separated in a contained skip bin containing a mesh screen, with the liquid portion being pumped out into the factory wastewater sump. Prior to the separation techniques, the solids were either accumulated in the wastewater tank or were irrigated onto land within the wastewater. In October of the 2016-2017 year the Company advised that the current carbon burial pit was to be filled in due to operational and health and safety constraints surrounding the regular on going presence and use of open pits on the farm. For a period from January 2018 the filtered material had been removed from the site by a composting/fertiliser company for use in their products. From August 2021, the solids were disposed of at an off-site location that holds a consent to accept this material for land stabilisation purposes.

Carbon from the wastewater tank continued to be buried on farm during the cleaning operations that occur during the shutdown period up to and including the winter 2018 shutdown. During the 2018-2019 year, the Company approached the Council for confirmation that shallow (between 25 and 50 mm) direct drilling of the waste into the pasture would still comply with Rule 29. Approval was given, and during the 2019 winter shutdown the waste was direct drilled into the paddock to the south of the southern stormwater pond on the corner of Manaia and Skeet Roads. This method and location of disposal was applied in the 2019-2022 years. The site visit undertaken on 5 July 2021, at the time this activity was being undertaken, confirmed that all conditions of Rule 29 appeared to be complied with at the time of inspection.

2.1.2.1.10 Bridges and culverts and pipe crossings

At the time of the routine compliance monitoring inspections it was found that the bridges, culverts and pipelines across all stream were in good repair at the time of each inspection. The programme of the replacement of the PVC wastewater pipelines with lower risk stainless steel pipelines was completed during the year under review.

2.1.3 Results of discharge monitoring

2.1.3.1 Physicochemical

2.1.3.1.1 Cooling water quality

Sampling of the spray cooling water discharge (authorised by discharge permit 0919-3) involved the collection by the Company of one representative 24-hour composite sample, to be analysed by the Council. The results of these analyses for year under review are presented in Table 22 (STW002017). Conditions of this consent do not place limits on individual component concentrations in the discharge, but focus on the avoidance of effects in the receiving waters.

The cooling water previously discharge via the combined stormwater/cooling water pipe discharge (STW02018, permit 0924-3) was diverted to the cooling tower and the pipework was removed in February 2018. Prior to this, a composite sample was collected from the discharge from this system by the Company, which was analysed by the Council.

A summary of the historical results for both the cooling water discharge and combined stormwater/cooling water discharge are given in Table 23 for comparative purposes.

All samples collected during the year under review were composite samples.

Table 22 Results of the analysis of spray cooling water discharge during the year under review (STW002017)

Date	BOD_5		Conductivity @ 25˚C	pH	Turbidity
	Total	Filtered			
	g/m^3	g/m^3	mS/m	pH	FNU
29 Oct 2021	0.8	0.8	10.8	7.0	0.47
20 Jan 2022	1.0	0.6	12.6	7.6	0.37
28 Apr 2022	0.7	0.5	10.8	7.4	1.73
26 May 2022	< 0.8	< 0.8	11.0	7.1	0.46
29 Jun 2022	0.6	< 0.4	12.8	7.5	0.62
Range	<0.8 – 1.0	<0.4 – 0.8	10.8 – 12.8	7.0 – 7.6	0.37 – 1.73
Median	0.7	0.5	11.0	7.4	0.47

Table 23 Summary of cooling water discharge quality from the Council surveys during the period March 1992 to June 2021

Waste	Spray cooling water (STW002017)				'Stormwater/cooling' water (STW002018 – to 15 Feb 2018)		
Parameter	Unit	No. of samples	Range	Median	No. of samples	Range	Median
BOD_5 (filtered)	g/m^3	261	<0.4 - 91	1.1	216	<0.5 - 1,100	1.4
BOD_5	g/m^3	206	<0.4 - 460	1.9	233	<0.5 - 1,100	2.5
Conductivity at 25˚C	mS/m	217	3.4 - 51.7	10.8	240	5.4 - 132	10.8
Oil and grease	g/m	2	<0.5	<0.5	99	<0.5 - 4.3	<0.5
pH	pH	126	5.8 - 8.2	7.5	144	4.6 - 10.6	7.2
Turbidity	FNU[a]	11	0.28 - 2.9	0.48	-	- - -	-
Turbidity	NTU[b]	227	0.35 - 450	1.7	125	0.26 - 110	4.2

a. From July 2019

b. To June 2019

For the spray cooling water, there were no notable seasonal variations in the parameters monitored. The median total BOD has remained low (less than 1 g/m^3) for five successive years following the three consecutive years (2013-2014 to 2016-2017) over which it decreased significantly.

2.1.3.1.2 Stormwater quality

Discharges from stormwater pipe outlets to the stream were previously been sampled at four locations: from the northern (STW001062) and southern (STW002018) areas of the lactose plant, the DFE plant (STW001109), and the southern stormwater pond (STW002078, Photo 3), as shown in Figure 58.

The discharge from the previously combined stormwater/cooling water discharges have been addressed in section 2.1.3.1.1 above.

During 2017-2018, stormwater from the DFE plant, factory extension (STW001109), and the southern area outside the lactose plant itself (stormwater component of STW002018) was combined with the northern discharge (STW001062) for treatment in the northern stormwater pond. The discharge location for the northern stormwater pond outfall is STW002099.

There were no stormwater discharges from the containment ponds at the time of inspection during the year under review. The water level in the stormwater ponds were also too low at the time of the inspections to allow a sample to be collected from the ponds as an indicator of potential stormwater quality.

Photo 3 Outfall from the southern stormwater pond to Kaupokonui Stream (STW002078)

2.1.4 Receiving water (Kaupokonui Stream) quality

Sampling of the Kaupokonui Stream adjacent to the Company's factory and Farm 1's wastes irrigation area was performed by the Council on the monthly inspection visits. Three sites are located in the Kaupokonui Stream (Figure 58).

Table 24 Location of water quality sampling sites

Site code	Site	Location	Map reference, NZTM	
			Easting	Northing
KPK000655	Kaupokonui Stream	1 km upstream of rail bridge	1697963	5630770
KPK000660	Kaupokonui Stream	At water intake	1697644	5629758
KPK000679	Kaupokonui Stream	150 m downstream of spray cool discharge zone	1697607	5629399

Sampling was performed under varying flow conditions ranging from 1.22 m^3/s to approximately 3.93 m^3/s, as measured at Upper Glenn Road hydrometric station, 9.8 km downstream, where the median flow is approximately 1.89 m^3/s, and mean annual low flow (MALF) is approximately 0.67 m^3/s. The lowest flow conditions under which one of these stream surveys has been carried out is 0.52 m^3/s on 17 March 2020.

A record of flows (hydrograph) over the reporting period is presented in Figure 86. Samples were generally taken in the mornings. The results of this monitoring are summarised in Table 25 and a copy of the full results are available on request. Past Council sampling results from these sites are presented in summary form in Table 26 for comparative purposes. It is noted that the Council moved to using a contract laboratory for analytical work in April 2018.

Table 25 Summary of Kaupokonui Stream water quality data (ranges) from monthly monitoring for the year under review (N=5 samples)

Parameter	Unit	KPK000655		KPK000660		KPK000679	
		Range	Median	Range	Median	Range	Median
Ammoniacal-N	g/m^3 N	<0.010 - 0.028	0.012	<0.01 - 0.022	0.010	<0.010 - 0.016	<0.01
Dissolved BOD_5	g/m^3	<0.4 - 0.7	<0.4	<0.4 - 0.7	<0.4	<0.4 - 0.6	<0.4
Total BOD_5	g/m^3	<0.4 - 0.9	<0.4	<0.4 - 1.0	0.5	<0.4 - 0.7	<0.4
Conductivity@25°C	mS/m	10 - 11.4	10.3	10.7 - 12.2	10.9	10.8 - 12.6	11.1
Dissolved Reactive Phosphorus	g/m^3 P	0.006 - 0.011	0.010	<0.004 - 0.010	0.008	0.005 - 0.014	0.010
Nitrate+Nitrite-N	g/m^3 N	0.49 - 1.11	0.66	0.62 - 1.20	0.74	0.63 - 1.24	0.77
pH	pH	7.1 - 7.7	7.6	7.2 - 7.7	7.6	7.1 - 7.8	7.6
Temperature	°C	10.5 - 17.8	12.1	10.5 - 17.9	11.1	10.6 - 18.6	12.1
Total Kjeldahl Nitrogen	g/m^3	<0.10 - 0.29	0.22	<0.10 - 0.12	<0.10	<0.1 - 0.12	0.11
Total nitrogen	g/m^3	0.72 - 1.17	0.80	0.74 - 1.25	0.80	0.74 1.37	0.84
Turbidity	FNU	0.64 - 2.2	0.69	0.53 - 1.0	0.64	0.6 - 1.11	0.85
Free Ammonia	g/m^3	<0.01 - <0.01	<0.01	<0.01 - <0.01	<0.01	<0.01 - <0.01	<0.01

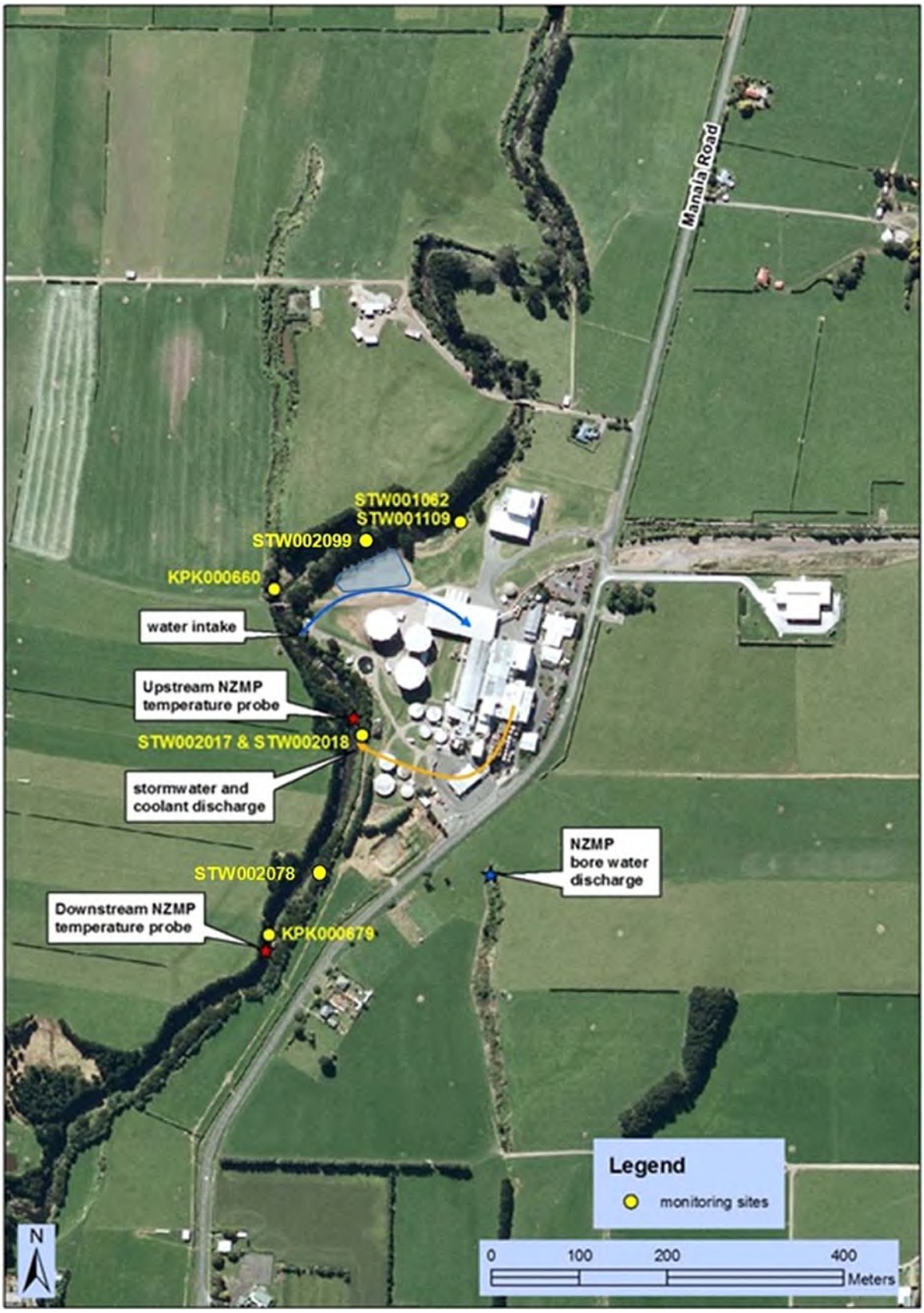

Figure 58 Section of Kaupokonui Stream for physicochemical monitoring in relation to Fonterra Ltd's waste discharges to water

Table 26 Summary of Kaupokonui Stream water quality data from the Council surveys during the period August 1994 to June 2021

Parameter	Unit	KPK000655			KPK000660			KPK000679		
		No.	Range	Median	No.	Range	Median	No.	Range	Median
Ammoniacal-N	g/m^3 N	272	<0.003 -0.869	0.022	0.016	0.003 - 0.147	0.020	272	<0.003 - 0.248	0.017
Dissolved BOD_5	g/m^3	231	<0.4 -2.0	0.5	0.500	<0.4 - 2.4	<0.5	233	<0.4 - 8.0	<0.5
Total BOD_5	g/m^3	309	<0.4 -8.3	0.6	0.6	<0.2 - 7.5	0.6	312	<0.4 - 8	0.6
Conductivity@25°C	mS/m	273	3.60 -12.3	10.1	282	3.65 - 13.0	10.6	275	3.54 - 14.6	10.8
Dissolved Reactive Phosphorus	g/m^3 P	84	0.003 -0.097	0.014	84	<0.003 - 0.101	0.015	84	<0.003 - 0.103	0.015
Nitrate+Nitrite-N	g/m^3 N	141	0.06 -1.26	0.44	141	0.07 - 1.36	0.52	141	0.06 - 1.4	0.53
pH	pH	270	6.8 -8.5	7.7	270	6.6 - 9.0	7.7	271	6.9 - 8.6	7.7
Temperature	˚C	270	4.9 -19.1	11.9	287	5.1 - 19.5	12.3	273	5.2 - 21.7	13.3
Total Kjeldahl Nitrogen	g/m^3	34	<0.10 -0.46	0.12	34	<0.1 - 0.51	0.10	34	<0.1 - 0.52	0.12
Total nitrogen	g/m^3	34	0.30 -1.02	0.59	34	0.37 - 1.16	0.73	34	0.32 - 1.16	0.68
Turbidity	FNU	24	0.31 -3.0	0.74	24	0.33 - 3.6	0.75	24	0.28 - 3.8	0..85
Turbidity	NTU	248	0.39 -120	1.10	250	0.40 - 130	1.07	250	0.42 - 160	0.93
Free Ammonia	g/m^3	45	<0.01 -0.010	<0.01	45	<0.01 - 0.013	<0.01	45	<0.01 - 0.01	<0.01

The receiving water quality results indicated that there were minimal, if any, impacts measured in the Kaupokonui Stream at time of sampling as a result of the stormwater and cooling water discharges. There was also no sewage fungus noted over the monitoring period.

The consent limit for the maximum concentration of filtered BOD in the river at the mixing zone periphery of 2 g/m^3 was complied with on all monitoring occasions.

Total nitrogen was added to the analysis suite in September 2018 to help quantify relative influences of the instream oxidation of the reduced ammoniacal form of nitrogen and/or organic nitrogen inputs, compared to potential increases in nitrates due to additional inorganic nitrogen inputs.

Total nitrogen has generally followed similar trends to the nitrate-nitrite concentrations, which it did for the year under review.

On one occasion in the 2019-2020 year (7 March 2020) it was found that there was an increase in total nitrogen between sites KPK000660 and KPK000679 that was not accounted for by an associated increase in nitrate-nitrite concentration. On this occasion the ammoniacal nitrogen also remained low, but there was an increase in the total Kjeldahl nitrogen (TKN). This would indicate the presence of organic nitrogen species during this dry and low flow condition survey.

The results for 2021-2022 show that there was no similar findings at the time of any of the surveys undertaken during the year under review.

All water temperature increases at the periphery of the mixing zone (150 m downstream of the spray system) were within the 3˚C rise permitted by consent conditions at the time of monitoring.

The summary of Kaupokonui Stream water quality data for the upstream (control) site recorded over the 27 year period prior to the 2021-2022 year (Table 26) and during this monitoring period (Table 25), shows that

generally, apart from a single lapse in May 2007, there has been good water quality for the parameters measured under normal flow conditions.

2.1.5 Groundwater quality

Sampling of shallow groundwater bores was undertaken approximately every two months through the monitoring period by the Council. The monitoring frequency had been increased from bi-annual to monthly in 2006-2007 for a period of three years to gain a better understanding of the seasonal variation in groundwater quality, and was reduced to approximately every second month in 2009-2010. During the year under review up to 12 bores were sampled on the three wastewater spray irrigation farm properties, as described in Table 27 and depicted in Figure 59. One bore ('control') on each property is sited upslope of the irrigation area and at least another one or two bores ('impact') within or down-slope of each irrigation area.

Table 27 Description of the groundwater monitoring sites

Property	Bore	Designation	Site code	Depth m	Map reference, NZTM	
					Easting	Northing
Farm 1	North	Control	GND0636	6.5	1697543	5630420
	South	Impact	GND0637	6.5	1697238	5629857
Farm 2	North	Control	GND2049	5.6	1698575	5628905
	West	Impact	GND0638	5.9	1698332	5628562
	South-west	Impact	GND0639	4.3	1698408	5627793
	South-west	Impact	GND2050	7.0	1698397	5627747
	South-east	Impact	GND2063	7.0	1698397	5627747
Farm 3	North	Control	GND2051	6.5	1697634	5627538
	West	Impact	GND0640	4.5	1696911	5627162
	Central	Impact	GND0641	3.4	1697367	5626969
	South-west	Impact	GND2052	7.0	1697216	5626790
	South-east	Impact	GND0700	4.5	1697445	5626790

Relocation and replacement of the original 'impact' bores on Farm 2 and Farm 3 was performed in April 1998 (see TRC 98-73, Southern and No. 3 farms respectively), in consultation with the consent holder and following investigations into groundwater contours and flow directions at each of these farms' monitoring sites. During the year under review, the head works on all the bores were upgraded and the bores were redeveloped by air lifting. Bore GND0640 had been damaged by farming activities in 2007. During the bore maintenance works, this bore was located and returned to a serviceable condition, with monitoring recommencing in January 2021.

It is noted that originally, bore GND0640 was a control bore for Farm 3. However, following the expansion of this farm and the incorporation of the "No. 3 extension" (Figure 1) in 2008, this became an impact bore.

A summary of selected groundwater quality data previously collected by the Council from the farm bores is presented in Table 28 for comparison with data collected during the monitoring period under review.

Nitrogen species, chloride, conductivity, and pH are determined on the samples collected at all of the surveys, with the additional parameters, including those that enable the anion/cation balance to be determined, are analysed at alternate surveys only.

The bores shaded in Table 28 are those no longer monitored.

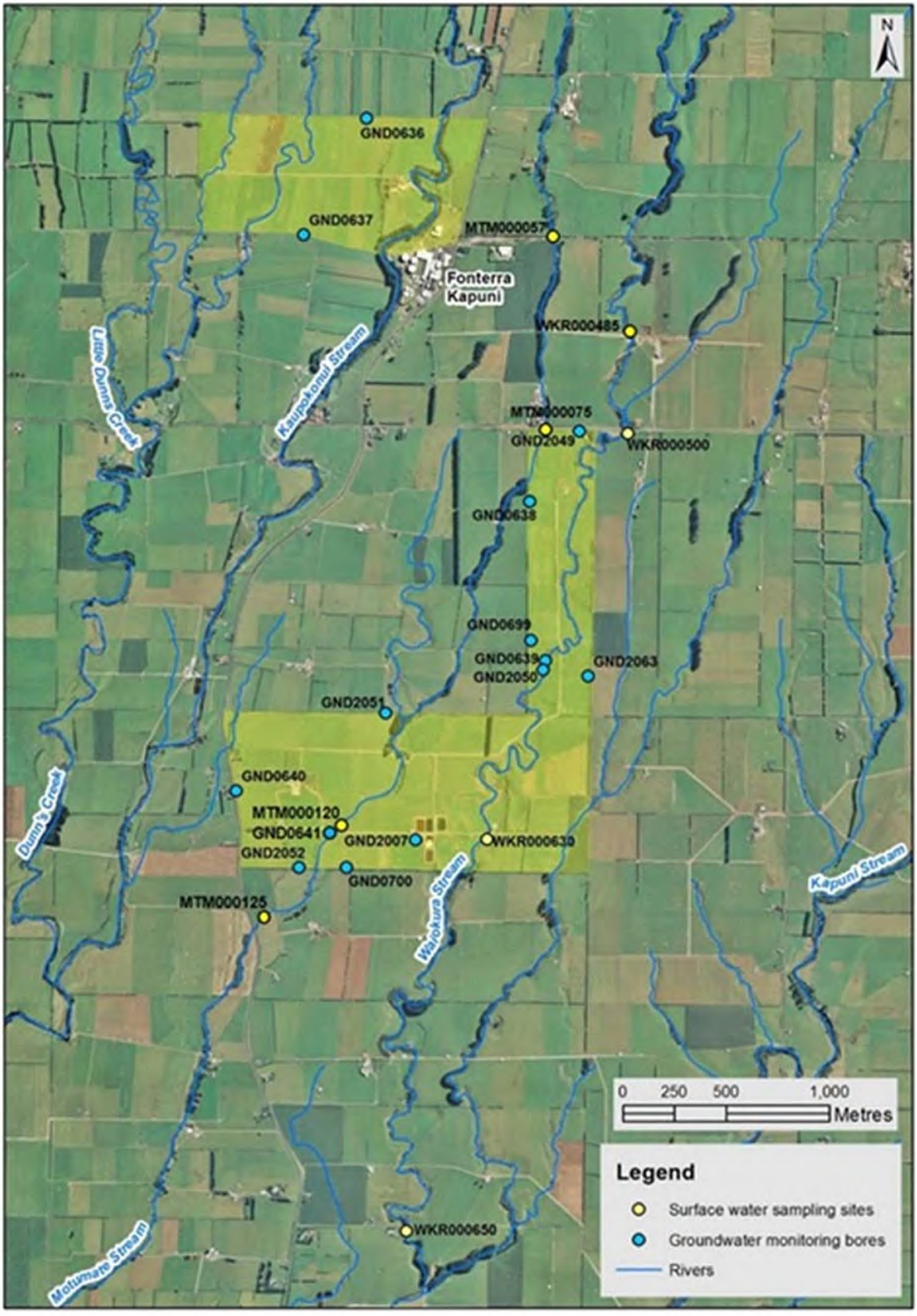

Figure 59 Groundwater monitoring bores, Motumate and Waiokura Stream sampling site locations on the three Company farms

Table 28 Summary of selected parameters from previous Council groundwater quality sampling performed during the period October 1991 to June 2021

Parameter		Level		pH		Conductivity @ 25˚C		Sodium		Nitrate/nitrite-N		COD*	
Unit		m		pH		mS/m		g/m³		g/m³N		g/m³	
Farm site	Bore	N	Range (median)	N	Range (median)	N	Range (median)	N	Range (median)	N	Range (median)	N	Range (median)
Farm 1	Control GND0636	119	1.55-4.83 (2.91)	159	6.2-7.1 (6.5)	172	29.2 -63.8 (32.9)	103	12.0-56 (24.6)	178	3.7-24 (8.3)	92	<5-27 (6)
	Impact GND0637	118	2.77-6.15 (4.15)	155	6.1-7.8 (6.5)	145	36.5-91.1 (62.8)	100	40-179 (72.6)	172	1.5-33 (12.1)	88	<5-50 (6)
Farm 2	Control ('new') GND2049	90	1..3-3.80 (2.52)	90	6.2-7.2 (6.4)	90	21.4-53.3 (41.9)	49	21-38 (31)	90	1.6-27 (15.3)	49	<5-7 (<5)
	Impact ('central') GND0638	116	1.08-3.68 (2.55)	151	4.7-7.2 (6.5)	149	60.1-165 (81.2)	96	67-136 (88)	149	<0.01-71 (8.9)	90	<5-1600 (5)
	Impact ('original') GND0639	83	1.90-4.22 (2.85)	101	6.5-7.5 (6.9)	102	27.8-91.3 (71.1)	67	62-157 (116)	102	3.8-29 (10.4)	62	<5-57 (6)
	Impact ('new') GND2050	91	1.60-3.20 (2.59)	91	6.5-7.4 (6.8)	91	15.1-80.0 (62.5)	49	49-102 (64)	91	<0.01-13.4 (1.1)	49	<5-21 (6)
	Impact GND2063	82	1.55-5.00 (3.46)	82	6.3-6.9 (6.5)	82	27.9-54.3 (34.2)	45	35-59 (41)	82	0.4-18.6 (4.9)	45	<5-24 (6)
Farm 3	Control ('original') GND0640[a]	18	0.85-3.24 (1.99)	51	6.4-7.0 (6.8)	51	23.2-46.2 (28.6)	45	28-49 (29)	51	<0.01-3.4 (0.13)	42	4-30 (6)
	Control ('new") GND2051	79	1.86-4.46 (3.13)	79	6.3-7.2 (6.5)	79	28.1-67.5 (36.6)	43	214-37 (29)	79	0.03-30 (7.0)	43	<5-31 (5)
	Impact GND0640[b]	4	2.05-4.40 (2.76)	4	6.8-6.9 (6.9)	4	30.2-31.9 (30.8)	2	31-34 (32.5)	4	0.01-0.33 (0.02)	3	8-42 (25)
	Impact GND0641[c]	51	1.01–3.00 (1.84)	54	6.3-7.2 (6.6)	54	27.9-70.3 (61.5)	50	30-57 (47)	54	0.87-15.6 (9.8)	47	<5-54 (7)
	Impact ('original') GND0700	109	0.40-4.60 (2.12)	121	5.6-7.2 (6.8)	121	33.5-170 (66.3)	73	39-188 (81)	122	0.02-47 (6.9)	73	<5-33 (6)
	Impact ('new') GND2052	85	1.30-4.38 (2.49)	85	6.4-7.5 (6.7)	85	20.9-49.7 (37.7)	46	35-60 (44)	85	<0.01-12.9 (2.0)	46	<5-29 (<6)
	Impact ('deep') GND2007	0	-	48	6.7-8.0 (7.7)	48	35.8-39.0 (36.9)	26	35-39 (37)	48	<0.01-0.10 (<0.01)	23	<5-44 (10)

* COD filtered prior to 2006

a GND0640 monitoring from April 1992 to April 2007 (control prior to Farm 3 extension)

b GND0640 monitoring re-commenced January 2021 (impact post Farm 3 extension)

c GND0641 not monitored between June 2013 and May 2018 due to a blockage in the bore

The groundwater quality monitored at each farm is discussed below. Wastewater irrigation occurred on each farm throughout the monitoring period (see Section 2.1.1.6).

In previous reports it has been stated that, without onsite rainfall and time series paddock by paddock irrigation data, it is difficult to gauge whether the effects found in the groundwater bores are related to periods of irrigation, rain related flushing, or a combination of these. It was signalled to the Company that paddock by paddock irrigation records are likely to be required by the reissued discharge consent. The Company provided this information voluntarily for part of the 2020-2021 year and, following discussions on how this data could be managed effectively, began providing this information on a monthly basis from the start of the 2021-2022 year. A summary of this data has been presented in Section 2.1.1.6 and, where appropriate, the more detailed data will be used to inform effects found in the groundwater where possible.

2.1.5.1 Farm 1 groundwater

The results of groundwater monitoring on this farm during the period under review are summarised in Table 29. The full set of results is available upon request.

Table 29 Results of groundwater quality sampling on Farm 1

Waste		Control (GND0636)			Impact (GND0637)		
Parameter	**Unit**	**No.**	**Range**	**Median**	**No.**	**Range**	**Median**
Alkalinity Total	g/m^3 CO_3	3	44 - 54	46	3	114 - 140	126
Ammoniacal nitrogen	g/m^{3}N	6	<0.01 - 0.098	<0.01	6	<0.01 - <0.01	<0.01
Bicarbonate @ 25'C	g/m^3	3	54 - 65	56	3	138 - 171	153
Calcium	g/m^3	3	16.4 - 20.0	18.0	3	16.6 - 22	19
COD	g/m^3	3	<6 - 6	<6	3	<6 - 6	<6
Chloride	g/m^3	6	27 - 49	43	6	31 - 54	40.5
Conductivity @ 25'C	mS/m	6	27.5 - 66.9	35.0	6	49.4 - 62.7	54.6
DRP	g/m^{3}P	3	0.020 - 0.025	0.023	3	0.015 - 0.033	0.022
Hardness Total	g/m^3 CO_3	3	67 - 72	72	3	68 - 87	79
Magnesium	g/m^3	3	5.3 - 6.7	6.2	3	6.4 - 7.9	7.8
Nitrite nitrogen	g/m^{3}N	3	<0.002 - 0.015	<0.002	3	<0.002 - <0.002	<0.002
Nitrite+nitrate	g/m^{3}N	6	3.0 - 7.9	4.9	6	8.7 - 11.7	9.5
pH		6	6.6 - 6.9	6.8	6	6.7 - 7.0	6.7
Potassium	g/m^3	3	7.2 - 26	8	3	48 - 75	60
Sodium	g/m^3	3	21 - 25	22	3	45 - 52	48
Sulphate	g/m^3	3	22 - 26	22	3	27 - 36	31
Sum of Anions	meq/L	3	2.4 - 3.2	2.5	3	4.7 - 5.7	4.9
Sum of Cations	meq/L	3	2.4 - 3.2	2.6	3	4.8 - 5.9	5
Temperature	˚C	6	13.7 - 14.9	14.2	6	14.0 - 14.9	14.3
Total Kjeldahl nitrogen	g/m^{3}N	6	<0.1 - 0.26	0.17	6	<0.1 - 0.25	0.14
Total nitrogen	g/m^{3}N	6	3.20 - 8.1	5.0	6	8.9 - 11.7	9.6
Un-ionised ammonia	g/m^3	6	<0.01 - <0.01	<0.01	6	<0.01 - <0.01	<0.01
Water Level	m	6	1.81 - 2.65	2.39	6	3.17 - 4.03	3.71

At the end of the 2016-2017 year it was considered that the water quality of the control bore GND0636 groundwater appeared to have been improving slightly in terms of nitrate. Based on the 2017-2018 data, it appeared that this had stabilised somewhat, but this was followed by an increased median during the 2018-2019 year. During the 2019-2020 and 2020-2021 years the annual medians have again improved. It is noted that the nitrate concentrations in this bore have now remained below the drinking water standard for three consecutive years. It is noted that during this period the groundwater levels have shown a trend of decreasing groundwater level, though still retaining the expected variation due to seasonal changes. The combination of decreasing nitrate-nitrite concentration alongside decreasing groundwater levels is consistent with the observation that heavy rainfall tends to flush more nitrate into the groundwater and/or that increases in groundwater levels tend to "collect" nitrates stored in the surface soils.

Water quality at the impact bore GND0637 was found to have higher ionic strength and showed a marked elevation in alkalinity, bicarbonate, median nitrate, potassium, sodium, sulphate and conductivity levels when compared to the control bore. Monitoring of alkalinity and potassium in the groundwater commenced in the 2018-2019 year. The results obtained for these parameters in the sample collected on 16 June 2022 were the highest on record for site GND0637.

It is noted that there have generally been some large "seasonal variations" in the down gradient bore that are not present in the control bore that, together with the findings above, are consistent with the effect of leaching of wastewater from spray irrigation disposal to shallow groundwater (Figure 60 to Figure 64). The usual seasonal effects were not apparent during the year under review in either the groundwater levels (Figure 67) or the contaminant concentrations at the time of the sampling surveys. It is noted that the groundwater levels at the time of the sampling surveys during the year under review were all at, or above, the peak groundwater level recorded during the previous year.

There was an elevation in the conductivity of the sample collected from the control bore (GND0636) on 4 April 2022 (Figure 60). Corresponding elevations were also recorded for chloride (Figure 61) and total nitrogen (Figure 62). The additional parameters were not determined for the samples collected at the time of this survey.

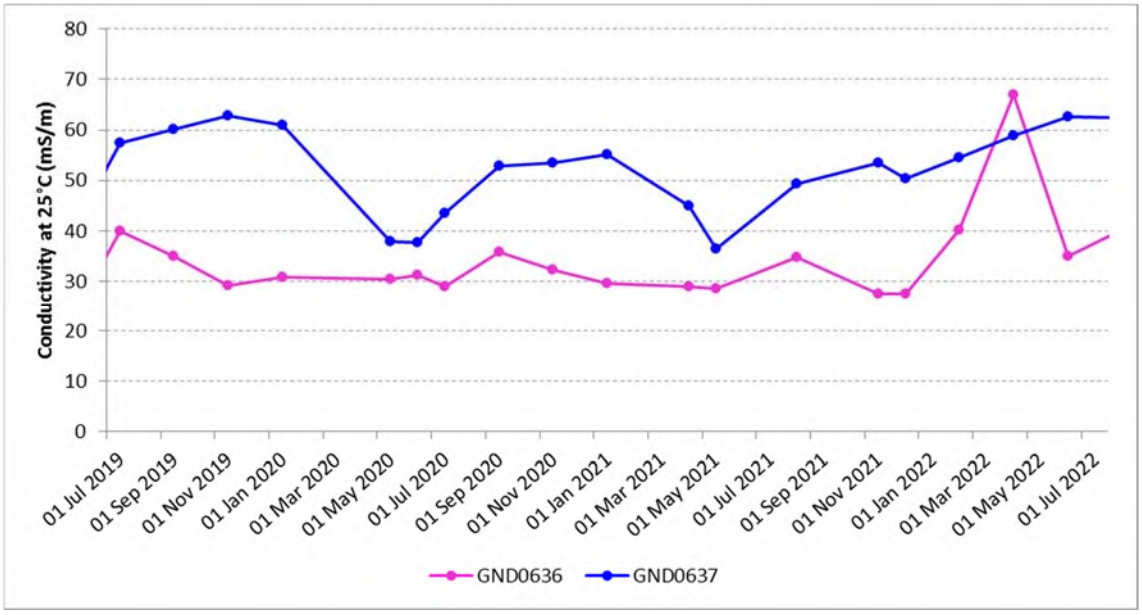

Figure 60 Three year trends in groundwater conductivity at Farm 1

Irrigation events took place in paddock 11, the paddock adjacent to the one in which this bore is located, between 31 March and 2 April 2022. There was 491 m^3 of FWW and 57 m^3 of DSE irrigated (27.4 mm equivalent) at a time when soil moisture at the Glenn Road monitoring site was above median. The

composite wastewater samples covering this period were of just above average in terms of conductivity and total nitrogen in the FWW and at or above median in the Farm 1 DSE.

There was a steady increase in the chloride concentration of the impact bore (GND0637) during the year under review and a single large increase in the chloride concentration in the control bore sample collected on 15 February 2022.

In relation to the control bore, irrigation events again took place in paddock 11 in the days preceding the groundwater survey. Over the 13 and 14 February 2022 there was 321 m^3 of FWW and 77 m^3 of DSE irrigated (19.9 mm equivalent) at a time when soil moisture at the Glenn Road monitoring site was above median. There was 151 mm of rain recorded at the Farm 3 weather station between the days of 12 to 14 February, with 50 to 64 mm of rain falling on the days when the irrigation events occurred. The four day FWW composite covering this period had above average concentrations of all contaminants determined, and also had the highest COD recorded during the 2021-2022 year. The Farm 1 DSE contained contaminant concentrations that were similar to or below median. It is likely that these irrigation events may have impacted on the groundwater quality at the control bore under these conditions.

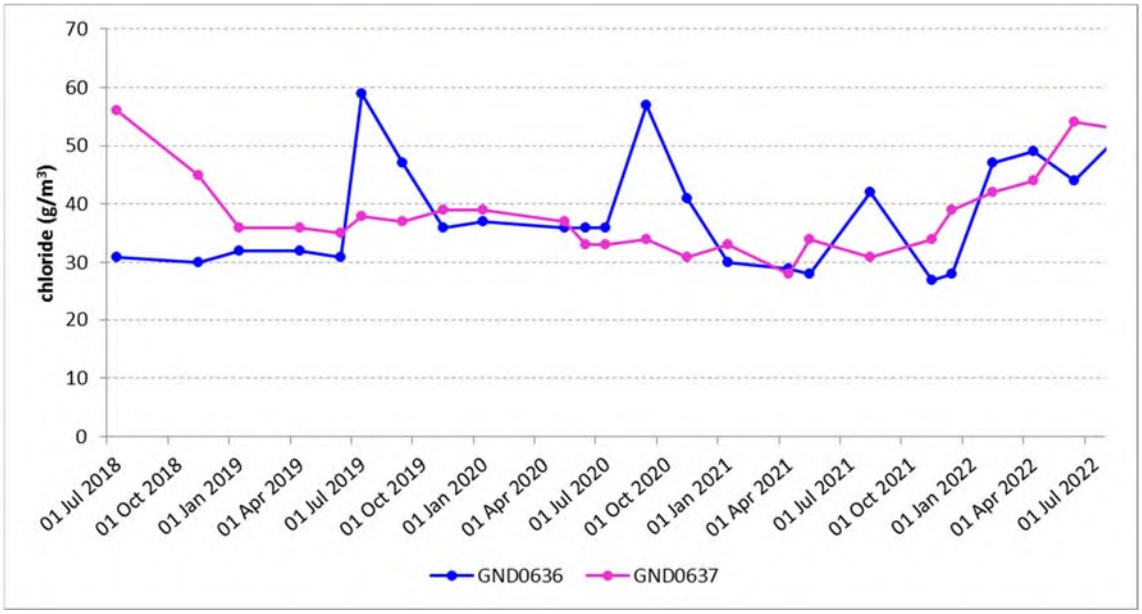

Figure 61 Trends in groundwater chloride at Farm 1

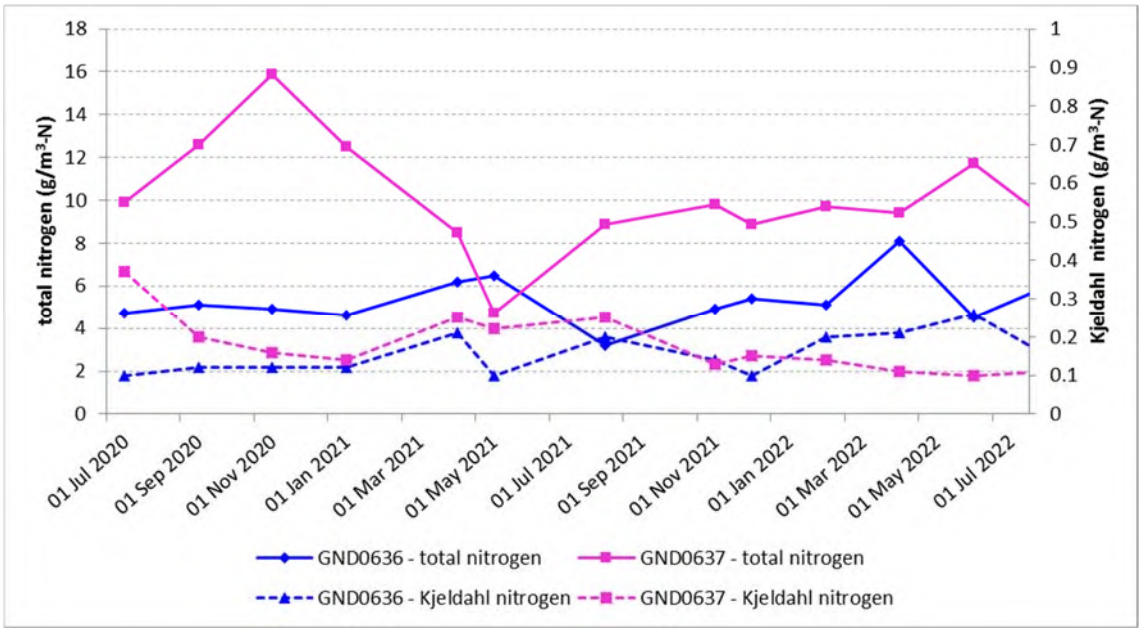

Figure 62 Trends in groundwater total and Kjeldahl Nitrogen at Farm 1

In terms of the increase in total nitrogen observed at GND0636 at the time of the 4 April 2022 survey, it is noted that 67 Kg of nitrogen was discharged to paddock 11 between 31 March and 2 April 2022. There was no corresponding peak in the Kjeldahl nitrogen of the groundwater in this bore indicating that recent diffuse agricultural discharges were not having a significant contribution to these findings. Although there had been no significant rainfall for 3 days prior to the start of this irrigation, soil moisture was likely to have been above the annual median (as indicated at the Glenn Road site). It is likely that the 548 m^3 of combined wastewater irrigated at this time may have resulted in the elevated nitrogen concentration found in GND0636 at the time of the April survey. It is noted that the nitrogen concentration of the groundwater at this monitoring bore had reduced at the time of the following survey.

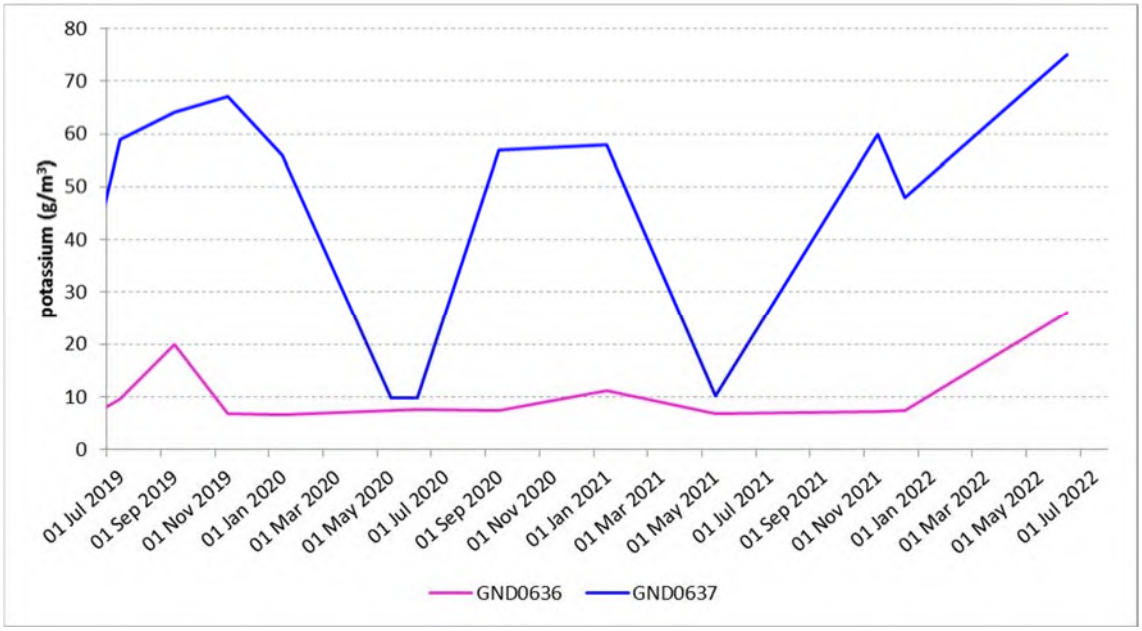

Figure 63 Three year trends in groundwater potassium at Farm 1

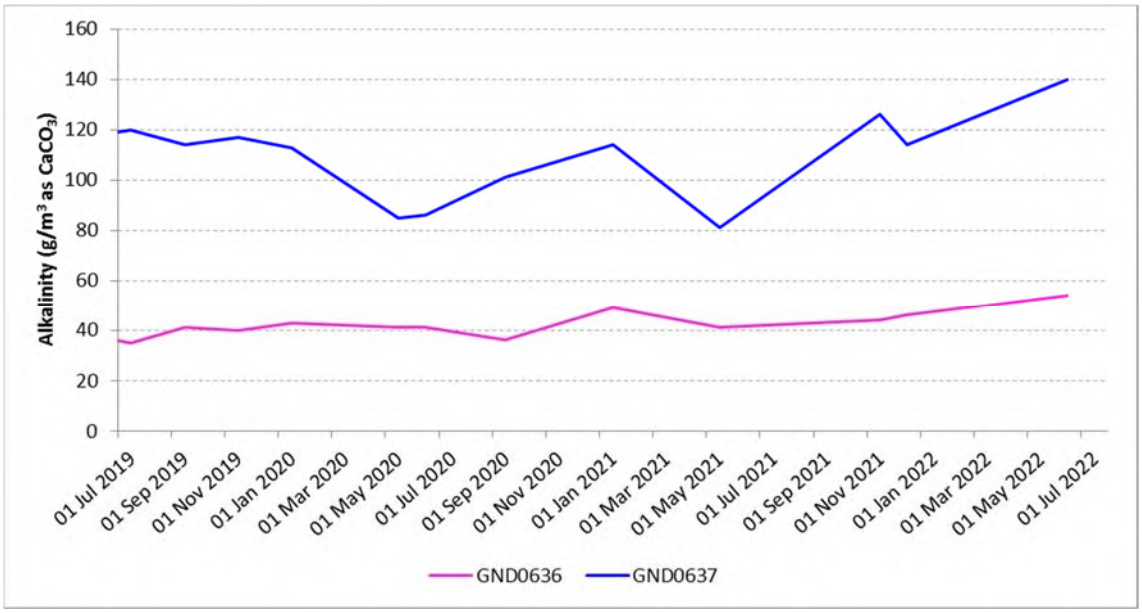

Figure 64 Three year trends in groundwater alkalinity at Farm 1

The sodium concentration again appears to be reducing overall, with all values recorded during the year under review being slightly below the historical median (refer to Figure 65 and Table 29). The COD of both bores was found to be low at each of the sampling surveys. The nitrate concentration at the impact bore was significantly higher than at the control bore. The median values for both sodium and nitrate in the 2021-2022 year, and for the historical data, are higher at the impact bore than at the control bore.

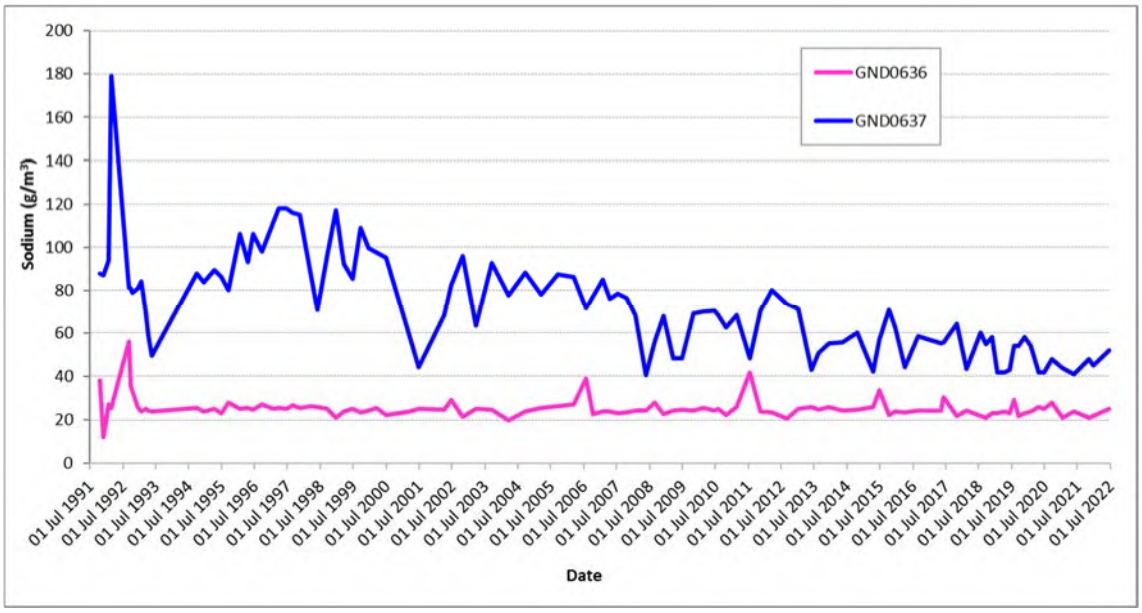

Figure 65 Long term trends in groundwater sodium concentration at Farm 1

Figure 66 compares the long term trends in groundwater nitrate-N levels at the impact bore with the control bore, 640 m up-gradient, on the northern boundary of the farm. During the year under review, only one of the samples collected was above the drinking water standard (11.3 g/m^3).

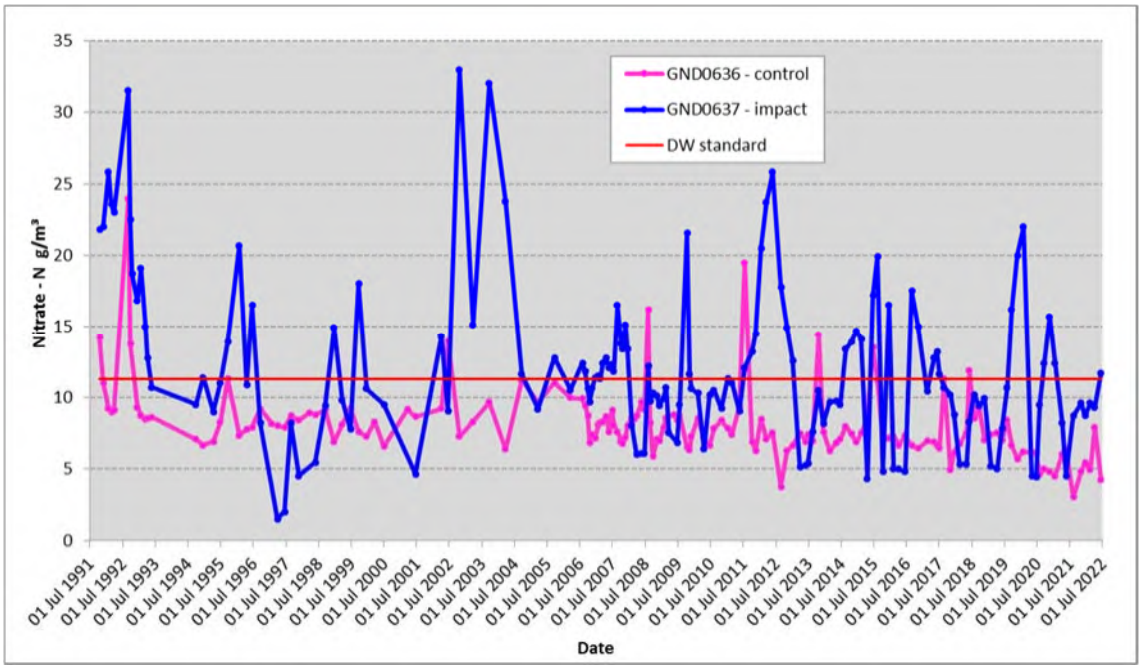

Figure 66 Long term trends in groundwater nitrate-N concentration at Farm 1

When looking at the changes in groundwater level and nitrate concentration at the time of the April 2022 survey (Figure 67), it is likely that this data also supports a likely effect of irrigation being evident in the control bore (GND0636). Although the groundwater levels at the two sites were showing a consistent trend of lower groundwater levels at the time of the previous survey, there was an increase in the nitrate-N concentration at the control bore (which, as discussed, is in the vicinity of a preceding irrigation event) that was not evident in the impact bore.

At the time of both the August 2021 and June 2022 surveys, there were increases in the groundwater levels that were accompanied by significant increases in the nitrate-N concentrations of the groundwater in the impact bore (GND0637) that were not evident in the control bore. There had been no irrigation on the paddocks in the vicinity of either the control bore or the impact bore between the start of the 2021-2022 year and the August 2021 survey. There had been 309 mm of rainfall between the August 2021 and the previous survey.

Irrigation had occurred on the paddocks in the vicinity of both bores in the time between the April and June surveys and there had been 320 mm of rain during this period. These factors along with the absence of a corresponding increase in nitrogen concentration at the control bore as the groundwater levels increased, indicate that the effects are unlikely to be connected to localised short term effects of the irrigation events. Instead it supports the theory that the flushing effects of rainfall combined with the "collecting" of any subsurface nitrate-N in the soil in the groundwater levels as it rises is evident in the impact bore.

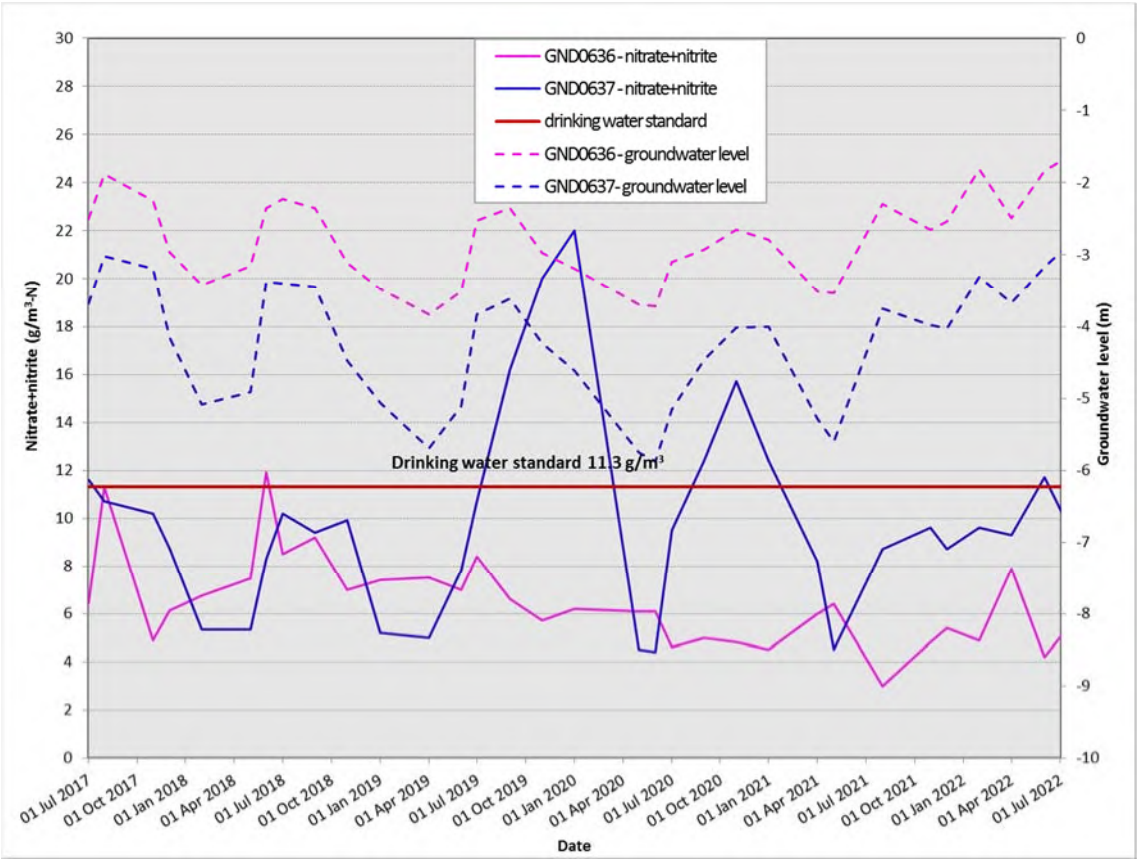

Figure 67 Farm 1 groundwater levels and nitrate + nitrite nitrogen concentrations during the year under review

2.1.5.2 Farm 2 groundwater

The results of groundwater monitoring on this farm during the year under review are summarised in Table 30, with the relative concentrations of selected parameters, nitrate-N, conductivity, pH, sodium, chloride and potassium, shown in Figure 68 to Figure 74. The full set of results is available upon request.

The control bore for Farm 2, GND2049, was drilled in March 2008, on the northern boundary beside Skeet Road (Figure 59, page 80). This replaced the original 'control' bore, GND0638, which is situated on the western boundary with about 350 m of irrigated paddocks up-gradient. This bore was affected by ponding of effluent in spring 2006 and possibly again in spring 2007. For this reason, following this discovery, the wastewater was irrigated only in summer in the paddock immediately up-gradient (number 13B). However, this paddock was subsequently aerated, and irrigation was resumed. No further issues with ponding have been reported.

The impact monitoring bore, GND0699, some 670 m down-gradient due south of GND0638 collapsed in December 2006, following damage caused by farm activities. A replacement impact bore, GND2050, was installed above the Waiokura Stream in March 2008. This was the third impact bore drilled on Farm 2 west of the Waiokura Stream.

Figure 68 compares the long term trends in groundwater nitrate-N levels at the newer impact bores (GND2063 and GND2050), the two longer standing impact bores (GND0639 and GND0699), and the original control bore (GND0638) that is now considered to be an impact bore, with the new control bore (GND2049).

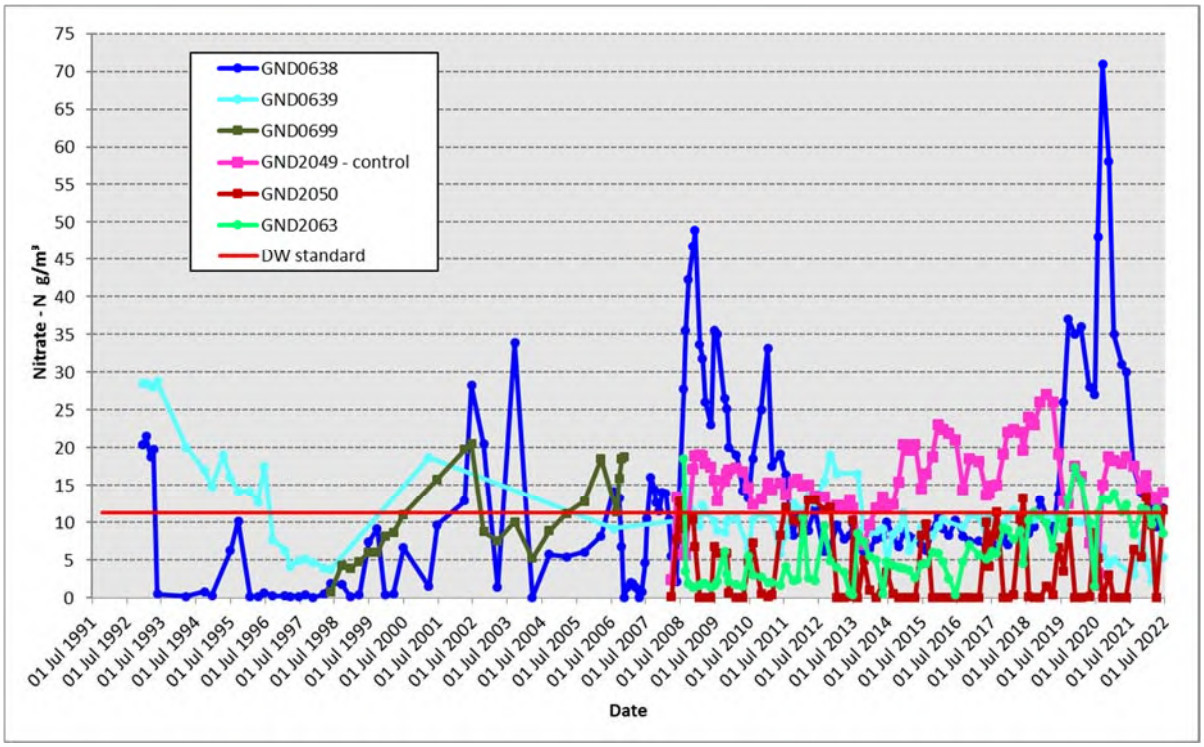

Figure 68 Long term trends in groundwater nitrate-N concentration at Farm 2

The control bore, GND2049, continued to show the influence of an unknown source during the year under review. The nitrate-N concentration in this bore ranged from 13.1 to 17.6 g/m^3 during the monitoring period, with an annual median of 14.3 g/m^3. The annual medians have been consistently above the drinking water standard since this bore was installed, with the highest annual median being found over the 2018-2019 monitoring period. All six results obtained during the year under review were above the drinking water standard. The median of the historical results to June 2021 has remained unchanged from that of the data to June 2019, 2020, and 2021, at 15.4 g/m^3 of nitrate-N. For the assessment of environmental effects to accompany the consent renewal application, the Company had been asked to investigate whether the nitrate being found in this bore originates from farming activities up-gradient across Skeet Road, from "mounding" of factory effluent applied down gradient, or by some other mechanism, noting that the nitrate level is often varying inversely with groundwater level. Although a theoretical analysis of the existing data was provided, there was no conclusive evidence supporting the theory that "upwelling" was the cause of the elevated nitrates at the control bore. It is likely that the renewed consent will require further work to be undertaken on this matter.

The conductivity, pH, sodium and chloride levels of the control bore were relatively low and within the normal ranges found in adjacent farming areas. COD and ammonia were low, indicating little leaching of organics into this bore.

Table 30 Results of groundwater quality sampling on Farm 2

Parameter	Unit	Control (GND2049)			Impact (GND0638)			Impact (GND0639)			Impact (GND2050)			Impact (GND2063)		
		No.	Range	Median	No.	Range	Median	No.	Range	median	No.	Range	median	No.	Range	median
Alkalinity Total	g/m³ CO_3	3	56 - 62	56	3	169 - 189	183	3	138 - 164	141	3	146 - 166	163	3	46 - 81	50
Ammoniacal nitrogen	g/m³N	6	<0.01 - <0.01	<0.01	6	<0.01 - <0.01	<0.1	6	<0.01 - <0.01	<0.01	6	<0.01 - 0.017	<0.01	6	<0.01 - <0.01	<0.01
Bicarbonate @ 25'C	g/m³	3	68 - 75	68	3	210 - 230	220	3	168 - 200	172	3	178 - 200	199	3	57 - 99	61
Calcium	g/m³	3	25 - 30	28	3	34 - 38	36	3	12.1 - 15.7	15	3	14.7 - 21	18	3	10.6 - 11.9	11.0
COD	g/m³	3	<6 - <6	<6	3	<6 - <6	<6	3	<6 - <6	<6	3	<6 - 7	<6	3	<6 - <6	<6
Chloride	g/m³	6	36 - 47	44	6	38 - 104	59	6	27 - 56	35	6	32 - 59	46	6	30 - 123	37
Conductivity @ 25'C	mS/m	6	40.0 - 43.3	40	6	72.2 - 89.9	79.4	6	27.8 - 68.2	48.5	6	55.2 - 68.5	64.9	6	35.1 - 68.0	42.0
DRP	g/m³P	3	<0.004 - 0.007	0.006	3	0.008 - 0.019	0.017	3	0.026 - 0.028	0.028	3	<0.004 - 0.009	0.007	3	0.007 - 0.019	0.01
Hardness Total	g/m³ CO_3	3	110 - 128	122	3	133 - 152	145	3	65 - 83	82	3	61 - 92	75	3	67 - 77	68
Magnesium	g/m³	3	11.5 - 13.0	12.6	3	11.5 - 14.1	13.1	3	8.3 - 10.7	10.6	3	6.0 - 9.9	7.2	3	9.9 - 11.4	10.0
Nitrite nitrogen	g/m³N	3	<0.002 - <0.002	<0.002	3	<0.002 - <0.002	<0.002	3	<0.002 - <0.002	<0.002	3	<0.002 - <0.002	<0.002	3	<0.002 - <0.002	<0.002
Nitrite+nitrate	g/m³N	6	13.1 - 17.6	14.3	6	9.4 - 17.4	13.0	6	2.3 - 8.4	4.8	6	0.011 - 13.4	8.1	6	8.4 - 11.9	10.8
pH		6	6.4 - 6.8	6.6	6	6.7 - 7.2	7.0	6	6.8 - 7.2	6.9	6	6.7 - 7.2	6.9	6	6.4 - 6.9	6.6
Potassium	g/m³	3	7.0 - 8.5	7.0	3	54 - 59	57	3	17.7 - 28	24	3	55 - 70	68	3	8.9 - 31	10
Sodium	g/m³	3	28 - 32	30	3	70 - 75	75	3	62 - 100	71	3	69 - 77	71	3	37 - 52	38
Sulphate	g/m³	3	18.0 - 19.7	19.0	3	52 - 68	56	3	31 - 53	33	3	41 - 57	46	3	26 - 30	28
Sum of Anions	meq/L	3	3.7 - 4.0	3.9	3	7.0 - 7.6	7.4	3	4.8 - 6.6	5.0	3	5.7 - 6.5	6.5	3	3.2 - 4.5	3.4
Sum of Cations	meq/L	3	3.7 - 4.2	3.9	3	7.3 - 7.8	7.4	3	4.8 - 6.7	5	6	6.0 - 6.6	6.3	3	3.2 - 4.6	3.2

Parameter	Unit	Control (GND2049)			Impact (GND0638)			Impact (GND0639)			Impact (GND2050)			Impact (GND2063)		
		No.	Range	Median	No.	Range	Median	No.	Range	median	No.	Range	median	No.	Range	median
Temperature	˚C	6	13.6 - 15.8	14.6	6	13.6 - 15.9	14.5	6	13.6 - 15.3	14.5	6	13.6 - 15.9	14.5	6	13.9 - 15.3	14.1
Total Kjeldahl nitrogen	g/m^{3}N	6	<0.1 - 0.16	<0.1	6	<0.1 - 0.17	0.14	6	0.11 - 0.33	0.19	6	<0.1 - 0.2	0.12	6	<0.1 - 0.20	0.12
Total nitrogen	g/m^{3}N	6	13.2 - 17.8	14.4	6	9.5 - 17.5	13.2	6	2.5 - 8.6	4.9	6	<0.11 - 13.6	8.2	6	8.6 - 12.0	10.8
Un-ionised ammonia	g/m^3	6	<0.01 - <0.01	<0.01	6	<0.01 - <0.01	<0.01	6	<0.01 - <0.01	<0.01	6	<0.01 - <0.01	<0.01	6	<0.01 - <0.01	<0.01
Water Level	m	6	1.91 - 2.78	2.37	6	1.57 - 3.12	2.35	6	1.96 - 3.23	2.44	6	1.63 - 2.87	2.31	6	2.52 - 3.71	3.07

At GND0638 nitrate-N concentration had reduced from the peak of 49 g/m³ recorded during 2008-2009 down to 8 g/m³ in 2012, after the change was made to only irrigating this paddock in summer. For the six years from June 2012 to June 2018 nitrate-N concentration had been fluctuating between 6 to 11 g/m³, remaining just below the drinking water standard of 11.3 g/m³. The annual median nitrate-N began to increase again in the 2018-2019 year. In the 2019-2020 year, the nitrate-N results were in the range 26 to 37 g/m³, with a further sharp increase in concentration found at the start of the 2020-2021 year. The Company was asked to investigate and undertake follow-up action as per condition 12 (a) of consent 0923 and section 9.7 of the WFMP. The findings of the investigation and mitigation measures that were to be undertaken until a reduction in groundwater nitrate-N level was observed are discussed in the 2020-2021 Annual Report. The mitigation measures and their implementation during the year under review are outlined below:

1. No PROLIQ to be spread on paddocks 13B, 14 A/B and 15 A
2. No fertiliser to be applied on paddocks 13B, 14 A/B and 15 A
3. No maize to be planted on paddocks 13B, 14 A/B and 15 A
4. Reduce irrigation of wastewater on paddock 13B and 14 A/B to reduce load by ~30%
5. Continue current monitoring schedules and review progress in 6 and 12 months

Five of the six results obtained during the year under review were above the drinking water standard with an annual median of 13.0 g/m³ and the maximum result obtained being 17.4 g/m³. This shows a significant and relatively sustained reduction from the concentration of 71 g/m³ recorded in September 2020. The nitrate concentration in this bore was also similar to or less than the nitrate concentration in the control bore (GND2049) from 14 August 2021 onwards (Figure 69).

In relation to mitigation measure 4, the application rates on paddocks 13B and 14 A/B are compared with the average application rates for Farm 2 in Table 31.

Table 31 Comparison of application rates on paddocks 13B and 14 A/B with the Farm 2 average rates

	Annual application (mm equivalent)		Annual nitrogen application (kgN/ha/y)	
	paddock application	Farm 2 average	paddock application	Farm 2 average
13B	211	334	282	423
14A	338		446	
14B	339		459	

This shows that, although the loadings have continued to be reduced in paddock 13B, the irrigation loads in paddocks 14A and B were above average. At the time of the progress review, the Company determined that it was no longer necessary to maintain reduced irrigation loadings in paddocks 14A and 14B as the nitrate concentration at GND0638 had reduced and was remaining below that found at the control bore. It is noted, however, that the nitrate nitrogen concentration in GND0638 was still elevated when compared to the historical median for this bore (8.9 g/m³).

The ionic strengths (sum of anions and cations) of the samples from bore GND0638 continued to be higher than the other bores monitored in the year under review, but not by as much as in the 2020-2021 year (annual median of 7.4 meq/L compared to 10.8 meq/L in 2020-2021). Conductivity, sodium, potassium and chloride values continued to be elevated, with some recovery in groundwater quality evident in the sample collected in June. The conductivity and chloride concentrations followed similar trends to the nitrate-N results (Figure 69, Figure 70 and Figure 73). It is noted that the COD and ammoniacal nitrogen levels were again low.

At the impact bore GND0639 it was found that the nitrate concentration varied from 2.3 to 8.4 g/m^3 during the year under review, remaining below the drinking water standard. In contrast to the 2017-2018 year, there appeared to be little influence from changes in ground water levels in the 2018-2022 years (Figure 69). It is noted that this bore continues to exhibit higher sodium concentrations that in any of the other Farm 2 bores, with the exception of GND0638 and GND2050 at times, particularly on 21 December 2021 (Figure 72).

Historically, it has been found that at the newer impact bore beside the Waiokura Stream, GND2050, nitrate-N concentration appears to fluctuate with groundwater level (Figure 69). Over the total record, the nitrate-N concentration is typically in the range of approximately 3 to 13 g/m^3 during winter and spring, falling to <1 g/m^3 in summer and autumn. Denitrification is a likely explanation, as ammonia concentration varies inversely with nitrate, reaching >0.5 g/m^{3}N, while a low oxygen level (that is, conducive to denitrification) has been recorded.

During the year under review, only one of the samples collected had a nitrate-N concentration of < 1 g/m^3, with the other samples being in the range 5.4 to 13.4 g/m^3. The highest nitrate-N concentration recorded in the 2021-2022 year was in the sample collected on 21 December 2021, at a time of lower groundwater levels and at a time of year where the data suggests that, due to seasonal variations, a lower nitrate-N would typically be expected. The paddock by paddock irrigation data provided by the Company shows that 1572 m^3 of FWW, containing 184 kg of nitrogen, was irrigated onto the three paddocks up gradient of this bore between 8 and 14 December 2021. It is noted that the conductivity, sodium, potassium and chloride values continue to be elevated at GND2050 when compared to the control bore. There was a significant increase in the potassium concentration of the groundwater sample from this bore at the time of the April 2022 survey (Figure 74). The concentration recorded at the time of this survey was the highest on record for this monitoring location (N=16), with a further slight increase found in the sample collected on 16 June 2022.

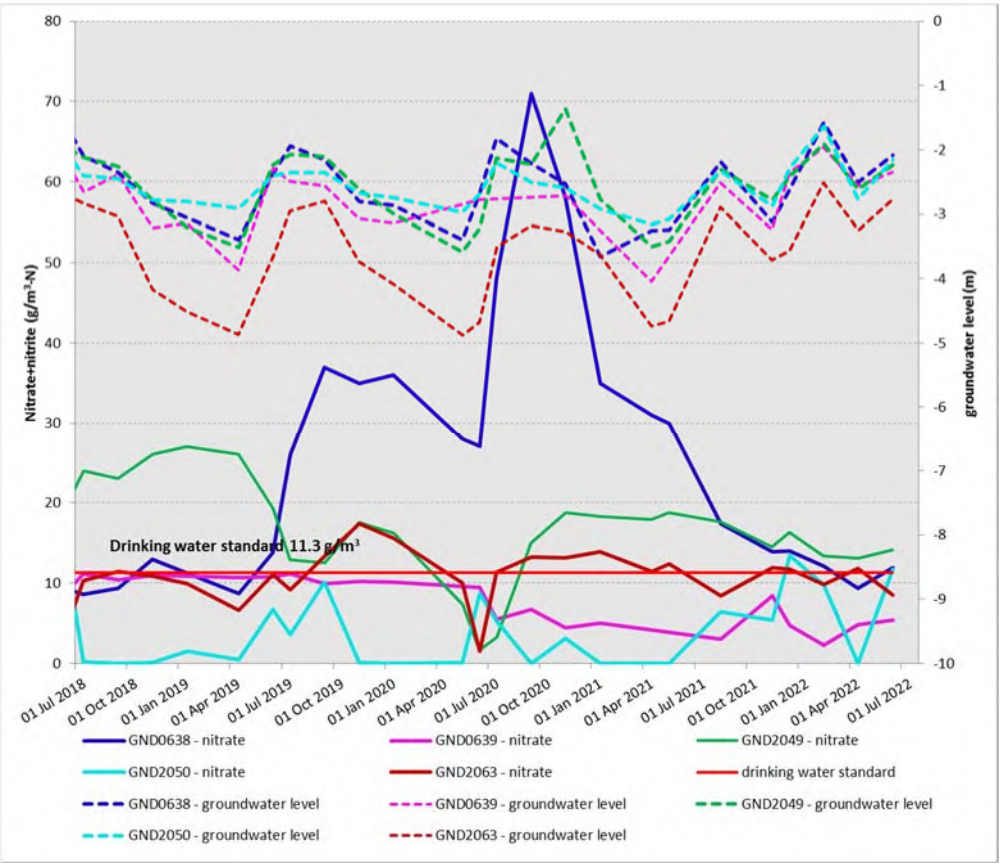

Figure 69 Farm 2 groundwater levels and nitrate + nitrite nitrogen concentrations and groundwater levels during the year under review

The nitrate-N concentrations in the impact bore GND2063 during the year under review were in the range 8.4 to 11.9 g/m³, with three of the six samples collected marginally above the drinking water standard. It is noted that the nitrate-N concentration varies inversely with the groundwater level, indicating potential minor effects from recent irrigation activities, rather than rising groundwater levels "collecting" accumulated nitrogen stored deeper in the soil. The annual median of 10.8 g/m³ is less than those of the 2019-2020 and 2020-2021 years.

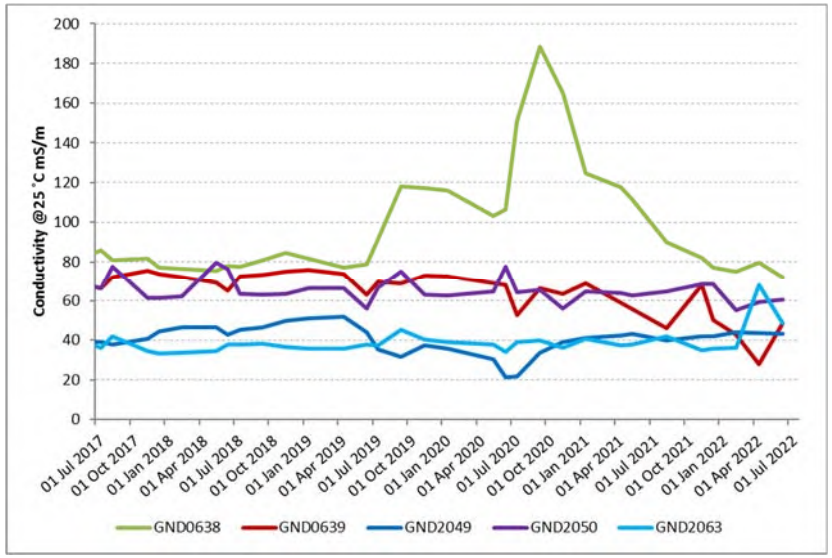

Figure 70 Groundwater conductivity at Farm 2 bores, June 2017 to date

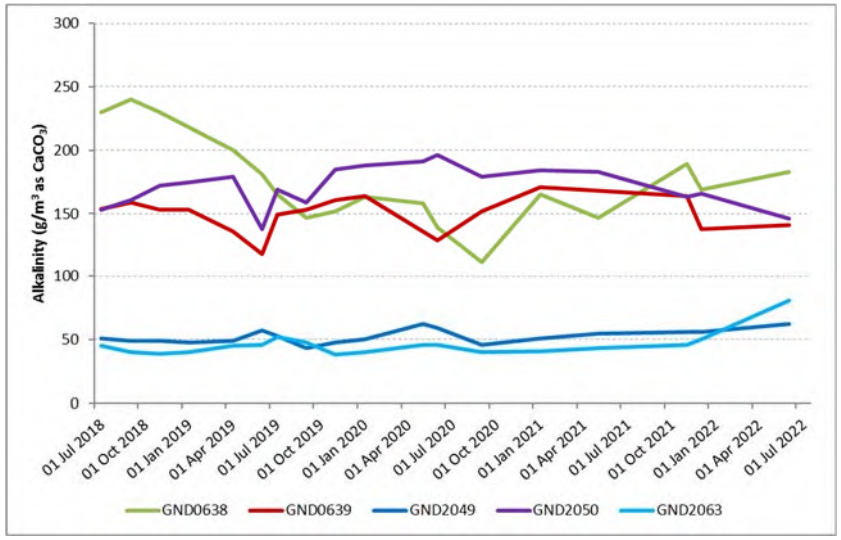

Figure 71 groundwater alkalinity at Farm 2 bores, June 2018 to date

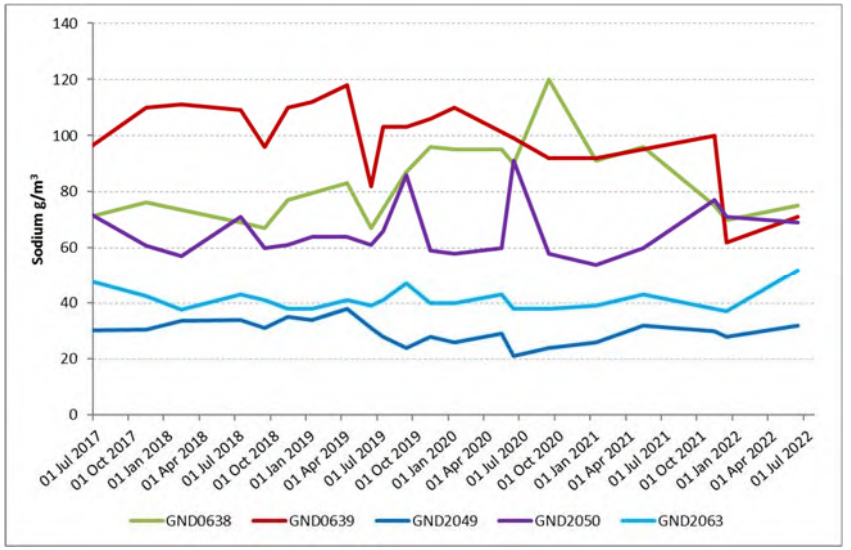

Figure 72 Groundwater sodium concentration at Farm 2, June 2017 to date

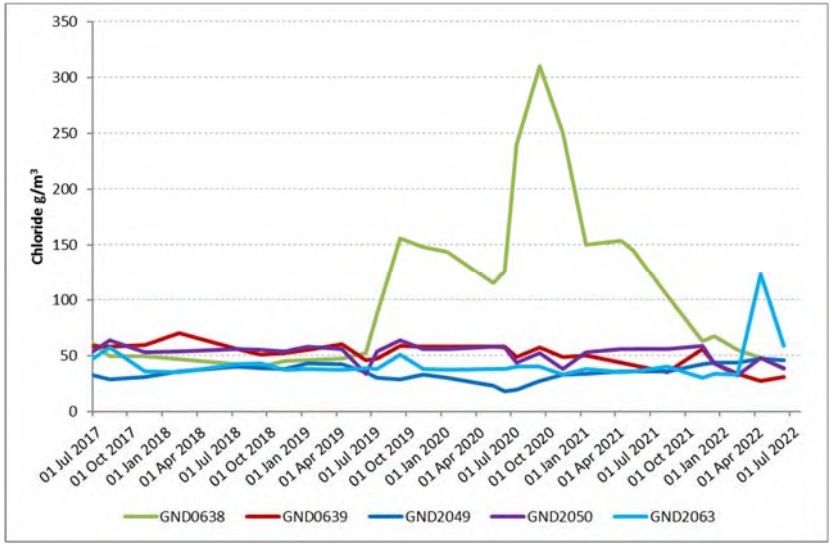

Figure 73 Groundwater chloride concentration at Farm 2, June 2017 to date

At the time of the survey undertaken on 4 April 2022 there was a very noticeable increase in the chloride concentration of the groundwater at GND2063. The concentration recorded (123 g/m^3) was a new maximum for this monitoring locations and was double the previous maximum concentration (59.7 g/m^3 in June 2015). Data provided by the Company showed that there was 287 m^3 of FWW but no DSE irrigated on paddock 18 (immediately up gradient of this bore) in two events, one 2 April 2022 and the other on the day of the sampling survey. The FWW analysis results for the composite sampled collected over the six days covering this period indicated that the chloride concentration in the FWW was relatively low (76 g/m^3). It is noted that there can be significant differences in concentrations recorded for consecutive composite samples however, (for example the chloride concentration in the subsequent composite sample was 123 g/m^3) indicating the potential for significant variations within the concentrations of the FWW on a daily basis within any given composite sample. The alkalinity of the groundwater sample collected on 16 June 2022 was the highest on record for this monitoring location, at almost double the historical median. Irrigation events had also occurred in paddock 18 prior to this sampling survey. 614 m^3 of FWW had been irrigated between 3 and 10 June 2022.

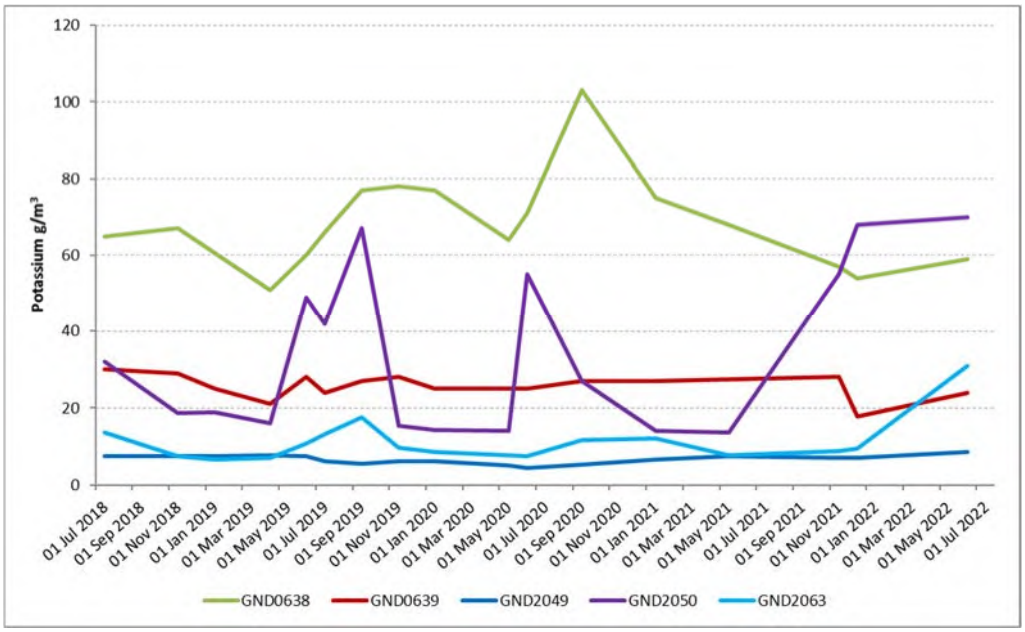

Figure 74 Groundwater potassium concentration at Farm 2 bores, June 2018 to date

2.1.5.3 Farm 3 groundwater

The results of groundwater monitoring on this farm during the period under review are summarised in Table 32. The full set of results is available upon request.

The control bore for Farm 3, GND2051, was drilled in March 2008, on the northern boundary above Motumate Stream. This replaced the original control bore, GND0640, which was situated beside Manaia Road on the western boundary down-gradient of the extended farm area, and was damaged by farm activities in May 2007.

Another impact monitoring bore (GND2052) was also drilled in March 2008, on the southern boundary to the west of Motumate Stream, immediately down-gradient of recently installed fixed in-ground irrigators. The existing impact bore, GND0700, to the east of Motumate Stream, was maintained. An old impact monitoring bore, GND0641, situated between the main access track and Motumate Stream, which had at times been dry, was reinstated in the programme in August 2008. This was not able to be sampled for a number of years due to a bailer becoming stuck inside the bore in May 2013. Sampling access to this bore was re-instated and routine monitoring recommenced in July 2018.

Table 32 Results of groundwater quality sampling on Farm 3

Parameter	Unit	Control (GND2051)			Impact (GND0640)			Impact (GND0700)			Impact (GND0641)			Impact (GND2052)		
		No.	Range	Median	No.	Range	Median	No.	Range	median	No.	Range	median	No.	Range	median
Alkalinity Total	g/m³ CO_3	3	44 - 49	46	3	73 - 76	74	3	118 - 130	120	3	88 - 132	99	3	72 - 77	74
Ammoniacal nitrogen	g/m³N	6	<0.01 - <0.01	<0.01	6	<0.01 - 0.43	0.21	6	<0.01 - <0.01	<0.01	6	<0.01 - <0.01	<0.01	6	<0.01 - 0.167	0.039
Bicarbonate @ 25'C	g/m³	3	54 - 59	56	3	89 - 93	90	3	144 - 158	146	3	107 - 161	121	3	88 - 94	91
Calcium	g/m³	3	13.8 - 15.1	15.0	3	12.0 - 17.2	15.8	3	12.1 - 16.8	12.3	3	19.7 - 27	22.0	3	12.9 - 17.3	16.2
COD	g/m³	3	<6 - <6	<6	3	<6 - 11	<6	3	<6 - <6	<6	3	<6 - 14	12	3	<6 - <6	<6
Chloride	g/m³	6	36 - 47	39	3	47 - 95	50	6	64 - 183	130	6	59 - 75	63	6	42 - 51	44
Conductivity @ 25'C	mS/m	6	31.3 - 48.3	34.9	6	30.9 - 73.8	33.6	6	56 - 114.9	86.5	6	48.6 - 67.9	60.4	6	36.5 - 44.8	44.8
DRP	g/m³P	3	0.008 - 0.016	0.01	6	<0.004 - 0.006	0.004	3	<0.004 - 0.012	0.012	3	0.004 - 0.008	0.005	3	0.015 - 0.037	0.022
Hardness Total	g/m³ CO_3	3	88 - 97	96	3	58 - 89	79	3	80 - 120	81	3	98 - 126	107	3	67 - 85	80
Magnesium	g/m³	3	13.1 - 14.4	14.3	3	7.3 - 11.3	9.5	3	12.0 - 19.0	12.1	3	11.8 - 14.2	11.9	3	8.5 - 10.2	9.7
Nitrite nitrogen	g/m³N	3	<0.002 - <0.002	<0.002	3	0.002 - 0.004	0.003	3	<0.002 - <0.002	<0.002	3	<0.002 - <0.002	<0.002	3	<0.002 - <0.002	<0.002
Nitrite+nitrate	g/m³N	6	4.2 - 14.4	6.4	6	0.026 - 26	1.9	6	5.0 - 12.5	9.0	6	3.7 - 9.8	6.1	6	0.38 - 2.6	2.2
pH		6	6.4 - 6.9	6.6	6	6.6 - 7.0	6.7	6	6.7 - 7.3	6.9	6	6.6 - 7.2	7.0	6	6.6 - 7.0	6.8
Potassium	g/m³	3	9.2 - 19.2	10.0	3	7.2 - 8.6	7.4	3	28 - 44	32	3	32 - 57	37	3	10.2 - 17.4	12.7
Sodium	g/m³	3	22 - 26	24	3	35 - 38	35	3	79 - 108	83	3	42 - 54	46	3	42 - 51	48
Sulphate	g/m³	3	31 - 31	31	3	3.2 - 18.6	13	3	34 - 48	42	3	36 - 39	38	3	20 - 53	39
Sum of Anions	meq/L	3	2.9 - 3.3	3.1	3	2.9 - 3.5	3.2	3	5.2 - 7.9	5.6	3	4.6 - 6.3	4.9	3	3.3 - 4.2	3.8

Parameter	Unit	Control (GND2051)			Impact (GND0640)			Impact (GND0700)			Impact (GND0641)			Impact (GND2052)		
		No.	Range	Median	No.	Range	Median	No.	Range	median	No.	Range	median	No.	Range	median
Sum of Cations	meq/L	3	3.0 - 3.6	3.2	3	3.0 - 3.7	3.3	3	5.8 - 8.2	5.9	3	4.8 - 6.3	4.9	3	3.4 - 4.4	4.0
Temperature	˚C	6	13.9 - 15	14.6	6	13.9 - 16.1	15.0	6	13.8 - 15.8	14.7	6	13.8 - 16.4	14.9	6	13.9 - 15.1	14.6
Total Kjeldahl nitrogen	g/m^{3}N	6	<0.1 - 0.14	0.08	6	0.28 - 0.67	0.41	6	0.12 - 0.29	0.16	6	3.7 - 0.51	0.28	6	0.12 - 0.18	0.13
Total nitrogen	g/m^{3}N	6	4.2 - 14.6	6.6	6	0.5 - 27	2.20	6	5.1 - 12.8	9.20	6	6.6 - 10	6.30	6	0.6 - 2.7	2.3
Un-ionised ammonia	g/m^3	6	<0.01 - <0.01	<0.01	6	<0.01 - <0.01	<0.01	6	<0.01 - <0.01	<0.01	6	<0.01 - <0.01	<0.01	6	<0.01 - <0.01	<0.01
Water Level	m	6	1.93 - 3.29	2.83	6	1.01 - 2.85	1.75	6	1.09 - 2.63	1.84	6	1.40 - 2.70	2.10	6	1.62 - 2.98	2.27

The impact of wastewater irrigation upon the old impact bores (GND0700 and GND0641 at times) was reflected in elevated alkalinity, sodium, chloride, conductivity and potassium levels (Figure 76, Figure 77, Figure 78, and Figure 79), with GND0641 appearing be showing a trend of increasing potassium.

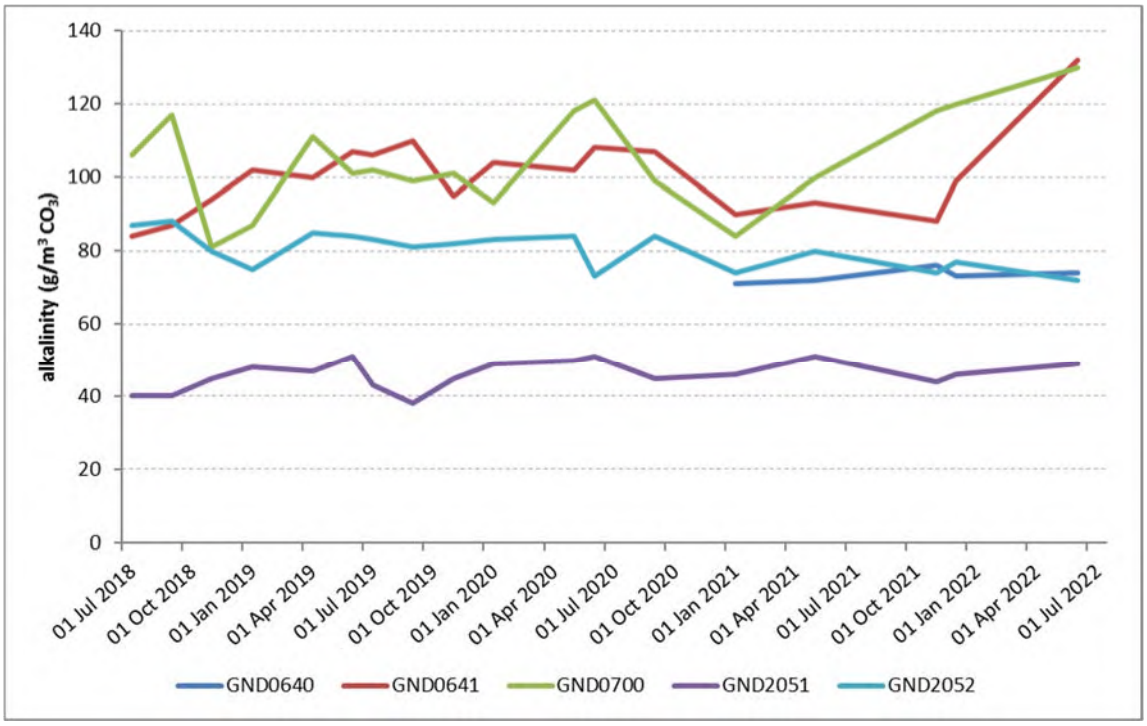

Figure 75 Groundwater alkalinity at Farm 3 bores, June 2018 to date

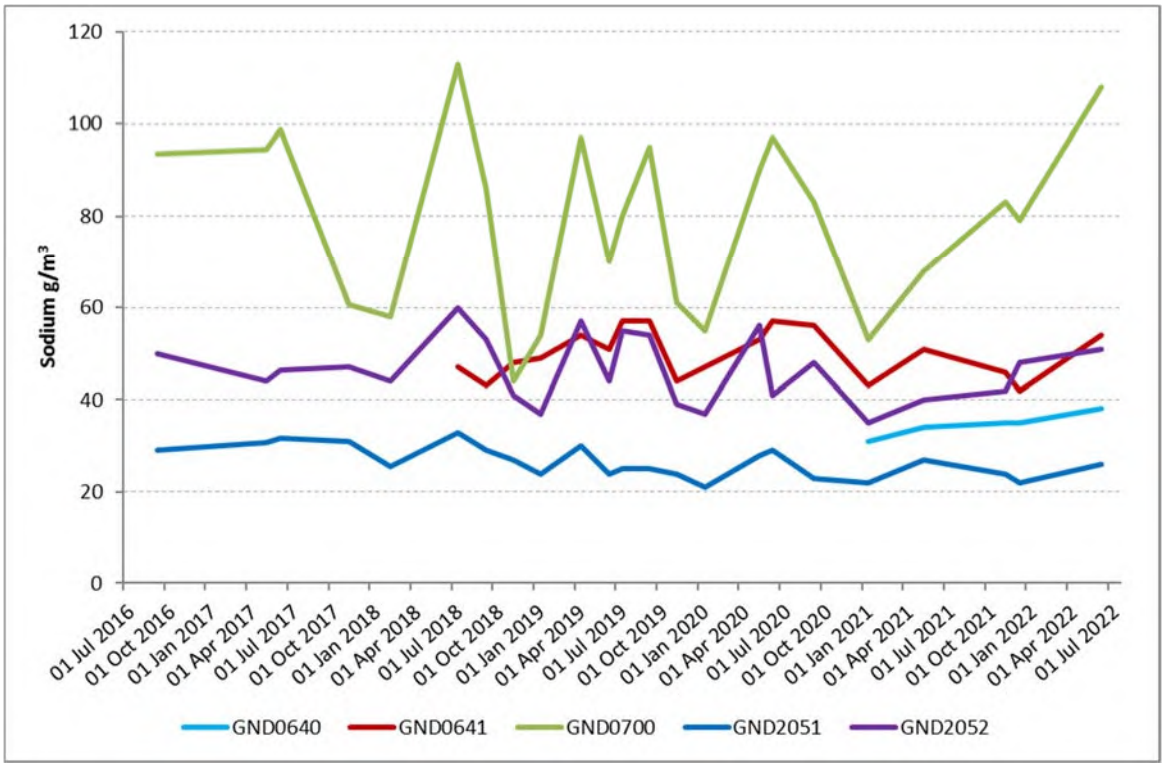

Figure 76 Groundwater sodium concentration at Farm 3 bores, June 2016 to date

It is noted that the chloride concentration and conductivity of the new control bore GND2051 had also been elevated at times in the 2015 to 2018 years. These parameters have returned to a lower level over the 2019-2022 years. Potassium can be elevated in this bore at times.

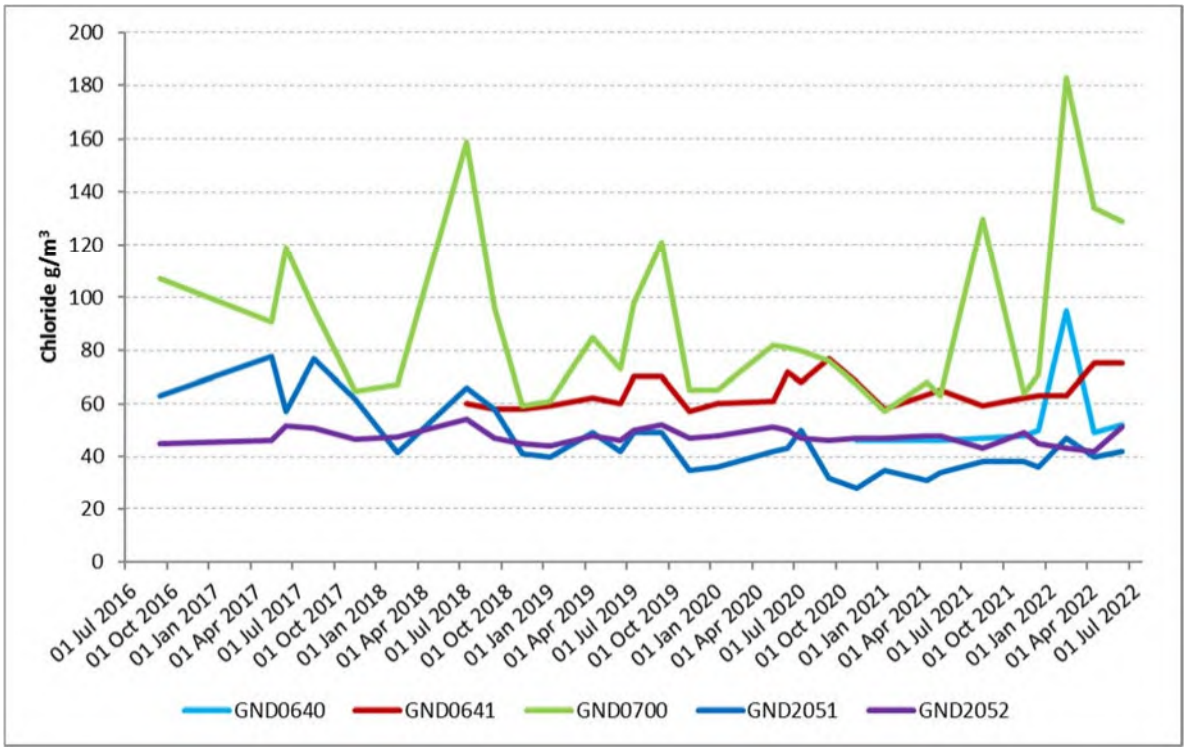

Figure 77 Groundwater chloride concentration at Farm 3 bores, June 2016 to date

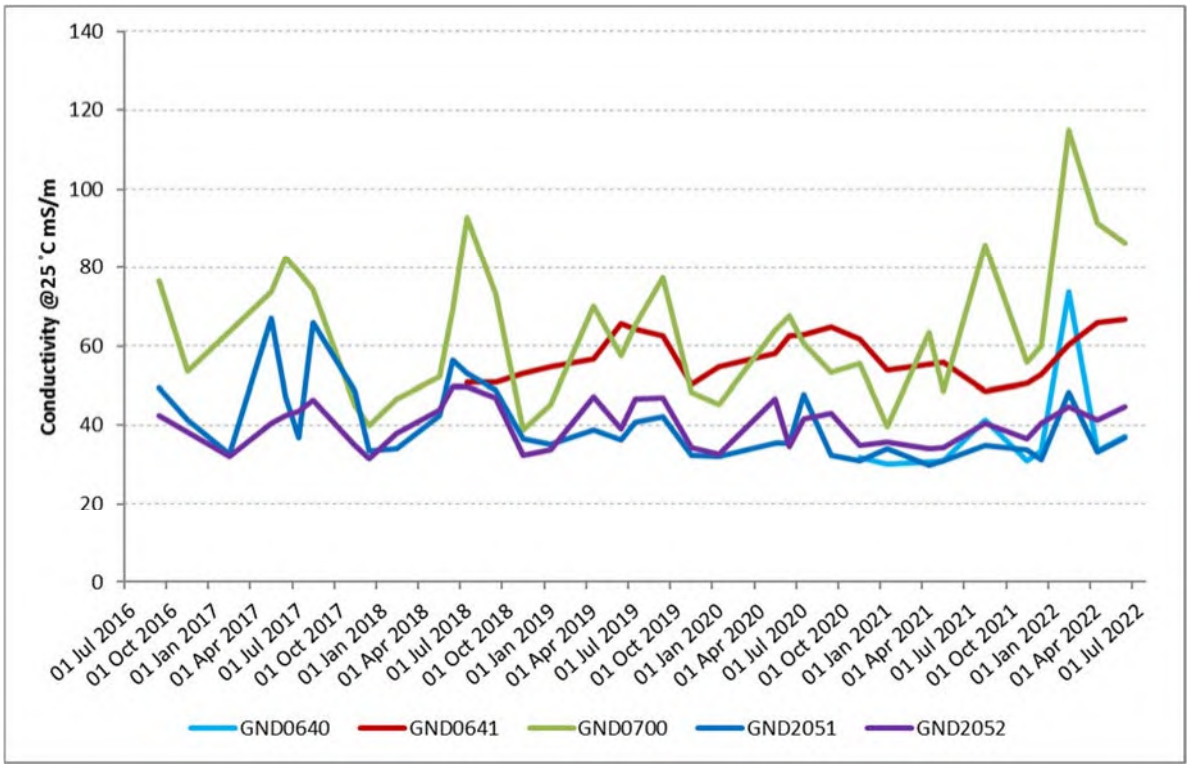

Figure 78 Groundwater conductivity at Farm 3 bores, June 2016 to date

It is noted that there were increases in chloride and conductivity at GND0700 at the time of the survey on 10 August 2021, and increases in conductivity in this bore and GND0640 at the time of the survey on 15 February 2022. These increases occurred at times when there were increases in the groundwater level, with irrigation events occurring in the vicinity of these bores prior to the samplings surveys as discussed following Figure 80.

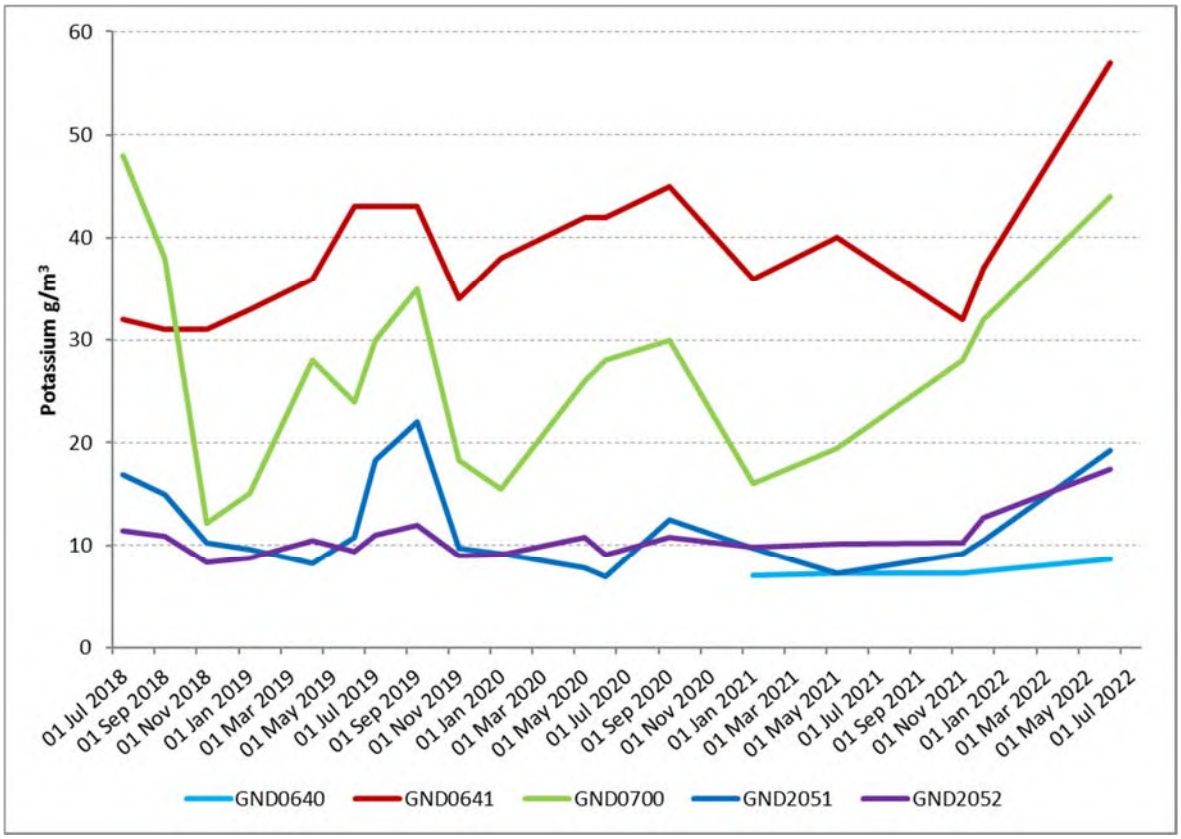

Figure 79 Groundwater potassium concentration at Farm 3 bores, June 2018 to date

Figure 80 compares trends in groundwater nitrate-N levels at the two current impact bores, GND2052 and GND0700, and the reinstated impact bore, GND0641 (between 2008-2013 and June 2018-July 2019), with the old and new control bores, GND0640 (until 2007) and GND2051.

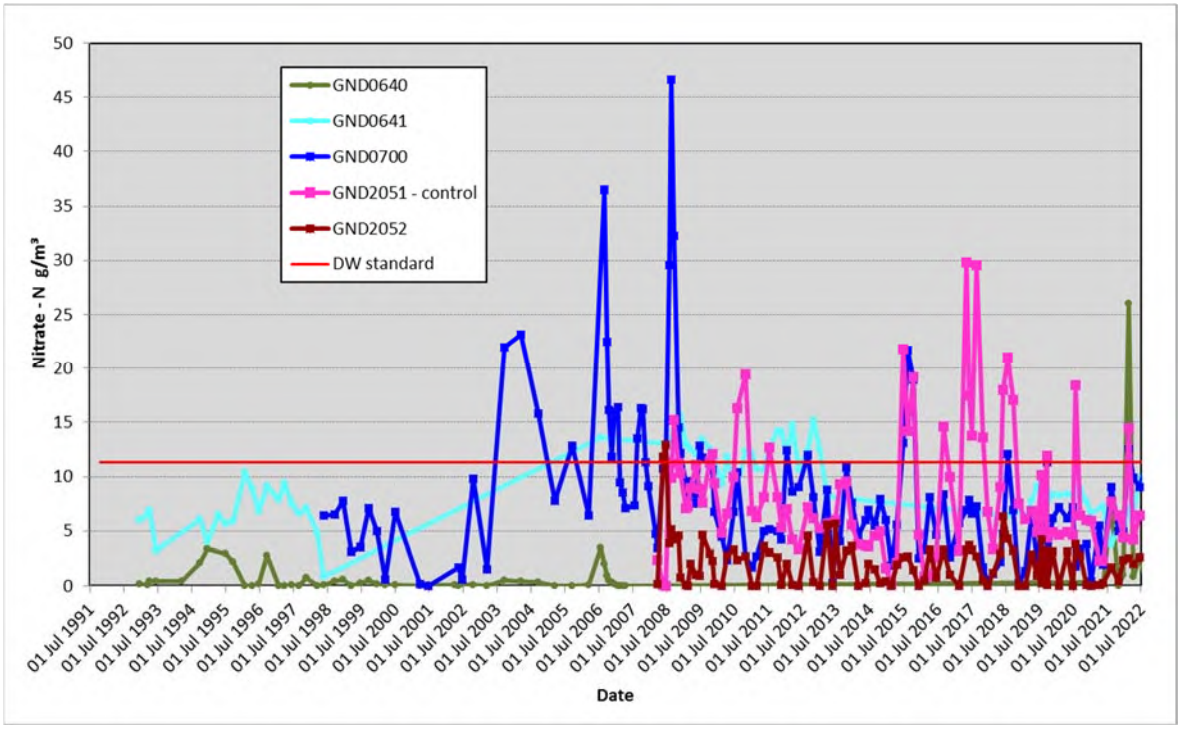

Figure 80 Trends in groundwater nitrate N concentration at Farm 3

At the new control bore (GND2051), nitrate-N values were still elevated at times. There was marked increase in the nitrate-N in the sample collected on 15 February 2022. This coincided with a 0.9 m increase in the groundwater level at this bore (Figure 81). The groundwater level at the time of this survey was the highest that it had been since June 2015. In addition to the potential effect of the groundwater level increase "collecting" stored nitrogen as it rose, there was also 581 m^3 (approx. 63 kgN) FWW irrigated on the paddock in which this bore is located (paddock 6b) in series of events over four days that ended less than a week before the sampling survey. As the groundwater levels receded, the nitrate-N concentrations decreased from the high of 14.4 g/m^3 to 4.2 g/m^3. A similar pattern was observed in the 2020-2021 year. The annual median of the samples collected during the year under review (6.4 g/m^3) has continued to be below the historical median, as has been the case for the previous two monitoring periods.

Groundwater samples from impact bore GND0700 have generally contained low levels of nitrate-N, with the median of historical results being 6.8 g/m^3. The annual median for samples collected during the year under review was 9.0 g/m^3, which is significantly higher than the 2020-2021 annual median of 2.7 g/m^3. During the year under review there were increases in the nitrate-N concentration of the samples collected from this bore at the time of the surveys carried out on 10 August 2021 and 15 February 2022. These were accompanied by the increases in chloride and conductivity mentioned earlier. The groundwater level rose by 1.57 m between the May and August 2021 surveys and by 1 m between the December 2021 and February 2022 surveys. Prior to the August 2021 survey a total of 2,015 m^3 of wastewater (approximately 262 kgN) was irrigated on the paddocks up gradient of this bore (paddocks 38 and 39, between 1 and 8 August 2021). The irrigation events that preceded the February survey were carried out between 27 January and 2 February 2022. There was a total of 2343 m^3 of wastewater applied to paddocks 38 and 39 during these events.

In the 2020-2021 Annual Report it was noted that for the third consecutive year the new impact bore GND2052 had a much lower annual median nitrate-N value (0.17 g/m^3) when compared to the 2018-2019, 2017-2018 and 2016-2017 years (1.67 g/m^3, 2.71 g/m^3 and 6.94 g/m^3 respectively). In comparison to the 2020-2021 year, the annual median for year under review had increased slightly to 2.2 g/m^3.

At the impact bore GND0640 that was re-instated in November 2020, and for the remainder of that monitoring year, the nitrate-N concentrations were low, with a median of only 0.02 g/m^3. Although this is now an impact bore, the median of the four samples collected during the 2020-2021 year was lower than the median of historical results collected between 1992 and 2007 (0.13 g/m^3), when this was a control bore for the southern section of Farm 3. During the year under review, there was a marked increase in the nitrate-N concentration of the groundwater in this bore at the time of the survey undertaken in August 2021 and a significant increase at the time of the survey undertaken on 15 February 2022. The nitrate-N concentration recorded on this occasion was 27 g/m^3, over twice the drinking water standard. The Company was informed of this finding and were asked to investigate the reasons for this change, as per consent 0923-3.3 and the WFMP. The Council was informed of the early findings of this investigation and that additional investigations were on going. This is discussed in Section 2.3. Data available to Council showed that there had been increases in the groundwater level that coincided with both the increases observed in the nitrate-N concentrations. The increases in the groundwater levels were similar to those observed in GND0700, with an increase of 1.5 m at the time of the August 2021 survey and 1 m at the time of the February 2022 survey. There had been 548 m^3 (74 kgN) of FWW irrigated on paddock 2, which is up gradient of GND0640, in irrigation events occurring over 5 to 10 August 2021. There was a total of 825 m^3 (108 kgN) of wastewater irrigated over 12 to 15 February 2022 on paddock 27, which is adjacent to GND0640.

At the impact bore GND0641 that was re-instated in July 2018, the nitrate-N concentrations were elevated, however the annual median of 6.1 g/m^3 was lower than both the historical median (9.3 g/m^3) and the 2020-2021 annual median (7.7 g/m^3). There were again no results that exceeded the drinking water standard.

Overall, the results showed that the impact bores were generally experiencing only minor effects and indicated generally good management of nitrogen application rates in the vicinity of these three bores. However, the nitrate-N results obtained for the new control bore (GND2051) indicate that the groundwater on the northern boundary of Farm 3 may be experiencing similar effects to those seen at the Farm 2 control bore (GND2049). Again, for the assessment of environmental effects to accompany the consent renewal application, the Company was asked to investigate whether the nitrate comes from farming activities up-gradient, from "mounding" of factory effluent applied down (the ground surface) gradient, or by some other mechanism.

Historically, GND2049 and GND2051 tend to show elevations in chloride, conductivity, and to a lesser extent sodium, in the surveys in which elevations in nitrate-N occur. It is noted that the relative contaminant concentrations are different in the other impact bores. These findings highlight that this is a complex system, and the relative contaminant concentrations would depend on when irrigation was last undertaken in the vicinity of each of the bores, the component concentrations of the wastewater as these vary according to wastewater type and site activities, and the mobility of the various contaminants in the soil/groundwater.

Although a theoretical analysis of the existing data was provided, there was no conclusive evidence supporting the conclusion that "upwelling" was the cause of the elevated nitrates at the control bores. It is likely that the renewed consent will require further work on this matter.

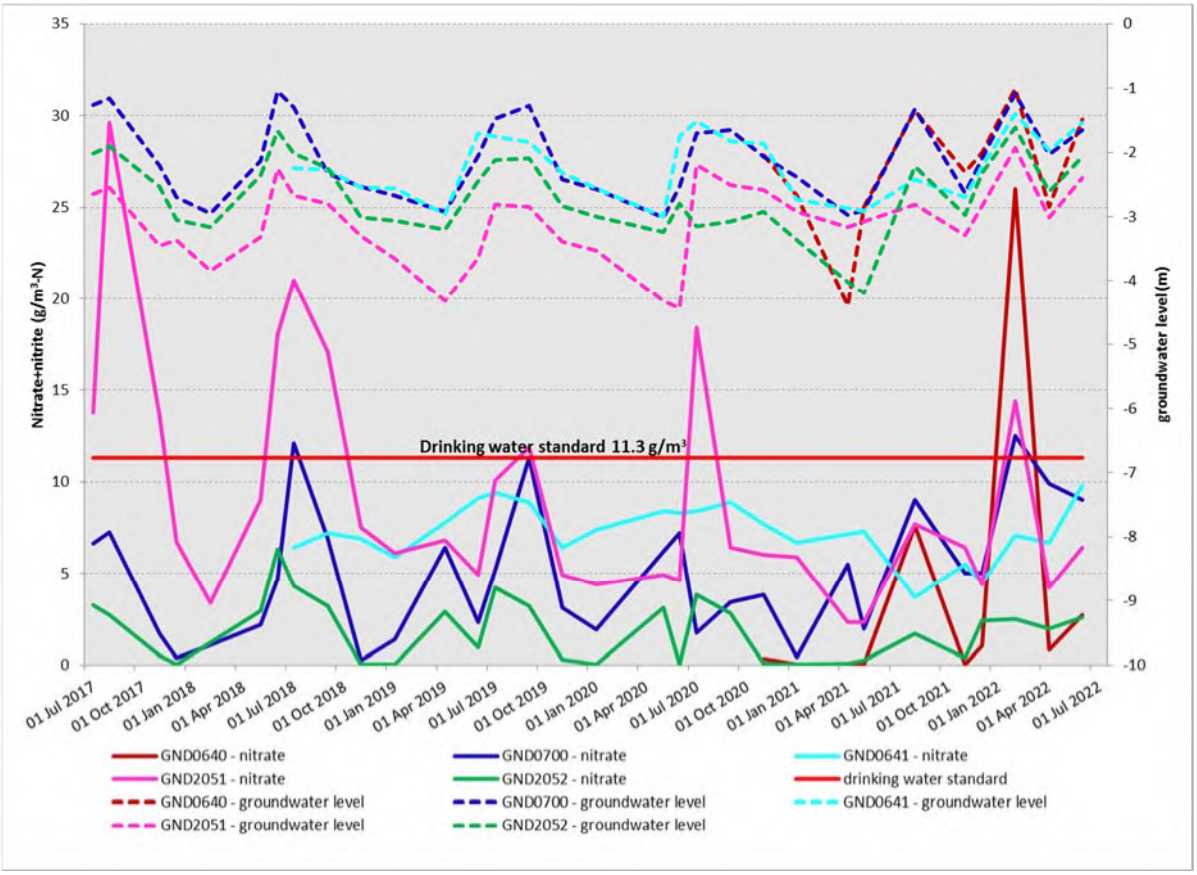

Figure 81 Farm 3 groundwater levels and nitrate + nitrite nitrogen concentrations during the year under review

2.1.5.4 General

The use of all three farms for spray irrigation of wastewater has impacted on shallow groundwater to varying degrees, raising sodium and conductivity levels and altering nitrate levels.

The main parameter of concern is nitrate level, given the NZ Drinking Water Standard of 11.3 g/m^3 (as nitrate-N) has been exceeded frequently during this and previous monitoring periods. There are no known shallow groundwater water users in the immediate vicinity of the spray irrigation area, because of the availability and usage of the Waimate West Rural Water Supply Scheme. However, the Regional Freshwater Plan for Taranaki (2001) does provide for the taking and use of groundwater at a scale that would enable reasonable farm use as a permitted activity. GWR Policy 4 of the Regional Policy Statement for Taranaki (2010) also states that groundwater quality will be maintained and enhanced by promoting land use practices that minimise, as far as practicable, the potential adverse effects on groundwater quality.

A summary of the groundwater nitrate monitoring results is given in Table 33. It is noted that during the year under review, the minimum, maximum and median values obtained for GND0638 increased to their highest levels since 2007-2008 year.

Table 33 Summary of groundwater nitrate concentrations at monitoring bores during the year under review

Property	Site code	Bore location	Designation	Number of samples	Nitrate & Nitrite-N, g/m^3	
					Range	Median
Farm 1	GND0636	North	Control	6	3.0 - 7.9	4.9
	GND0637	South	Impact	6	8.7 - **11.7**	9.5
Farm 2	GND2049	North	Control (new)	6	**13.1** - **17.6**	**14.3**
	GND0638	West	Impact	6	9.4 - **17.4**	**13.0**
	GND0639	South-west	Impact	6	2.3 - 8.4	4.8
	GND2050	South-west	Impact (new)	6	0.011 - **13.4**	8.1
	GND2063	South-east	Impact	6	8.4 - **11.9**	10.8
Farm 3	GND2051	North	Control (new)	6	4.2 - **14.4**	6.4
	GND0640	West	Impact	6	0.026 - **26**	1.9
	GND0641	Central	Impact	6	3.7 - 9.8	6.1
	GND2052	South-west	Impact (new)	6	0.38 - 2.6	2.2
	GND0700	South-east	Impact	6	5.0 - **12.5**	9.0
New Zealand Drinking Water Standard					**11.3**	

On Farm 1 during the 2021-2022 year, it appears that, overall, there had been a decrease in the base nitrate levels under the irrigation areas. The annual median for the control bore had remained similar to that of the 2020-2021 year, and remains below the historical median for this site. The annual median of the impact bore (GND0637) decreased 11.0 g/m^3 in the 2020-2021 year to 9.5 g/m^3 in the year under review. Only one of the six samples collected from GND0637 during the year under review exceeded the drinking water standard. The long term monitoring data has found that 47% of the samples collected from this bore to date have exceeded the standard. This is significantly higher than the 9% of the total dataset at the control bore (GND0636).that have been above the drinking water standard. At the control site (GND0636), again, none of the six samples collected during the year under review contained nitrate-N concentrations at or above the drinking water standard. The control bore is located in paddock 11. During the year under review, there was an annual equivalent of 275 mm and 339 kgN/ha/y applied in this paddock. This is slightly less than the average application rates of 284 mm equivalent (Table 12) and 350 kgN/ha/y (Table 17). The impact bore is located in paddock 20. During the year under review, there was an annual equivalent of 364 mm and 450 kgN/ha/y applied in this paddock. In addition to this bore being on the down gradient boundary of the

farm, the wastewater application the nitrogen application in the vicinity of the impact bore was above average during the year under review.

During the 2021-2022 year, the findings on Farm 2 indicate that whilst the average nitrogen loadings had increased by approximately 67 kgN/ha/y, the application was better managed in the north eastern area of the farm than in the previous year. During the year under review there was a reduction in the nitrate-N concentration at impact bore GND0638, however, all but one sample was still above the drinking water standard. A further reduction in nitrate-N at this bore may be achievable by ensuring that the mitigation measures for the paddocks up gradient of this bore are continued and ensuring that they are not irrigated with a higher than average annual load. On the whole, any effects found in the monitoring bores during the year under review were reduced when compared to the previous year, as indicated by the lower annual medians for the samples collected in 2021-2022 than they were in the 2020-2022 year. The exception to this was at impact bore GND2063 on the south eastern side of the farm, where the annual median increased from 0.05 g/m^3 in 2020-2021 to 8.1 g/m^3 in the 2021-2022 year.

On Farm 3, it had appeared that nitrate levels under the irrigation areas had decreased and were stabilising in response to the 2007-2008 increase in irrigated area. However, during the year under review, it was found that the annual medians for all the bores, except GND0641 were above their respective historical medians. On a survey basis, it is noted that that the nitrate levels in the control bore (GND2051) have continued to show the occasional elevation that is above the drinking water standard of 11.3 g/m^3. During the year under review, this occurred on only one occasion, in February 2022, when there were both a significant increase in ground water level and a series of irrigation events in the vicinity of the bore that ended less than a week before the sampling survey.

In the past, there have been spikes in groundwater nitrate concentrations that have occurred at most monitoring bores, both impact and control, that have coincided with recent heavy rainfall events and/or increases in groundwater levels. In addition to the localised effects of recent irrigation events, an additional likely mechanism that is considered to amplify any increases is the flushing of nitrate-N in the subsurface soils into the groundwater by the rainfall, combined with the groundwater "collecting" any subsurface nitrate-N in the soil as it rises. This was observed at several bores during the year under review and generally the bores with noticeable increases in nitrate-N concentrations were also affected by increasing groundwater levels. These bores also tended to demonstrate, to varying degrees, a trend of reducing nitrate-N concentrations that occurred with reductions in the groundwater level, which is a finding that continues to be consistent with the above theory.

However, during the year under review, bores GND0636 and GND2063 tended to show the opposite trend, as these showed an increase in nitrate-N concentration at times of reduced groundwater levels, indicating localised effects from recent irrigation activities.

GND0639 has tended to have relatively stable nitrate concentrations irrespective of changes in groundwater levels. However, during the year under review there was an increase in the nitrate-N in November 2021 at a time of reduced groundwater levels. Approximately 77 kg of nitrogen was irrigated in 547 m^3 of wastewater that was applied to the paddock in which this bore is located a week prior to this groundwater sample being collected.

Historically, GND2049 (control bore) has demonstrated nitrate-N concentrations that have varied inversely with groundwater levels, but this was not the case during the year under review.

As discussed above, the results for the two relatively new control bores, at the upslope boundaries of Farm 2 and Farm 3, have continued to show significant elevations in groundwater nitrate-N levels in excess of the drinking water standard at times. This may be as a result of activities on adjacent farms, or of groundwater mounding that can occur as a result of an elevated localised hydraulic loading due to irrigation. As stated in the 2016-2020 annual reports, it had been signalled to the Company that the Assessment of Environmental Effects (AEE) for the consent renewal would need to include paddock by paddock irrigation data, continuous

groundwater level and rainfall data to support the investigation and reasoning for the elevated nitrate-N levels in the bores on the up gradient boundaries of Farms 2 and 3. Stock rotation should also be considered when looking at the potential for cumulative effects. This information was not provided at the time of application, but the above continuous and daily data will be required by the replacement consents.

2.1.6 Motumate Stream surface water quality

In combination with groundwater monitoring, some spatial synoptic surface water monitoring was conducted at four sites on the Motumate Stream adjacent to and downstream of the Company's farms (Figure 59, Table 34). Three of these sites were previously monitored from November 2009 to April 2013, with approximately bi-monthly sampling recommencing in November 2017. A new site, MTM000057, was added further upstream in September 2018 due to the elevated level of contaminants observed in this stream and in the groundwater monitoring site at the control sites on the up gradient farm boundary.

These sites were originally chosen to monitor any possible effects on surface water from the discharge of groundwater used for cooling at the plant. The appropriateness of these locations may be re-evaluated to ensure that they are suited to the monitoring of potential effects in the stream from the spray irrigation of wastes on the Company's Farms 2 and 3, whilst also giving consideration to stream access. The results from the 2020-2021 monitoring period are presented in Table 35, and a summary of the monitoring previously performed is presented in Table 36.

Table 34 Description of the water quality monitoring sites in the Motumate Stream

Site	Site code	Description	Map reference, NZTM	
			Easting	Northing
1	MTM000057	Motumate Stream at railway line	1698475	5629820
2	MTM000075	Motumate Stream upstream of Skeet Road	1698445	5628959
3	MTM000120	Motumate Stream, Farm 3, Fonterra Kapuni	1697413	5626971
4	MTM000125	Motumate Stream at Hicks Road	1697046	5626558

The results for the 2021-2022 continue to show that the conductivity, sulphate, and dissolved magnesium measurements were generally similar at sites MTM000057 and MTM000075, with increases of varying degrees between this site and MTM000120. MTM000125 was generally similar to MTM000120 for these parameters (Table 35). Alkalinity, bicarbonate, chloride and sodium (Figure 82) were generally similar at sites MTM000057 and MTM000075, with increases of varying degrees between this site, followed by a further slight increase between MTM000120 and MTM000125. It is interesting to note that the two sites upstream of the Company's irrigation activities have comparable sodium concentrations to those recorded for all of the Waiokura Stream sites (generally in the range 17 to 25 g/m^3, Table 39), but that the two downstream sites (MTM000120 and MTM000125) have sodium concentrations that are consistently higher (generally in the range 30 to 40 g/m^3)

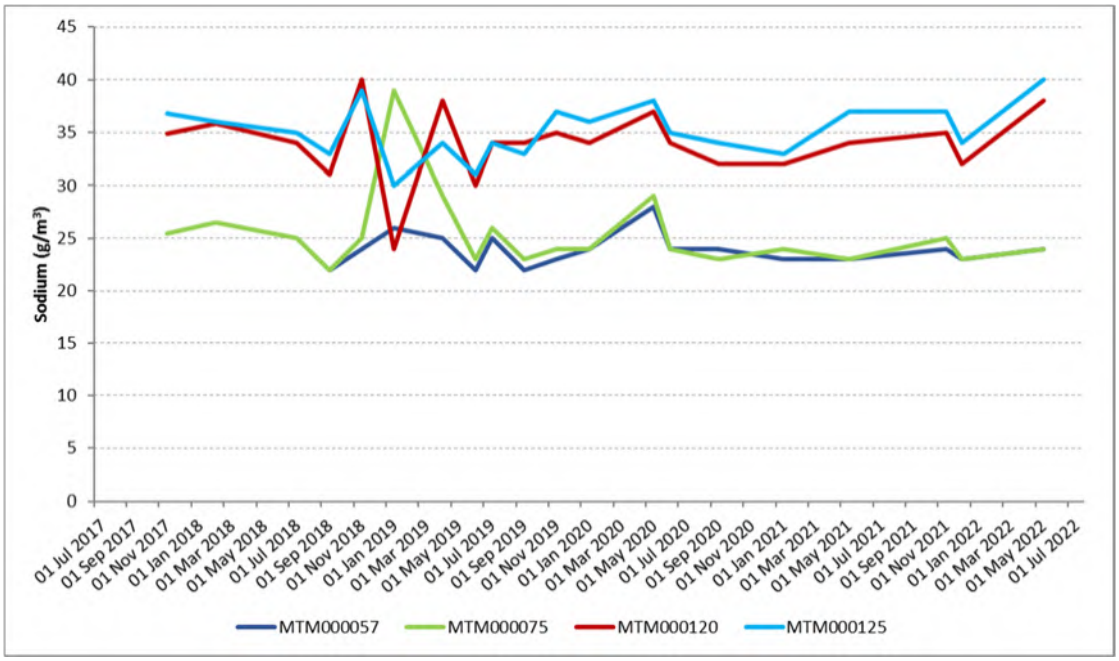

Figure 82 Sodium concentrations in the Motumate Stream 2017 to date.

None of the changes were such that they would be considered a significant adverse environmental effect.

Historically, the nitrate-N concentration has shown a large seasonal variation (Figure 83), decreasing from about 6 to 8 g/m^3 during times with higher groundwater level and/or soil moisture to 2 g/m^3 during times periods with lower groundwater level and/or soil moisture. This is a larger variation than has been observed in the Waiokura Stream, which was in the range of approximately 2.1 to 3.8 g/m^3 (Table 39 and Figure 84). This is also in comparison to the NPS bottom line of 3.5 g/m^3 (annual 95th percentile). On all occasions during the year under review the nitrate-N results increased between MTM000057 and MTM000075 and then decreased in a downstream direction. It is noted that the annual minimum was elevated when compared to previous years. This is likely to be due to the higher rainfall, groundwater levels and soil moistures than were typical for the time of year.

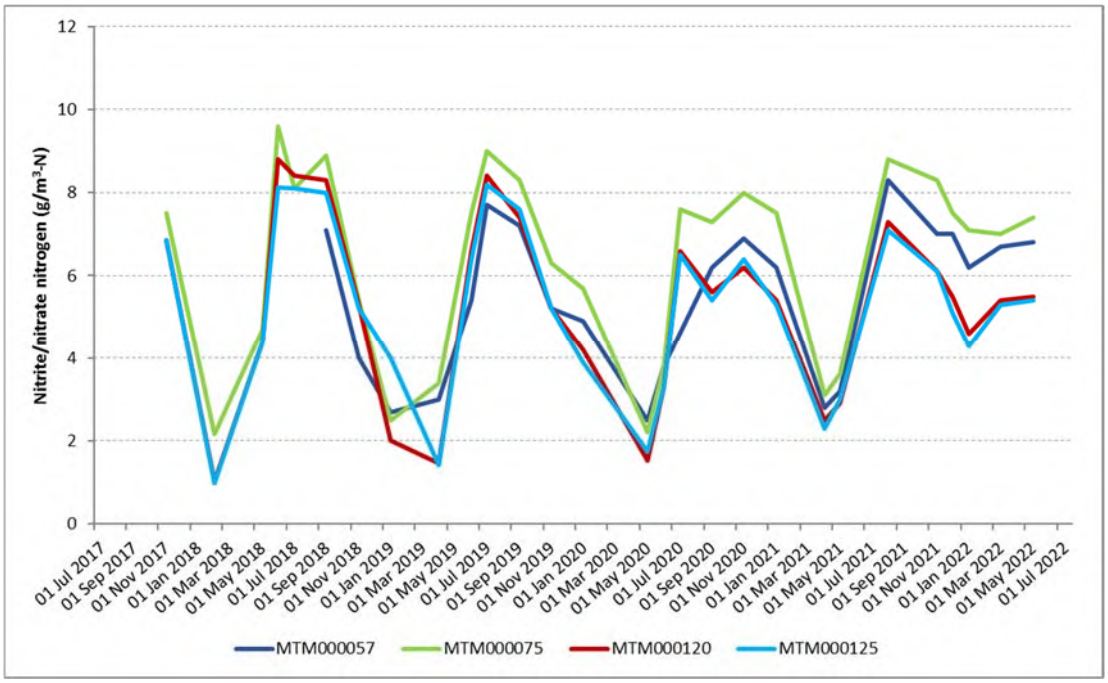

Figure 83 Nitrate/nitrite nitrogen concentrations in the Motumate Stream July 2017 to date

Continued monitoring will provide further information so that an assessment can be made regarding any possible environmental effects to surface water from the spray irrigation of wastewater on Farms 2 and 3, especially when paddock by paddock irrigation information is available. Total nitrogen was added to the analysis suite during the 2020-2021 year. Results obtained during the year under review showed that the total nitrogen concentration followed the same trends as the nitrate/nitrite-N concentration.

In terms of a comparison between the Motumate Stream and the Waiokura Stream it is noted that, in addition to the higher base nitrate-N concentrations, the conductivity and sodium were consistently higher in this water body during the year under review than in the Waiokura Stream. It is noted that there has been a shift in the range of nitrate-N concentrations observed in the Motumate Stream between monitoring undertaken in the 2009 to 2013 years (up to 5.9 g/m^3) and recent monitoring (up to 9.6 g/m^3).

In the 2018-2019 Annual Report it was proposed that if these higher levels continued in the 2019-2020 year, that consideration be given to re-establishing periodic biomonitoring in the Motumate Stream, and a recommendation to this effect was included in the report. As the high levels did continue, the stream habitat was evaluated. It was found that the habitat of the stream was such that biomonitoring results were likely to be influenced more by the habitat than any potential water quality issues through the irrigated area. Additionally it was likely that any effects from the high nitrates in the upper Motumate Stream would overshadow an effect potentially occurring through the irrigation area, if any were to be occurring.

Further investigations were initiated in the 2020-2021 year in order to identify whether there may be any unauthorised discharges occurring in the upper reaches of the catchment above the Fonterra Kapuni Farm 2 site in an attempt to identify the reasons for these elevated nitrates. Additional sampling was undertaken in December 2020. During these investigations found that the nitrate/nitrite-N concentration at the headwaters of the Motumate Stream was 2.3 g/m^3, which is similar to the concentration found in the Waiokura Stream. There were continued downstream increases in the nitrate/nitrite-N concentration, but no point source discharges were identified. These findings have now been shared with the Riparian Team within the Council for their consideration.

Table 35 Results of Motumate Stream quality sampling for the year under review

Parameter	Unit	MTM000057			MTM000075			MTM000120			MTM000125		
		No.	Range	Median	No.	Range	Median	No.	Range	Median	No.	Range	median
Alkalinity Total	g/m³ as $CaCO_3$	3	61 - 65	62	3	61 - 66	63	3	79 - 85	81	3	83 - 88	83
Ammoniacal nitrogen	g/m³-N	6	0.015 - 0.026	0.023	6	0.021 - 0.032	0.028	6	0.017 - 0.041	0.029	6	0.010 - 0.059	0.054
Bicarbonate	g/m³ at 25°C	3	74 - 79	76	3	74 - 80	76	3	96 - 103	98	3	100 - 107	101
Biochemical oxygen demand 5day	g O_2/m³	6	<0.4 - 0.8	0.7	6	<0.4 - 1.0	0.8	6	0.5 - 1.2	0.8	6	0.6 - 1.2	0.7
Calcium	g/m³	3	21 - 24	23	3	22 - 25	24	3	21 - 23	23	3	21 - 22	22
Chloride	g/m³	6	36 - 45	40	6	38.0 - 44	41	6	41.0 - 45	43	6	41.0 - 46	43
Conductivity @ 25'C	mS/m	6	31.2 - 35.3	34.8	6	36.2 - 39.0	37.4	6	39.3 - 41.4	39.9	6	40.5 - 422.0	41.0
Dissolved reactive phosphorus	g/m³-P	6	0.016 - 0.080	0.037	6	0.021 - 0.083	0.042	6	0.025 - 0.064	0.033	6	0.016 - 0.055	0.027
Hardness Total	g/m³ as $CaCO_3$	3	88 - 99	92	3	91 - 102	96	3	93 - 100	97	3	94 - 99	98
Magnesium	g/m³	3	8.5 - 9.4	8.7	3	9.0 - 9.9	9.1	3	9.9 - 10.7	10.0	3	10.2 - 10.7	10.5
Nitrite nitrogen	g/m³-N	3	0.012 - 0.016	0.0	3	<0.010 - 0.015	0.011	3	0.011 - 0.017	0.013	3	0.012 - 0.019	0.015
Nitrite/nitrate nitrogen	g/m³-N	6	6.2 - 8.3	6.9	6	7.0 - 8.8	7.5	6	4.6 - 7.3	5.5	6	4.3 - 7.1	5.4
pH	pH Units	5	7.3 - 7.9	7.7	6	7.3 - 7.9	7.7	6	7.0 - 8.00	7.7	6	7.4 - 7.80	7.7
Potassium	g/m³	3	15.7 - 17.5	16.9	3	15.7 - 17.8	16.6	3	14.7 - 16.2	15.3	3	15.4 - 17	15.6
Sodium	g/m³	3	23 - 24	24	3	23 - 25	24	3	32 - 38	35	3	34 - 40	37
Sulphate	g/m³	3	18.8 - 22.0	21.0	3	19.8 - 23.0	20.0	3	25 - 26.0	26.0	3	25 - 27.0	25.0
Sum of Anions	meq/L	3	3.1 - 3.3	3.3	3	3.3 - 3.4	3.4	3	3.7 - 3.8	3.7	3	3.8 - 3.9	3.8
Sum of Cations	meq/L	3	3.2 - 3.4	3.3	3	3.3 - 3.5	3.4	3	3.7 - 4.1	3.8	3	3.9 - 4.1	3.9
Temperature	°C	6	10.5 - 18.7	15.7	6	10.5 - 18.2	15.5	5	10.8 - 18	15.2	5	11.4 - 17.9	16.5
Total Kjeldahl nitrogen	g/m³-N	6	0.27 0.52	0.31	6	0.24 0.7	0.32	6	0.20 0.60	0.39	6	0.20 0.50	0.33
Total nitrogen	g/m³-N	6	6.5 8.6	7.3	6	7.4 9.1	7.95	6	5 7.5	5.9	6	4.5 7.6	5.7
Turbidity	FNU	6	4.1 - 17.5	6.6	6	5.6 - 10.2	7.4	6	5.8 - 11.3	9.0	6	2 - 10.6	6.7
Un-ionised ammonia	g/m³	6	0.0001 - 0.0005	0.00028	6	0.00011 - 0.0005	0.000385	6	0.00008 - 0.0006	0.00034	6	0.00029 - 0.0010	0.0005

Table 36 Summary of Motumate Stream water quality data from the Council surveys during the period November 2009 to April 2013 and September 2018-June 2021

Parameter	Unit	MTM000057			MTM000075			MTM000120			MTM000125		
		No.	Range	Median	No.	Range	Median	No.	Range	Median	No.	Range	median
Alkalinity Total	g/m^3 as $CaCO_3$	14	51 - 97	62	15	53 - 99	64	15	60 - 96	71	15	63 - 103	78
Ammoniacal nitrogen	g/m^3-N	16	0.012 - 0.330	0.020	28	<0.010 - 7.26	0.039	28	0.012 - 2.900	0.040	23	0.025 - 3.38	0.078
Bicarbonate	g/m^3 at 25°C	14	62 - 118	76	15	64 - 120	78	15	73 - 116	86	15	77 - 125	94
Biochemical oxygen demand 5day	g O_2/m^3	16	<0.4 - 10	0.8	34	<0.4 - 500	1.0	35	<0.4 - 13	1.5	22	0.5 - 3.2	1.0
Calcium	g/m^3	14	20 - 23	21.5	15	21 - 24	21	15	15 - 23	21.5	15	20 - 24	21
Chloride	g/m^3	16	32.0 - 47	36	18	32 - 51	37	18	28 - 52	44	18	40 - 50	44
Conductivity @ 25'C	mS/m	11	32.6 - 40.0	34.5	34	31.7 - 70.8	35.6	34	27.0 - 68.2	40.4	22	38.4 - 47.0	38.5
Dissolved reactive phosphorus	g/m^3-P	16	0.017 - 0.66	0.035	25	0.018 - 0.154	0.051	25	0.019 - 0.380	0.047	22	0.017 - 0.163	0.038
Hardness Total	g/m^3 as $CaCO_3$	14	81 - 98	89	15	87 - 98	91	15	64 - 105	97	15	89 - 108	95.0
Magnesium	g/m^3	14	7.4 - 10.2	8.9	15	8.0 - 10.7	8.69	15	6.5 - 11.4	10.5	15	9.0 - 12	10.0
Nitrate nitrogen	g/m^3-N	14	2.5 - 7.7	5.0	15	2.2 - 9.0	6.3	15	1.45 - 8.40	5.25	15	1.38 - 8.20	5.20
Nitrite nitrogen	g/m^3-N	14	0.005 - 0.048	0.014	15	0.008 - 0.164	0.020	15	0.008 - 0.044	0.014	15	0.013 - 0.131	0.019
Nitrite/nitrate nitrogen	g/m^3-N	16	2.5 - 7.70	5.1	31	0.95 - 9.60	5.4	31	1.02 - 8.80	4.65	22	0.98 - 8.20	5.3
pH	pH Units	16	7.2 - 7.7	7.60	34	7.1 - 7.8	7.5	33	7.1 - 8.0	7.5	23	7.3 - 7.7	7.5
Potassium	g/m^3	14	13.5 - 28	14.9	15	13.5 - 17.8	15.5	15	7.9 - 18.1	14.9	15	13.5 - 20	15.7
Sodium	g/m^3	14	22 - 28	24.0	24	21.9 - 39	25.0	24	24 - 40.8	34.0	17	30 - 39	35.0
Sulphate	g/m^3	14	17.3 - 26	19.7	15	17.1 - 26	21.0	15	10.1 - 32	25.5	15	16.4 - 33	26.0
Sum of Anions	meq/L	14	2.9 - 3.9	3.1	15	3.0 - 4.1	3.2	15	2.5 - 4.0	3.7	15	3.3 - 4.3	3.7
Sum of Cations	meq/L	14	2.9 - 3.8	3.2	15	3.0 - 4.1	3.2	15	2.5 - 4.3	3.8	15	3.5 - 4.4	3.9
Temperature	°C	16	10.1 - 19.0	14.1	3	1.2 - 19.9	13.4	33	10.7 - 19.7	14.0	22	11.3 - 20.0	14.3
Total Kjeldahl nitrogen	g/m^3-N	5	0.29 0.58	0.41	6	0.36 0.75	0.43	6	0.34 0.72		6	0.33 0.75	0.44
Total nitrogen	g/m^3-N	5	3.3 7.3	6.5	6	3.8 8.3	7.9	6	3.1 6.8		6	2.8 6.9	5.9
Turbidity	NTU	16	5.6 - 92	8.5	27	4.0 - 100	10.3	26	4.2 - 36	10.6	22	2.8 - 18.9	8.7
Un-ionised ammonia	g/m^3	16	0.00008 - 0.0047	0.00028	24	0.00008 - 0.070	0.0004	24	0.00013 - 0.0341	0.00035	22	0.00021 - 0.0137	0.00072

2.1.7 Waiokura Stream surface water quality

Some spatial synoptic surface water monitoring was conducted at three sites on the Waiokura Stream adjacent to and downstream of the Company's farms (Figure 59, Table 37). This was carried out approximately bi-monthly.

Table 37 Description of the water quality monitoring sites in the Waiokura Stream

Site	Site code	Description	Map reference, NZTM	
			Easting	Northing
0	WKR000485	Waiokura Stream approx. 400 m u/s Skeet Road	1698819	5629373
1	WKR000500	Waiokura Stream at Skeet Road	1698807	5628892
2	WKR000630	Waiokura Stream 1.5 km, u/s of Hicks Road (~ 150m upstream of Farm 3's southern boundary)	1698126	5626926
3	WKR000650	Waiokura Stream at Hicks Road	1697735	5625026

These sites were chosen to monitor any possible effects on surface water from the spray irrigation of wastes on the Company's Farms 2 and 3. The results from the 2020-2021 monitoring period are presented in Table 39, and a summary of the monitoring previously performed is presented in Table 38.

Although the medians show little change between sites during the year under review (Table 39), the results for the 2021-2022 monitoring period again indicate subtle increases in most parameters, in particular conductivity and sodium, in the samples downstream of the control site (WKR000500) during each of the surveys. However, the changes observed are not significant enough to be considered an environmental effect. Nitrate nitrite-N concentration showed a seasonal fluctuation, varying from about 3.6 g/m^3 in winter/spring to 2.7 g/m^3 in summer/early autumn. There was again much less of a fluctuation than has observed in earlier years, and particularly in the 2016-2017 year (6.8 to 2.0 g/m^3). The median nitrate-N concentration for 2021-2022 at all three long established sites were similar to the respective long-term median values, as were the median sodium concentrations.

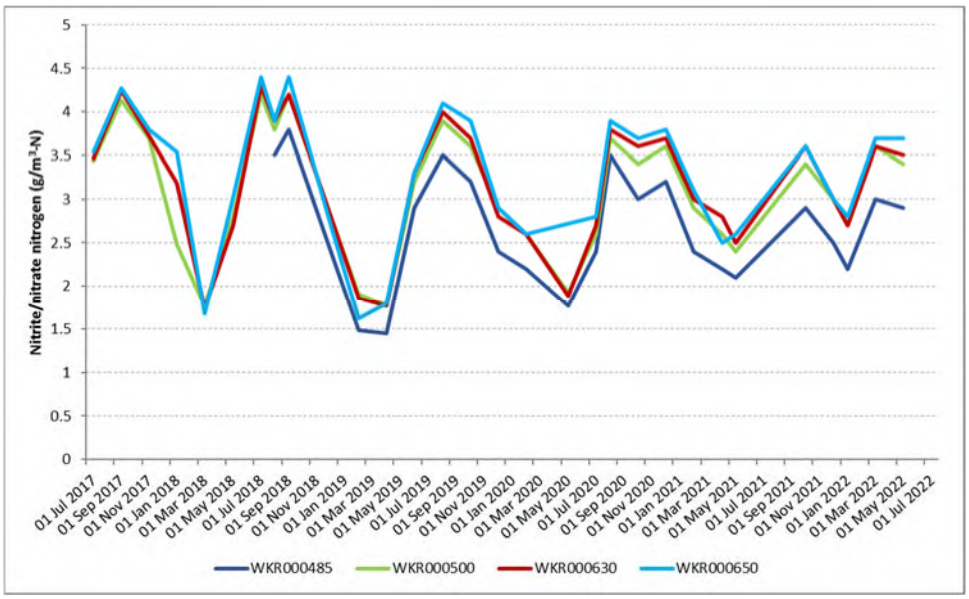

Figure 84 Nitrate/nitrite nitrogen concentrations in the Waiokura Stream July 2017 to date

Continued monitoring over future periods will provide further assessment of any possible environmental effects to surface water from the spray irrigation of wastewater on Farms 2 and 3.

Table 38 Summary of Waiokura Stream water quality data from the Council surveys during the period March 2001 to June 2021

Parameter	Unit	WKR000485			WKR000500			WKR000630			WKR000650		
		No.	Range	Median	No.	Range	Median	No.	Range	Median	No.	Range	median
Ammoniacal nitrogen	g/m^3-N	18	<0.010 - 0.4	<0.010	19	<0.010 - 0.520	0.015	18	<0.010 - 0.110	0.010	17	<0.010 - 0.123	0.010
Total BOD (5day)	g O_2/m^3	18	<0.4 - 3.0	<2	26	<0.4 - 12	2	25	<0.4 - 3.3	2.0	24	<0.4 - 3.4	<2
Conductivity @ 25'C	mS/m	18	22.1 - 24.9	22.9	143	18.3 - 24.3	23.4	144	18.8 - 28.0	24.8	142	16.6 - 31.5	23.2
Dissolved reactive phosphorus	g/m^3-P	18	0.023 - 0.158	0.033	88	0.012 - 0.196	0.035	89	0.013 - 0.095	0.032	87	0.016 - 0.444	0.031
Nitrite/nitrate nitrogen	g/m^3-N	18	1.45 - 3.80	2.40	130	1.27 - 4.20	2.78	130	1.03 - 6.51	2.95	129	1.03 - 4.40	2.93
pH	pH Units	18	7.4 - 7.8	7.7	108	6.6 - 8.0	7.6	110	6.9 - 8.2	7.7	107	7.0 - 8.3	7.7
Sodium	g/m^3	18	16.6 - 22.0	19.2	140	14.8 - 25.4	19.6	141	9.4 - 24.9	21.4	139	13.9 - 62.4	22.5
Temperature	°C	17	9.6 - 17.8	13.1	144	7.1 - 18.5	12.3	145	8.3 - 20.5	12.7	143	8.1 - 20.2	12.6
Turbidity	NTU	18	1.7 - 13.4	7.9	25	1.6 - 15.4	6.4	25	3.0 - 14.9	7.9	24	1.6 - 17.3	7.2
Un-ionised ammonia	g/m^3	18	0.00008 - 0.0037	0.00016	18	0.0001 - 0.0041	0.00017	18	0.00002 - 0.001	0.00014	17	0.00004 - 0.0029	0.00017

Table 39 Results of Waiokura Stream quality sampling for the year under review

Parameter	Unit	WKR000485			WKR000500			WKR000630			WKR000650		
		No.	Range	Median	No.	Range	Median	No.	Range	Median	No.	Range	median
Ammoniacal nitrogen	g/m^3-N	6	<0.010 - 0.033	0.016	6	<0.010 - 0.038	0.023	6	<0.010 - 0.161	<0.010	6	<0.010 - 0.041	0.012
Total BOD (5day)	g O_2/m^3	6	<0.4 - 0.9	<0.4	6	0.5 - 0.9	0.6	6	<0.4 - 0.8	0.6	6	<0.4 - 1.2	0.6
Conductivity @ 25'C	mS/m	6	22.4 - 24.0	22.9	6	22.8 - 24.7	23.8	6	24.6 - 30.8	26.0	6	25.6 - 27.0	26.4
Dissolved reactive phosphorus	g/m^3-P	6	0.027 - 0.057	0.035	6	0.026 - 0.034	0.030	6	0.019 - 0.055	0.027	6	0.021 - 0.038	0.029
Nitrite/nitrate nitrogen	g/m^3-N	6	2.2 - 3.0	2.4	6	2.7 - 3.6	3.3	6	2.7 - 3.6	3.4	6	2.8 - 3.7	3.5
pH	pH Units	6	7.6 - 7.9	7.8	6	7.4 - 7.8	7.7	6	7.36 - 8.0	7.8	6	7.7 - 7.9	7.8
Sodium	g/m^3	6	17.1 - 21	18.5	6	17.8 - 22.0	18.5	6	19.8 - 24.0	21.0	6	21 - 24	22
Temperature	°C	6	9.8 - 16.5	14.9	6	9.9 - 16.7	15.1	6	9.9 - 18.7	16.0	6	9.5 - 18.7	15.9
Turbidity	NTU	6	4.6 - 11.9	6.0	6	4.0 - 10.4	6.4	6	4.0 - 14.1	7.7	6	3.3 - 14.0	6.7
Un-ionised ammonia	g/m^3	6	<0.00017 - 0.0006	0.00023	6	<0.00007 - 0.0006	0.0003	6	<0.00002 - 0.0021	0.0003	6	<0.00004 - 0.0008	0.0002

2.1.8 Biomonitoring

2.1.8.1 Fish passage temperature compliance in mixing zone

The Council installed and maintained two water temperature data loggers in the Kaupokonui Stream during the 1994-1995 monitoring period. These loggers were sited toward the left and right banks of the stream flow channel at the downstream periphery of the spray cooling water discharge zone. The purpose of these temperature recorders was to monitor compliance with Special Condition 8 of consent 0919-3 and 9 of consent 0924-3 which require that these discharges shall not give rise to a thermal barrier preventing the movement of fish species within the designated mixing zone of the wastes with the Kaupokonui Stream.

The presence of a significant water temperature differential across the stream within the spray discharge zone was established during the temperature surveys of March 1993, March 1994 and January 1995. These surveys recognised that only a gradual rise in water temperature occurred toward the true right bank of the stream during spray cooling water discharges, and that this gradual increase would not be expected to present a thermal barrier preventing fish passage through the spray discharge or 150 m mixing zone of the stream. The across-stream temperature differences measured at the periphery of the spray zone were 9.5˚C, 3.7˚C, and 2.1˚C at the time of the 1993, 1994 and 1995 surveys respectively, although variation in disposal systems, weather, stream flow conditions and factory production contributed to these differences in results.

In January 2011, the Council stopped monitoring temperature differential across the width of the stream, after continuous monitoring (at 15-minute intervals with very occasional disruption) since August 1993. The record is depicted in Figure 85. The monitoring ceased for two reasons. First, there was an unacceptable risk to the safety of the personnel who climbed down the stream bank and waded to the monitoring sites. Secondly, while temperature measurement along the length of the mixing zone was continued by the Company, at the time it was considered that transverse monitoring was no longer considered necessary, as disruption to fish passage was not expected to occur. This was based on the fact that significant periods of cooler water conditions had been demonstrated towards the right bank of the stream and there was gradual mixing of the cooling water discharges with the receiving water. The assumption was made that the fish would make use of the cooler flow corridor close to the true right bank.

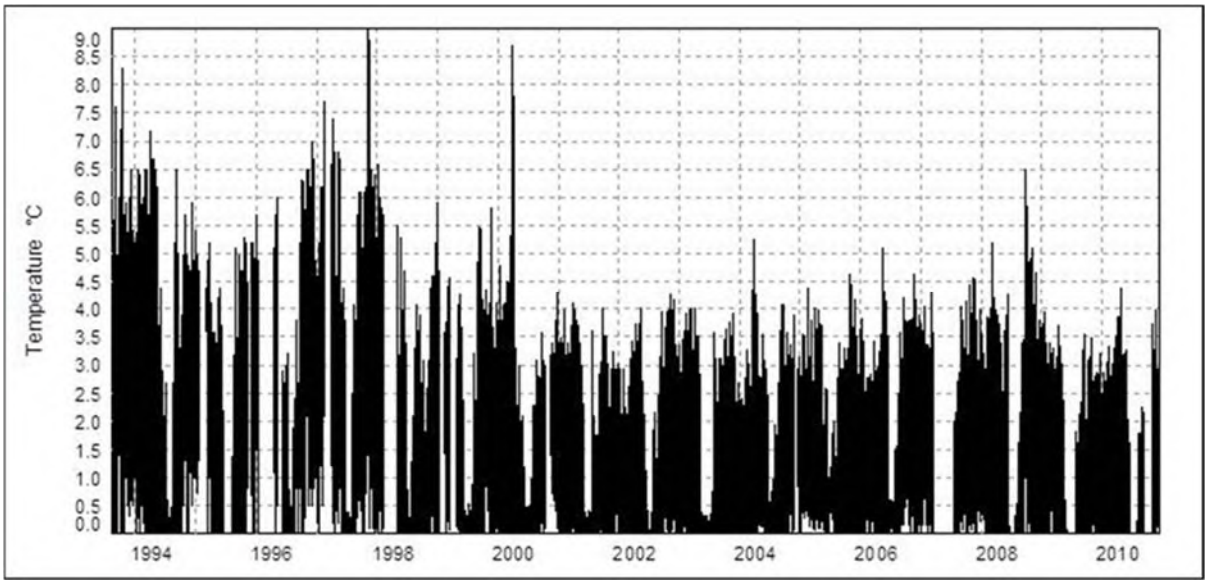

Figure 85 Kaupokonui Stream water temperature differential (LB-RB) records at the periphery of the Fonterra Ltd spray cooling water discharge zone, 1993-2010

It was requested that the current temperature conditions within the mixing zone and the validity of this assumption be investigated by the Company during the preparation of the AEE for the renewal of the cooling water discharge consent.

Work was undertaken by the Company and a report was submitted as part of the application, however it was noted that the temperature monitoring was carried out prior to the cooling water discharge temperatures reaching their maximum. The instream temperature differentials through the spray discharge area and mixing zone were measured during a period of time when the upstream temperatures in the Kaupokonui Stream were in the range 17.8˚C to 18.1˚C and the cooling water discharge temperatures were in the range of 30˚C to 32˚C. Although the report states that the cooling water discharge temperature was maximised (within operational constraints) during the survey, monitoring of the cooling water discharge temperature shows that the peak temperatures resulting from the operational changes (approximately 40˚C) were not reached until after the monitoring within this reach of the stream had been completed. As a result, the report cannot be considered representative of the worst case that may be found under normal operating conditions.

After the cross stream temperature monitoring was ceased, a programme of (triennial) fish monitoring was instituted, to assess both the influence of the cooling water discharge on fish passage, and the effectiveness of the fish pass at the water abstraction weir about 100 metres upstream. The first fish monitoring survey was conducted in January 2014. A second survey was carried out in June 2017 and was repeated again in the 2019-2020 year. The next survey was rescheduled to the 2021-2022 year following the removal of the Glenn Road weir.

Kaupokonui Stream flow records (peak and minimum values) for the monitoring period for the Upper Glenn Road recording station are presented in Figure 86.

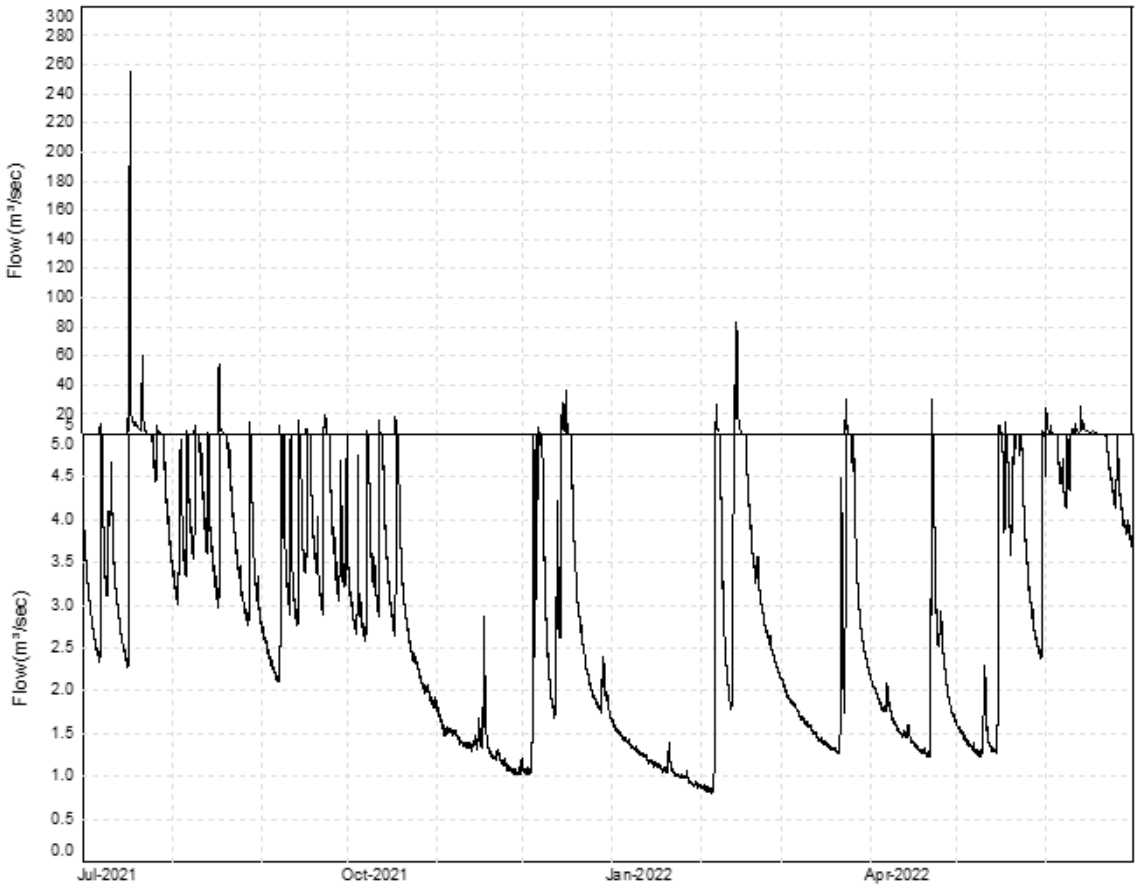

Figure 86 Kaupokonui Stream at Glenn Road flow record (m^3/s) for the year under review

2.1.8.2 Lower stream water temperatures

Two additional water temperature data loggers remained in place in the lower reaches of the Kaupokonui Stream for the duration of the year under review period to provide ambient stream temperature data over the 14 km reach downstream of the factory to the coast. These loggers are sited in the stream at Upper Glenn Road, about 9.8 km downstream of the lactose plant discharge, and above the tidal influence, approximately 1.4 km upstream of the stream mouth. The loggers were installed in July 1999, with the agreement of the Company, in response to concerns expressed by submitters to consents 0919-3 and 0924-3 to discharge cooling water from the lactose plant. The original location of the Upper Glenn Road monitoring site was at the Glenn Road weir. Due to the removal of the Glenn Road weir, a new monitoring location was established in the 2020-2021 year that is approximately 500 metres upstream of the original Glenn Road temperature monitoring site.

Water temperature records for these two sites are illustrated in Figure 87 and Figure 88.

A monthly summary of these data is included in Table 40.

Stream temperatures continued to be relatively high during the year under review, with the maximum temperatures at Glenn Road was 26.9˚C on 4 January 2022 and 25.8˚C at the beach on 4 February 2022.

On 4 January 2022 the maximum temperature differential recorded between the upstream and downstream temperatures at the Company's site was 1.5˚C approximately 5 hours earlier when the cooling water discharge temperature was approximately 30˚C.

On 4 February 2022 the maximum temperature differential recorded between the upstream and downstream temperatures at the Company's site was 1.5 ˚C approximately 5 hours earlier, when the cooling water discharge temperature was approximately 27˚C.

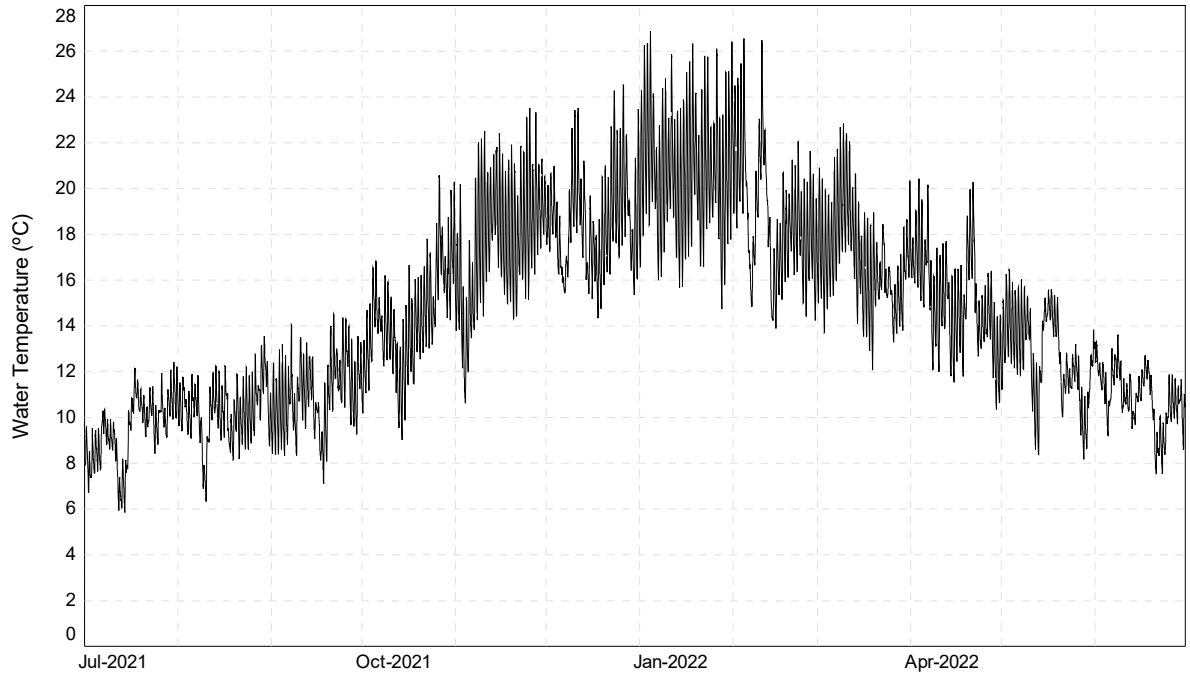

Figure 87 Water temperature (°C) records for the Kaupokonui Stream at Glenn Road Upper during the year under review

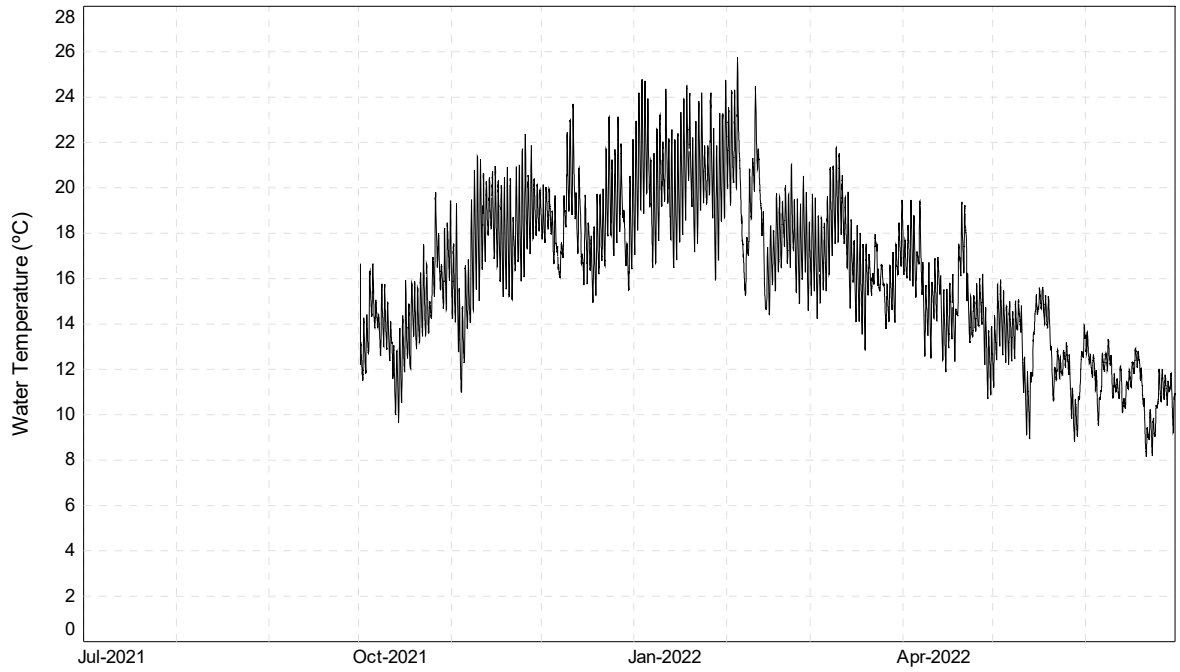

Figure 88 Water temperature (°C) records for the Kaupokonui Stream at the beach during the year under review

Table 40 Monthly Kaupokonui Stream water temperature data for Glenn Road and the coast during the year under review

Site	Upper Glenn Road			Near Coast		
	Min	Max	Mean	Min	Max	Mean
Jul 2021	5.9	12.4	9.5	-	-	-
Aug 2021	6.3	13.5	10.3	-	-	-
Sep 2021	7.1	14.5	11.0	-	-	-
Oct 2021	9.0	20.6	14.3	-	-	-
Nov 2021	10.6	23.5	17.7	11.0	22.4	17.6
Dec 2021	14.3	24.5	18.5	14.9	23.7	18.5
Jan 2022	14.7	26.9	20.8	15.9	24.8	20.5
Feb 2022	13.9	26.6	18.7	14.4	25.8	18.7
Mar 2022	12.1	22.8	17.0	12.8	21.8	16.9
Apr 2022	10.4	20.4	15.2	10.7	19.5	15.2
May 2022	8.2	16.5	12.7	8.8	16.0	12.9
Jun 2022	7.5	13.6	10.9	8.2	13.7	11.3

Key - missing data due to loss of the logger

An analysis of the stream water temperature data for each site over the year under review indicated that 20˚C, above which trout start to become stressed, was exceeded for approximately 12% of the year at Glenn Road and 15% of the year near the mouth. During the warmer months of November to March, the temperatures exceeded 20˚C for approximately 29% of the time at Glenn Road and 26% of the time at the coast. This is an increase in the amount of time at both sites when compared to the previous year.

The highest temperature recorded in the lower Kaupokonui River is 29.0°C, at Glenn Road on 9 January 1994 at 1500 NZST.

Instream temperatures continue to increase beyond the periphery of the mixing zone. It is not clear whether the increase in stream temperature due to the lactose plant's cooling water discharge introducing a step change that is cumulative, or whether stream temperatures below the lactose plant drop back to the upstream temperatures before natural heat fluxes take effect, and whether the reduction in flow due to the water consumption at the plant contributes to this in any way. This will be a matter for further investigation during the processing of the replacement consent applications.

2.1.8.3 Evaluation of fish passage

An assessment of the effectiveness of the fishpass on the Kaupokonui Stream weir at the Company's plant (Consent 0302-3) was performed by Council staff using night spotting techniques at six sites in the Kaupokonui Stream in April 1999. These results were reported in the 1998-1999 Annual Report by Council (TRC 1999), which contained a recommendation for further fish investigations in the Kaupokonui Stream upstream of the Company's weir. The purpose of the proposed investigations was to determine the upstream extent of red-finned bully migration within the stream. This information was required to determine whether or not passage for native fish needed to be specifically addressed in the design of a replacement fish pass. However, fish data recorded in the lower section of the Kaupokonui Stream in October 1999 demonstrated that passage for native fish needed to be given specific consideration in the design of a new fish pass.

Further investigations were undertaken in the 2000-2001, along with consultation with Fish and Game. It was agreed that the construction of a new fish pass was needed at this weir to enable the passage trout and native species. Although torrent fish had been recorded in the lower section of the Kaupokonui Stream, they were not able to negotiate the hydrological control weir in the Kaupokonui Stream at Glenn Road.

A report dated May 2001 prepared by Charles Mitchell and Associates was forwarded to the Council. This report outlined two possible options for upgrading fish passage past the weir. In November 2001, the Company advised the Council of the proposed works to construct the fish pass. The Council advised that it was appropriate to undertake the works in accordance with the conditions of consent 4623, and that no change to the consent was required.

Construction of the fish pass was subsequently completed in late March 2004, and the pass was commissioned in early April 2004. Council and Fish and Game Taranaki assisted with the construction, particularly the placement of rocks within the pass. Visual inspections have indicated the pass is functioning well, and trout have been observed immediately upstream that may have used the pass. However, in November 2010, during a routine biomonitoring survey, it was noted that a cut-out had formed in the side of the lower section of the pass, through which a significant amount of the water flow was escaping. Repairs to the upper and central sections were made in May 2013. Further work on the bottom section was carried out in summer 2013-2014.

To interpret the results of a fish passage survey correctly, it is important to be aware of other barriers to fish passage downstream of the site being surveyed. Located downstream of the Kapuni Lactose factory, there is a weir known locally as the Glenn Road weir. This weir is an orphaned structure which presents a significant barrier to the passage of most fish, but is considered to have some historical significance, and therefore it had been allowed to persist. Only the best climbing species have been able to negotiate the Glenn Road weir. As a result, it is extremely unlikely that swimming species, such as common smelt, inanga, and torrentfish were able to reach the Kaupokonui Stream near the lactose factory. Climbing species are also adversely effected by this structure as was seen in 2020 when 100+ adult lamprey were found dead surrounding the structure after failing to navigate the weir. This means that the Kapuni Lactose weir fish pass has never properly been assessed for provision of passage for swimming species as well as the full

natural extent in terms of abundance for climbing species. The Glenn Road weir was removed during the summer of 2021.

Following the removal of the Glenn Road weir, the weir at Kapuni Lactose has become the first known barrier to fish passage in the catchment. However, there may be some natural barriers or behavioural restrictions that could influence fish species reaching the Kapuni Lactose weir. It is now necessary for the fish pass to be assessed and maintained at a high standard to ensure swimming and climbing species have access to the catchment upstream of the Kapuni Lactose weir. Because most swimming species have likely been excluded from the catchment since the installation of the Glenn Road weir, it is expected that the fish community of the entire Kaupokonui catchment upstream of the Glenn Road weir will drastically (but not immediately) change upon removal of the weir. This means that swimming species, other than trout, may attempt to navigate the Kapuni Lactose weir, likely for the first time in many decades. This will require a more comprehensive assessment of the weir's fish pass.

A visual inspection of the weir during the March 2020 fish survey noted that there were areas of improvement that needed to be undertaken to ensure a higher proportion of successful fish passage attempts is achieved across all species. However, it was also noted that further improvements are also likely to be needed following the removal of the weir to accommodate swimming species that were not previously able to reach the Company's weir.

At the time of the 2020-2021 Annual Report, it was considered appropriate that any remedial work be delayed until the Glenn Road weir had been removed and passage reassessed in 2021-2022 (and potentially the following year) so that premature remedial actions are not made. By this slight delay of significant works, it can be ensured that any modifications address issues for different fish communities.

At the time of the routine compliance monitoring inspections trout were observed above the weir on four of the six inspections during the year under review.

2.1.8.4 Fish survey

Fish surveys were scheduled to take place every third year. A survey was carried out in March 2020, with the next survey scheduled for 2022-2023. However, due to potential issues found with the weir and fish passage, and the removal of the Glenn Road weir in the 2020-2021 year, the monitoring schedule was revised. Surveys are now scheduled on an annual basis while the changes in the fish communities stabilise following the removal of the Glenn Road weir.

A four-site fish survey was undertaken in the Kaupokonui Stream over three days (28 February, 2 March and 7 March 2022), in order to determine whether the activities of the Kapuni Lactose factory had had any impact on the fish communities of this stream. The fish communities were surveyed using the electric fishing technique, with all fish identified where possible, counted, and lengths estimated. The sites monitored are described in Table 41 and shown in Figure 89.

Table 41 Location and description of fish monitoring sites in relation to the Kapuni Lactose factory

Site	Site code	Site description	Grid reference	Distance to coast (km)	Approximate Altitude (m)
1	KPK000652	4.3 km upstream of intake weir	E1698130 N5632654	19.68	170
2	KPK000666	Between intake weir and cooling water discharge	E1697744 N5629658	15.5	160
3	KPK000677	Downstream of cooling water discharge	E1697644 N5629458	15.3	160

Site	Site code	Site description	Grid reference	Distance to coast (km)	Approximate Altitude (m)
4	KPK000685	Skeet Rd	E1697221 N5628986	14.51	150

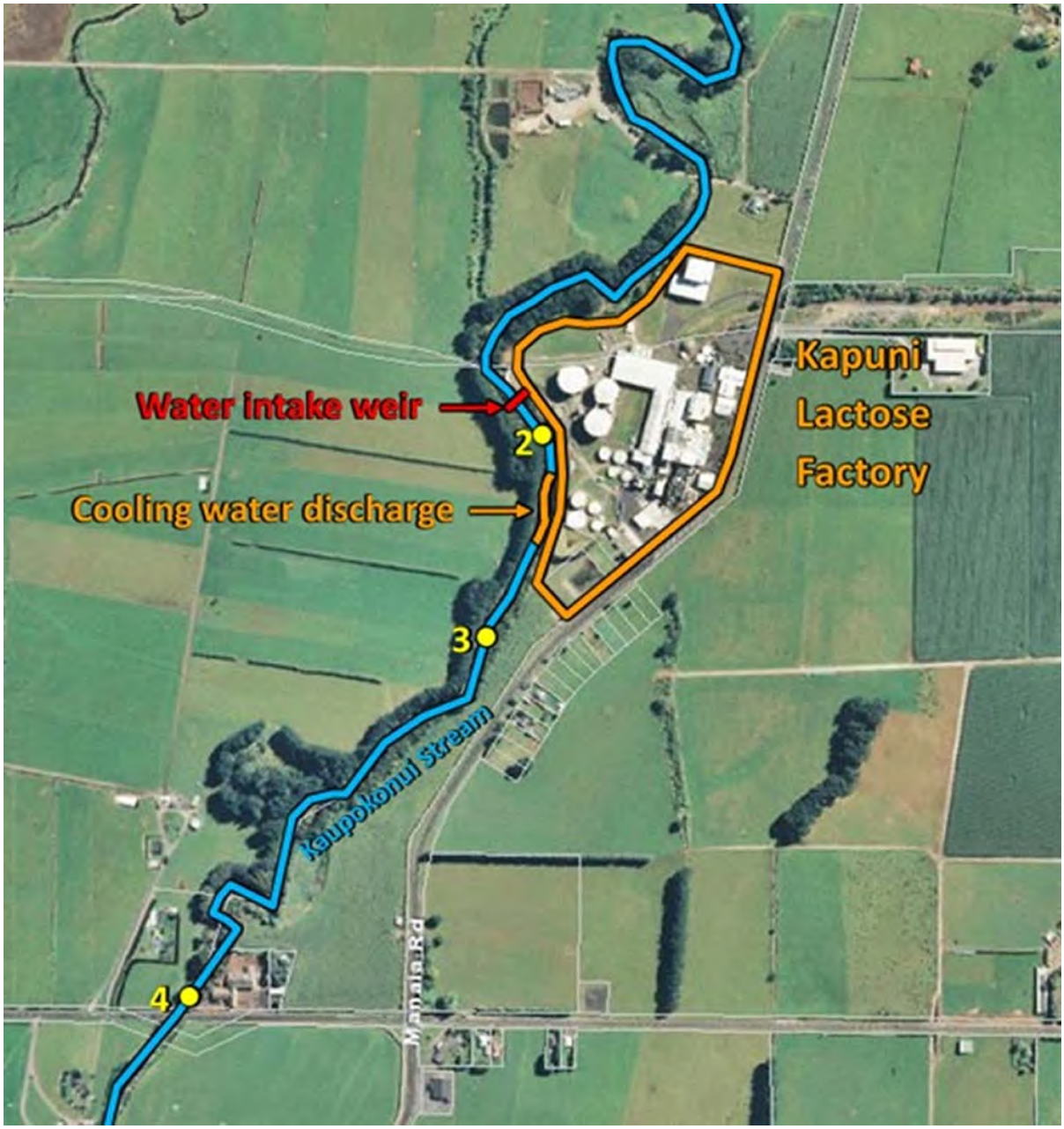

Figure 89 Fish monitoring sites sampled in the Kaupokonui River, in relation to the Kapuni Lactose factory. Site 1 is located approximately 4.3 km upstream of the weir

The two main activities that could potentially impact on the fish communities are the discharge of cooling water to the Kaupokonui Stream and the water intake weir, located just upstream of the cooling water discharge. In addition, it should be noted that in February 2021 the Glenn Road weir was removed several kilometres downstream of the factory. This structure had previously been a known fish passage barrier.

Five fish species were recorded during this survey, being longfin and shortfin eel, redfin bully, rainbow trout, and inanga. A single inanga was recorded at site 4 (below the Company's site), likely reflecting the recent removal of the Glenn Road weir.

Upstream of the Kapuni Lactose weir, redfin bully and longfin and shortfin eels were recorded, indicating that this weir is not posing a significant barrier to fish passage for these climbing species. The recent removal of the Glenn Road weir has resulted in the detection of inanga in this survey, and is expected to result in further species such as smelt and torrent fish gaining access to this section of the river. The ability for the current fish pass to provide access for these species will need to be assessed in future surveys as they begin to appear downstream of it. While rainbow and brown trout were not recorded at site 1, trout were observed immediately upstream of the weir, and one unidentified fish was recorded at site 1. The overall low abundance of fish in the current survey is believed to be due to the large flood event in early February.

While the fish pass is clearly navigable by the climbing species present in this area of the stream, there will likely need to be some improvement to the weir to allow easy fish passage to swimming species, and perhaps some improvement to increase the utilisation of the ramp by climbing species. It was noted that the weir has a large amount of attractant flow that could lead fish to the base of the weir which may result in the delay or failure of upstream passage. This could eventually lead to predation or mortality by movement to land as has been observed at a number of other similar structures. The face of the weir is not conducive to fish passage due to an overhanging perch and sharp edges. Additionally, the weir is leeching from the underside and true right side of the weir, which may further encourage fish to linger at the base of the weir. The fish pass is somewhat shallow, which would prove challenging to navigate for larger fish. The top of the fish pass is unprotected and will prove difficult for smaller fish exiting the fish pass to avoid predation. Large trout were observed loitering at the top of the fish pass, suggesting that it may be a frequent feeding spot, which has been seen to occur at a number of similar structures. Addition of some form of exit cover, such as boulders, would aid smaller fish in avoiding predation while exiting the fish pass.

Overall, these survey results appear to show that the activities of the Kapuni Lactose factory are not currently significantly adversely affecting the fish communities of the Kaupokonui Stream. However, it is expected that complete passage is not being provided for due to the reasons outlined earlier. In general these survey results are unlikely to effectively portray these issues due to the survey methodologies own limitations. As the riparian planting of the catchment matures, and effects of the passage remediation works at the Glenn Road weir become evident, the diversity and abundance of fish in this stretch of stream will likely improve.

A more comprehensive assessment of the weir and thermal effects of the cooling operation will be required as the stream values increase, and a shift to annual monitoring is recommended as opposed to the current three yearly survey in order to detect the expected changes. It is worthwhile delaying any remedial works until further information can be collected with respect to the changing fish community from the removal of the weir which would be used to inform remediation options. However, it is also important to recognise that there is a possibility of potentially significant effects through the lack of fish passage and thermal effects, so remediation may need to be undertaken promptly to ensure compliance.

General maintenance of the current fish pass (replacing loose or missing rocks, ensure base is not undercut, surface kept clear of debris etc.) should be carried out in the meantime, as well as potentially positioning large boulders near the top of the fish pass to provide protection from predation for small fish.

2.1.8.5 Macroinvertebrate surveys

Macroinvertebrate surveys were carried out on 3 November 2021 and 2 February 2022 in the Kaupokonui Stream, Dunns Creek and the Waiokura Stream in relation to the Company's activities. The surveys were

carried out to examine the effects of the Company's consented discharges to the Kaupokonui Stream and discharges to land on the Company's two farms that are in the vicinity of these water bodies.

The Waiokura Stream sampling was expanded to include three site at the time of the February 2021 survey, as per the recommendations of the 2019-2020 Annual Report, with the survey being carried out in spring as well as summer for the first time in the 20221-2022 year.

Biomonitoring in Dunns Creek commenced in the 2021-2022 year to monitor the potential impacts of the Company's irrigation to land on Farm 1 as per the recommendations of the 2020-2021 Annual Report.

Macroinvertebrates were identified and number of different types of taxa counted (taxa richness), macroinvertebrate community index (MCI) and semi-quantitative macroinvertebrate community index (SQMCI) scores were calculated for each site. The sites monitored are described in Table 42 and shown in Figure 90. Samples were sorted and identified to provide the number of taxa (richness), MCI and $SQMCI_s$ scores for each site. The report summaries are provided below. Copies of the full reports are available from the Council upon request.

Table 42 Biomonitoring sites in the Kaupokonui and Waiokura streams sampled in relation to Fonterra Kapuni

River	Site number	Site code	Grid reference (NZTM)	Location
Kaupokonui Stream	3b	KPK000655	E1697963 N5630770	1 km u/s of railway bridge
	4	KPK000660	E1697613 N5629791	Railway, above factory
	5	KPK000679	E1697607 N5629399	160 m below cooling water discharge zone
	6	KPK000685	E1697221 N5628986	Skeet Road
Dunn's Creek	D1	DNN000250	E1697261 N5630470	Immediately U/S Fonterra Farm 1
	D2	DNN000290	E1697044 N5629858	U/S railway bridge
Waiokura Stream	U	WKR000500	E1698807 N5628892	Skeet Road
	I	WKR000640	E1697979 N5626757	Immediately D/S Fonterra Farm 3 boundary
	D	WKR000650	E1697735 N5625026	At Hicks (Thomas) Road

The MCI is a measure of the overall sensitivity of the macroinvertebrate community to the effects of organic pollution in stony streams. It is based on the presence/absence of taxa with varying degrees of sensitivity to environmental conditions. It may be used in soft-bottomed streams to detect trends over time. The $SQMCI_s$ takes into account taxa abundance as well as sensitivity to pollution, and may reveal more subtle changes in communities, particularly if non-organic impacts are occurring. Significant differences in either MCI or $SQMCI_S$ between sites indicate the degree of adverse effects (if any) of discharges being monitored and enable the overall health of the macroinvertebrate communities to be determined.

Previous surveys had recorded a substantial decline in macroinvertebrate health at site 7 in the Kaupokonui Stream. This site is a substantial distance downstream of the other monitored sites and the Company's activities. The decline has been attributed to both the influence of Dunn's Creek (a major tributary of the Kaupokonui), which was thought to have had poor water quality, and the progressive deterioration often observed in a downstream direction due to cumulative land use pressures. Consequently, this site was removed from the biomonitoring programme and two new sites established in Dunn's Creek. These sites are at the upstream and downstream boundaries of the Farm 1 irrigation area within this catchment. Monitoring at these sites will provide a better reflection of activities taking place on the Company's farm and irrigation area, than the Kaupokonui Stream site downstream of the Dunn's Creek confluence.

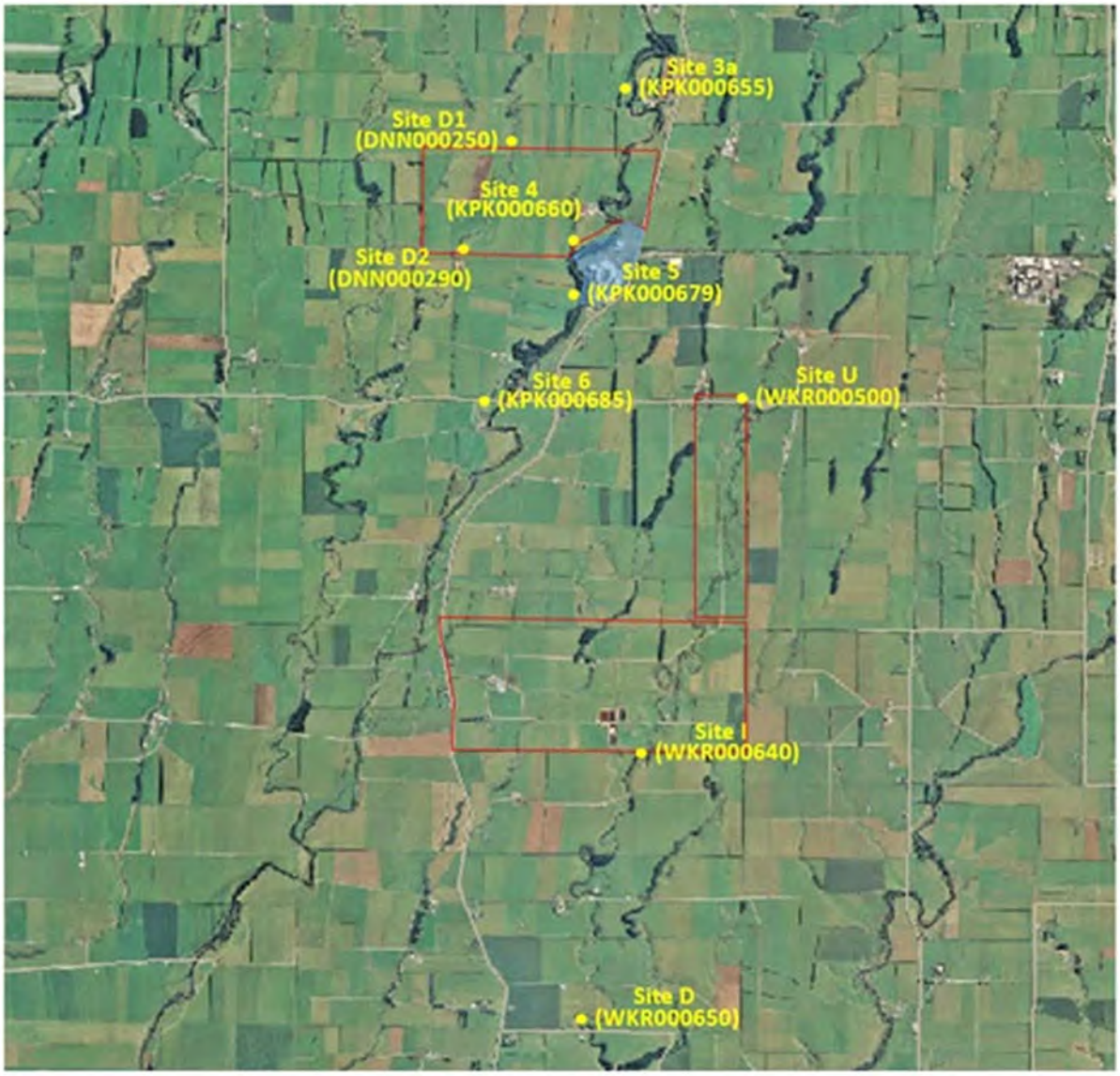

Figure 90 Biomonitoring sites in the Kaupokonui River sampled in relation to the Company's factory discharges

Kaupokonui Stream

At the time of the November 2021 survey the four sampling sites in the Kaupokonui Stream supported taxa richness of between 20 and 27 taxa, with richness increasing in a downstream direction. The richness was within four taxa of the median richness since 1998 at all sites. At the time of the February 2022 survey the four sampling sites in the Kaupokonui Stream supported taxa richness of between 15 and 20 taxa. Compared to the preceding survey, the richness at individual sites was lower at each of the four sites.

The MCI scores at the time of the November survey indicated 'very good' macroinvertebrate community health at the upstream site, and 'good' macroinvertebrate community health at the lower site. Overall, and as is typical, MCI scores decreased in a downstream direction, although there were no significant differences between sites. At the time of the February 2022 survey the MCI scores indicated 'good' macroinvertebrate community health throughout the surveyed reach. There were no significant differences in MCI scores between the sites, and again scores were similar to median scores since 1998 at each of the sites.

From these surveys it may be concluded that the factory's cooling water discharges had not resulted in significant adverse effects on the macroinvertebrate communities of the Kaupokonui Stream, and that the communities were largely in average condition, although taxa richness was lower than is typical. The surveys

undertaken during the year under review did not record the presence of heterotrophic growths, supporting a lack of impacts from the stormwater and cooling water discharges. Further, the trend of improvement in communities adjacent to the factory observed in more recent years has continued to be recorded during the year under review.

Dunns Creek

The November 2021 survey found that there was a moderate taxa richness of 21 to 25 taxa recorded in Dunn's Creek, and MCI scores showed a narrow range of 98 to 102 units. SQMCI scores showed a significant decrease from site D1 to site D2. On the basis of MCI scores, site D1 had 'good' and site D2 had 'fair' macroinvertebrate community health.

At the time of the February 2022 survey a moderate taxa richness of 18 to 21 was recorded in Dunn's Creek. On this occasion there was no difference between the MCI (92 units) or SQMCI (5.3 units) of the two sites.

When compared to the Kaupokonui Stream, at the time of both surveys the taxa richness was similar and MCI sores were significantly lower in Dunns Creek than in the Kaupokonui Stream. The Dunns Creek SQMCI scores were similar to or lower than in the Kaupokonui Stream.

Overall, the habitat was relatively similar between the Dunn's Creek and Kaupokonui Streams, although there was reduced shading in Dunn's Creek. This reduced shading might favour more 'tolerant' taxa, thereby accounting for the differences in MCI and SQMCI scores between the two streams. Nonetheless, comparison between these two nearby waterbodies in the same catchment provides context for the interpretation of the results from these new sites.

Waiokura Stream

Historically there have been differences found between the communities at site U and site D. This difference had been largely attributable to the distance between the sites (approximately six kilometres), and the marked habitat differences between sites (especially the predominance of macrophytes at site D), rather than to any effects of the application of wastes to land from the Fonterra factory. Given the large distance between the two sites there had been insufficient evidence either to conclude that the change between sites was related to impacts caused by wastewater irrigation to land, or to rule this out as a cause of the observed deterioration. In the summer 2021 survey, site I was introduced immediately downstream of the irrigation area to help ascertain whether the differences between sites U and D related to habitat differences, wastewater irrigation to land, other land uses in the intervening catchment area, or a combination of these factors.

At the time of the November 2021 survey, it was found that results of the two surveys to date showed little difference between sites U and I. I was concluded that, overall, there was no evidence supporting that the impacts of wastewater irrigation to land are causing deterioration in the macroinvertebrate communities of the Waiokura Stream. Furthermore, given the results recorded in the two surveys at site I, it appears that the deterioration typically observed between sites U and D is most likely a result of marked habitat differences between the sites, as well as other land use influences on the stream over the six kilometre distance between sites. However, given that only two surveys have been carried out at site I, it is recommended that both sites I and D are surveyed for a minimum of five surveys to ensure consistency and allow comparison with previous surveys. Should results and habitat remain similar at sites I and U for a minimum of five surveys, consideration should be given to removing site D from the monitoring programme.

At the time of the February 2022 survey, it was found that the habitat at site I was relatively similar to that at site D, with extensive macrophytes present on the streambed and similar substrate, while site U had no macrophytes present due to increased shading. Macroinvertebrate indices at the time of this survey indicated that the communities at site I are in a current condition intermediate between that of sites U and D. Given the difference in habitat between site U and the two downstream sites on this occasion, the survey provided limited ability to compare macroinvertebrate communities between sites or to determine the

cause of any observed effects on the macroinvertebrate communities. Given the results recorded in the two surveys at site I, it appears that the deterioration typically observed between sites U and D is most likely a result of marked habitat differences between the sites, together with other land use influences on the stream over the six kilometre distance between sites. Should there continue to be differences in the habitat between site U and site I, the inclusion of the Waiokura Stream macroinvertebrate monitoring sites should be reviewed, and consideration given to alternate forms of monitoring that might be appropriate to detect effects of the consented activities.

In the case of Dunns Creek and the Waiokura Stream, it has been noted that additional investigation would be required to positively ascertain whether any impacts could be directly attributed to the consented discharge to land rather than the agricultural land uses of the Company's farms. However, in the reissuing of the discharge to land consents, the cumulative effects of the Company's activities should be considered.

The possibility of reducing the frequency of the macroinvertebrate monitoring in Dunns Creek and the Waiokura Steam to a spring and summer survey carried out every three to five years, with accompanying water chemistry monitoring, is being considered.

2.2 Air

Officers of the Council carried out inspections in relation to air emissions, of the Kapuni lactose plant, during the 2021-2022 monitoring period. These inspections are an important part of the monitoring programme, and are incorporated as part of the monthly inspections and water sampling, allowing for discussion of air discharge management issues.

From an air emissions perspective, the plant appeared to be well managed and well maintained, with a high standard of housekeeping observed at the time of each inspection. During each inspection a survey of the site boundary and the surrounding neighbourhood was carried out for odours and lactose powder fallout. No evidence of any lactose powder fallout was found during any of these surveys. No objectionable odours or visible emissions were noted beyond the site boundary during any of the inspections, with only on-site odours noted on occasion during inspections. On 20 August it was noted that there was a typical "sweet" wastewater odour localised around the wastewater tank, but this odour was not noticeable at the site boundary.

2.2.1 Emission monitoring

A wet scrubber system was commissioned by the Company in October 1998. The wet scrubber system links the exhaust streams from the flash drier (pre-drier) stack and the refined fluid bed drier, with this emission source then referred to as the flash drier. Continuous particulate meters have also been installed by the Company to give a real time indication of the powder emissions from each drier. These meters are indicators only, but do provide a warning to operators that the discharge levels have increased, enabling this to be responded to.

Table 43 is included for comparison of results prior to the installation of the wet scrubber system.

Table 43 Summary of the refined and pre-drier emission testing results prior to the installation of the wet scrubber (October 1998)

Stack	Date	Emission (mg/m^3)
Refined drier	26 November 1997	515
Refined drier	10 December 1997	215
Pre-drier	8 December 1999	158
Refined drier	21 January 1998	567

Isokinetic stack sampling and analysis of the exhaust from the flash drier stack for particulates was conducted on 21 September 2018 by CRL Energy, using USEPA method 17. During the year under review, there was again a slight change in the methodology of the emissions monitoring. In the 2019-2020 year the determination was an average of three tests performed over a period of about 60 minutes for the Flash drier and the small drier, but 50 minutes for the North and South Supertab. From the 2018-2019 year to date, the determination returned to being an average result from three tests each conducted over approximately 60 minute periods, rather than the one approximately 60 minute period used during the 2017-2018 year. Again, no information was included in the report regarding the production rate at the time the test was undertaken. The current consent does not contain any conditions specifying the methodology and reporting requirements for the stack testing required to confirm compliance with particulate emission rate limit. This will be addressed in the replacement consent.

The result is presented in Table 44 below, along with previous averaged CRL and Council results since 1998.

Table 44 Summary of isokinetic stack analysis of the flash drier (pre-drier) for 1998-2022

Date	Production rate (t/hr)	Stack emission rate (dsm^3/hr)	Emission (mg/dsm^3)*	Comments
5 November 1998	-	-	<10	No visible emissions noticed
25 February 1999	-	-	<10	No visible emissions noticed
4 May 1999	-	-	<10	No visible emissions noticed
9 May 2000	-	-	<10	No visible emissions noticed
27 October 2000	-	-	<10	No visible emissions noticed
30 November 2000	-	-	21	No visible emissions noticed
29 November 2001	-	-	<10	No visible emissions noticed
21 January 2009	-	-	58	
6 February 2010	-	-	53	
20 January 2011	-	-	18	Mass emission rate 0.7 kg/hr
11 January 2012	-	-	67	Mass emission rate 3.0 kg/hr
9 January 2013	-	-	27	Mass emission rate 1.3 kg/hr
11 December 2013	-	-	18	Mass emission rate 0.9 kg/hr
17 December 2014	-	-	23	Mass emission rate 1.2 kg/hr
11 November 2015	-	-	18	Mass emission rate 0.9 kg/hr
21 September 2016	5.4	44891	17	Mass emission rate 0.8 kg/hr
25 October 2017	Not provided	46229	17.1	Mass emission rate 0.8 kg/hr
21 September 2018	Not provided	44408 to 45407	1.2	Mass emission rate 1.2 kg/hr
29 October 2019	Not provided	43305 to 44457	30	Mass emission rate 1.3 kg/hr
30 October 2020	Not provided	42383 to 45956	29	Mass emission rate 1.3 kg/hr
8 December 2021	Not provided	46636 to 48323	24	Mass emission rate 1.15 kg/hr

Key * mg/dsm^3 = milligrams per cubic meter of gas, at 0˚C, 1 atmosphere pressure and calculated as a dry gas

The emission monitoring performed after the installation and commissioning of the wet scrubber system clearly shows the success of the wet scrubber in abating powder emissions from the refined drier and pre-drier at the lactose plant. In view of the consistently low particulate emissions, Council in 2002 stopped

emission monitoring but continued the ambient deposition monitoring and inspections. The Company instituted its own emission testing in 2009, as part of product loss monitoring.

The consent limit for emissions from the wet scrubber system is 125 mg/m³ of gas, adjusted to 0˚C, 1 atmosphere pressure and calculated as dry gas. Prior to the consent renewal (7 April 2000) the discharge limit was 250 mg/m³ of gas, adjusted to 0˚C, 1 atmosphere pressure and calculated as dry gas.

The results obtained in December 2021 were again well below consent limits.

The Company commenced voluntary particulate emissions monitoring of the other three emission sources on site in 2016. The results are presented in Table 45, Table 46 and Table 47. There are currently no consent limits on these sources, however the renewed consent will contain particulate emissions limits for each of these stacks. Two of the three average particulate emission rates during the year under review were below the 125 mg/m³ limit that applies to the flash drier.

Table 45 Summary of isokinetic stack analysis of small drier, commenced in 2016

Date	Production rate (t/hr)	Stack emission rate (dsm³/hr)	Particulate emission (mg/dsm³)*	Particulate emission rate (kg/hr)
21 September 2016[a]	2.5	26428	66	1.8
25 October 2017[b]	Not provided	23478	70.3	1.65
21 September 2018[c]	Not provided	22992 to 23635	104	2.4
29 October 2019[c]	Not provided	23054 to 24397	56	1.3
30 October 2020[c]	Not provided	24598 to 24851	55	1.35
8 December 2021[c]	Not provided	24042 to 25898	60	1.49

Key * mg/dsm³ = milligrams per cubic meter of gas, at 0˚C, 1 atmosphere pressure and calculated as a dry gas
a average of three test results using USEPA method 201A
b single test result using USEPA method 17
c average of three test results using USEPA method 17

Table 46 Summary of isokinetic stack analysis of the supertab north drier, commenced in 2016

Date	Production rate (t/hr)	Stack emission rate (dsm³/hr)	Particulate emission (mg/dsm³)*	Particulate emission rate (kg/hr)
21 September 2016[a]	0.629[d]	18863	93	1.7
25 October 2017[b]	Not provided	20616	24.7	0.50
21 September 2018[c]	Not provided	20553 to 23635	87	1.9
29 October 2019[c]	Not provided	17447 to 18851	110	2.0
29 October 2020[c]	Not provided	16858 to 18156	130	2.25
29 March 2022	Not provided	18280 to 19786	99	1.88

Key * mg/dsm³ = milligrams per cubic meter of gas, at 0˚C, 1 atmosphere pressure and calculated as a dry gas
a average of three test results using USEPA method 201A
b single test result using USEPA method 17
c average of three test results using USEPA method 17
d tested in combination with supertab south drier

Table 47 Summary of isokinetic stack analysis of the supertab south drier, commenced in 2016

Date	Production rate (t/hr)	Stack emission rate (dsm^3/hr)	Particulate emission (mg/dsm^3)*	Particulate emission rate (kg/hr)
21 September 2016[a]	0.629[d]	21831	138	3.0
25 October 2017[b]	Not provided	20208	47.4	0.98
21 September 2018[c]	Not provided	22527 to 22927	90	2.0
29 October 2019[c]	Not provided	14204 to 14813	65	0.9
29 October 2020	Not provided	18841 to 21122	113	2.26
29 March 2022	Not provided	19541 to 20162	167	3.32

Key * mg/dsm^3 = milligrams per cubic meter of gas, at 0˚C, 1 atmosphere pressure and calculated as a dry gas
a average of three test results using USEPA method 201A
b single test result using USEPA method 17
c average of three test results using USEPA method 17
d tested in combination with supertab north drier

2.2.2 Deposition gauging

Many industries emit dust from various sources during operational periods. In order to assess the effects of the emitted dust, industries have been monitored using deposition gauges.

Deposition gauges are basically buckets elevated on a stand to about 1.6 m. The buckets contain deionised water to ensure that any dust that settles out of the air is not re-suspended by wind. A copper sulphate solution at a concentration of 5 g/L acts as a preservative to prevent growth of algae and bacteria.

In the year under review, gauges were deployed at five sampling sites around the lactose plant for a period of approximately five weeks during summer. The contents of the gauges were analysed for COD (chemical oxygen demand). The COD results are compared with the theoretical value for lactose powder and a "total deposited powder" (TDP) value is calculated.

The descriptions and locations of the five air deposition monitoring sites are provided in Table 48 and Figure 91.

The Council guideline value for total particulate deposited to cause nuisance is 130 mg/m^2/ day, but the Council does not have a specific guideline value for lactose powder deposited. The lactose deposition survey determines deposition due to lactose powder only, not total deposition.

Guideline values used by the Council for dust deposition are 4 g/m^2/30 days or 130 mg/ m^2/day deposited matter. Consideration is given to the location of the industry and the sensitivity of the surrounding community when assessing results against these values.

The deposition gauge results for the deployment period in the year under review are compared with previous results since 1997 in Figure 92 and Table 49.

Prior to the commissioning of the wet scrubber in October 1998, deposition rates of up to 1,300 milligrams per square metre were reported from surveys carried out surrounding the lactose factory site. There has been a significant reduction in deposition since the wet scrubber began operating. This is consistent with the decrease in stack emission concentrations measured (see section 2.2.2).

Table 48 Description of the Fonterra Ltd air deposition sample sites

Site number	Description
AIR002301	east of plant, across Manaia Road adjacent to the plant
AIR002302	east of plant, opposite the tanker bay
AIR002303	south of plant
AIR002304	west of plant
AIR002305	south west of plant

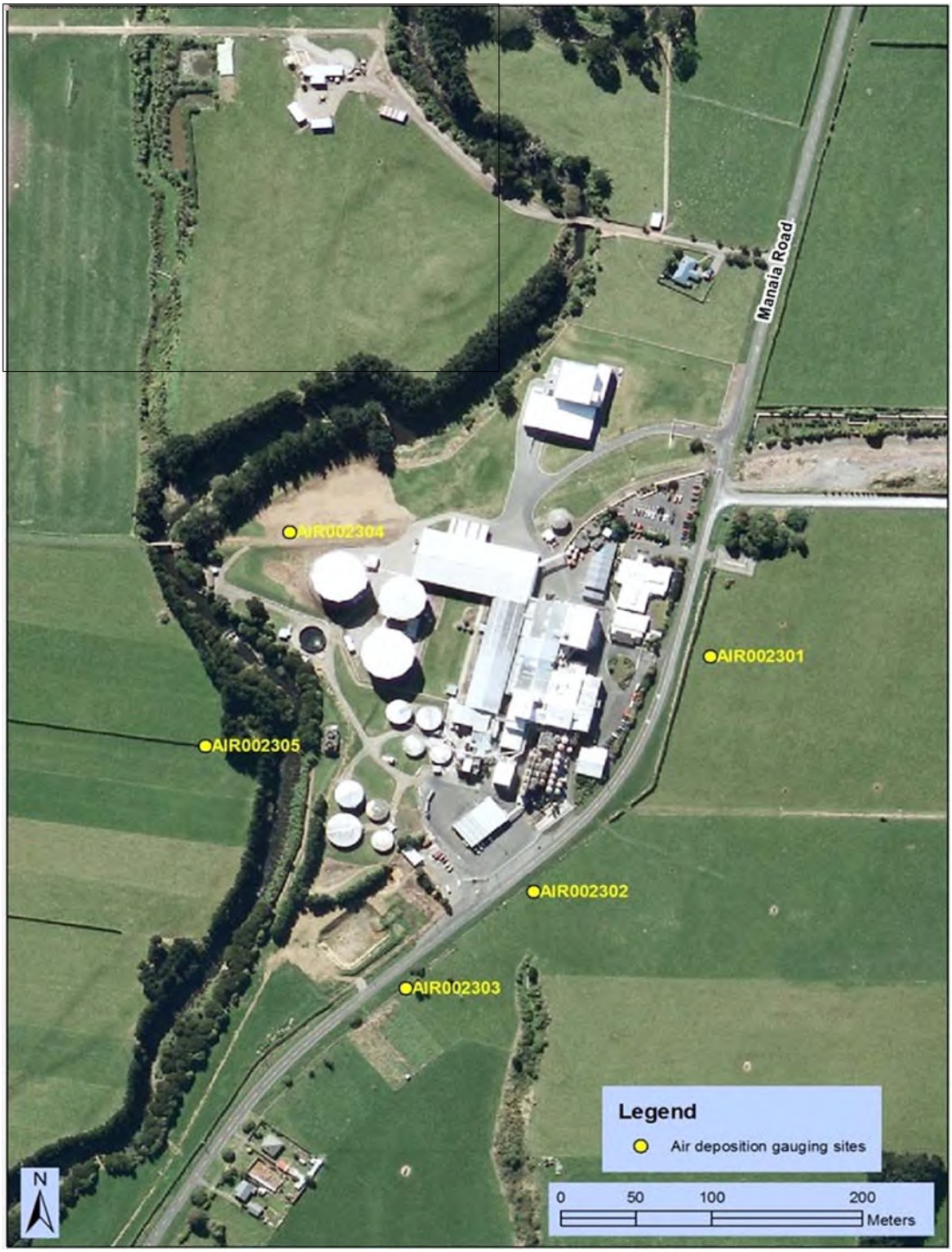

Figure 91 Location of air deposition gauging sites

A review of the monitoring data from the nearest wind monitoring station (Taungatara at Eltham Rd) indicated that it was likely that winds were predominantly from the SE and the N.

The lactose deposition rates recorded were above their respective historical medians at AIR002302 AIR002303, and AIR002305. It appears that there is an emerging trend of increasing lactose deposition rates at site AIR002302 (Figure 92), which is supported by an increasing 5 year rolling median for this monitoring location.

The deposition rates obtained were below the guideline value at all sites during the period under review.

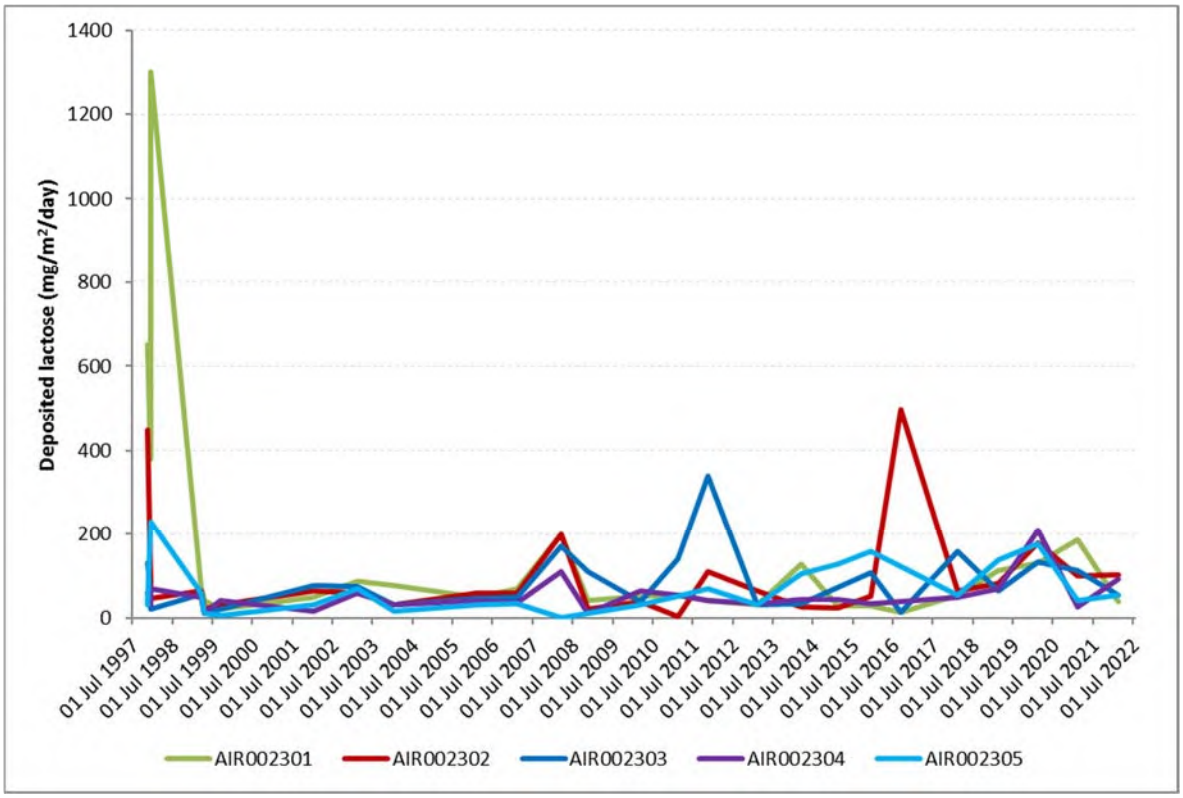

Figure 92 Deposition gauge results from 1997 to date

Table 49 Deposition gauge results from 1997 to date

Period	Number of days	Deposited lactose mg/m²/day				
		AIR002301	AIR002302	AIR002303	AIR002304	AIR002305
10 Nov to 24 Nov 1997	14	**650**	**450**	**130**	59	30
24 Nov to 9 Dec 1997	15	**380**	83	53	30	-
9 Dec to 22 Dec 1997	13	**1300**	46	20	68	**230**
4 Mar to 18 Mar 1999	14	71	63	56	50	60
12 Apr to 26 Apr 1999	14	40	20	<20	<20	<20
9 Sep to 29 Sep 1999	20	20	30	-	40	<10
9 Jan to 24 Jan 2002	16	50	63	78	<30	30
21 Jan to 3 Feb 2003	13	86	60	75	60	69
14 Jan to 29 Jan 2004	15	76	30	30	30	<30
11 Apr to 10 May 2005	29	-	-	-	-	-

Period	Number of days	Deposited lactose mg/m^2/day				
		AIR002301	AIR002302	AIR002303	AIR002304	AIR002305
10 Jan to 1 Feb 2006	22	50	59	47	40	30
11 Jan to 13 Feb 2007	33	70	59	49	37	34
15 Feb to 14 Mar 2008	28	**200**	**200**	**170**	110	-
20 Oct to 10 Nov 2008	21	40	20	110	<20	<20
12 Feb to 9 March 2010	25	52	38	39	63	30
25 Jan to 15 Feb 2011	21	21	<8	140	54	51
29 Sep to 17 Oct 2011	18	40	110	**340**	40	70
28 Jan to 15 Feb 2013	18	30	64	30	33	30
20 Feb to 17 Mar 2014	25	127	27	33	44	105
28 Jan to 18 Feb 2015	21	28	24	-	45	127
24 Nov to 15 Dec 2015	21	29	51	109	32	**159**
6 Sep to 27 Sep 2016	21	12	**498**	13	*	*
11 Jan to 2 Feb 2018	22	53	63	**158**	48	53
21 Jan to 26 Feb 2019	36	112	82	65	69	**139**
27 Jan to 17 Feb 2020	21	130	**178**	**134**	**210**	**176**
3 Feb to 23 Feb 2021	20	**187**	100	112	25	42
3 Feb to 23 Feb 2022	20	39	102	53	92	54
Historical median	-	*55*	*60*	*65*	*42*	*42*

* gauge contents contaminated by bird/bird droppings

2.3 Incidents, investigations, and interventions

The monitoring programme for the year was based on what was considered to be an appropriate level of monitoring, review of data, and liaison with the Company. During the year matters may arise which require additional activity by the Council, for example provision of advice and information, or investigation of potential or actual causes of non-compliance or failure to maintain good practices. A pro-active approach, that in the first instance avoids issues occurring, is favoured.

For all significant compliance issues, as well as complaints from the public, the Council maintains a database record. The record includes events where the individual/organisation concerned has itself notified the Council. Details of any investigation and corrective action taken are recorded for non-compliant events.

Complaints may be alleged to be associated with a particular site. If there is potentially an issue of legal liability, the Council must be able to prove by investigation that the identified individual/organisation is indeed the source of the incident (or that the allegation cannot be proven).

Table 50 below sets out details of any incidents recorded, additional investigations, or interventions required by the Council in relation to the Company's activities during the 2021-2022 period. It also includes matters that commenced and were reported on in previous monitoring periods, only where additional activity by the Council continued during the monitoring period under review. This table presents details of all events that required further investigation or intervention regardless of whether these were found to be compliant or not.

Table 50 Incidents, investigations, and interventions summary table

Date	Details	Compliant (Y/N)	Enforcement Action Taken?	Outcome
18 Aug 2021	Notification was received advising that there was an unexpected discrepancy between the abstraction and discharge flow rates at Fonterra Kapuni that had affected all of the data recorded in the new season.	N	Letter of explanation requested.	Investigation found that a loose connection on the input/output card had resulted in the abstraction flow being compromised. Repairs were undertaken. Initially it was thought that it may be possible to recover the data post repair, however it was later confirmed that the correct abstraction totals could not be recovered. The letter of explanation was received and accepted.
16 Dec 2021	Notification was received advising that there had been a minor exceedance of the two day irrigation volume permitted by this consent.	Y	N	Investigation found that that the limit was exceeded by 1.8% (71 m^3) due to the failure of the Farm 1 pump. It is recognised that the consent exceedance was within the accepted ± 5% accuracy of flow measuring devices and therefore non-compliance could not be confirmed. At the time of this incident there was no spare pump on hand and no contingency infrastructure in place. A spare pump is now kept in reserve and other contingency measures are being put in place.
28 Feb 2022	Following the review of data from the February 2022 groundwater survey, the Company was asked to investigate nitrate/nitrite concentration in bore GND0640 as per the WFMP.	Y	N	Interim investigation found that the sampling had occurred on the fourth day of an irrigation event, and the paddock had been grazed by stock the day prior to the irrigation commencing. There had been 310mm of rain recorded at the Farm 3 weather stations, and groundwater levels were at an 8 year high. Cow urine and wastewater both have the potential to impact the nitrate/nitrite nitrogen monitoring result. It was considered the above factors could all have contributed to the elevated results. An investigation that includes on-going monitoring is continuing and it is expected that the report will be provided in the 2022-2023 year.

3 Discussion

3.1 Discussion of plant performance

General site management

Generally the onsite management and operation of the Kapuni lactose plant site was undertaken in a satisfactory manner. Continual liaison between the Company's staff and the Council has contributed to this performance. A number of improvements were made at the site during the year under review, including improvements in the tracking of nitrogen loadings applied to irrigation areas, completion of the programme to replace all of the PVC pipe crossings conveying wastewater over streams with stainless steel pipes, review of wastewater transfer system alarms, re-introduction of the ability to transfer the wastewater to multiple farms, introduction of real time monitoring of powder emissions from each dryer and an update to the Air Management Plan for the site.

Work identified for the 2022-2023 year included:

- reviewing practices to improve the management of nutrients at the site,
- ensuring that the site would receive raw materials of an improved quality from the other Fonterra sites to reduce the CIP requirements,
- investigating options such as changes in CIP chemicals, recovery of the CIP material, and available technologies to treat the wastewater from the site to reduce the nutrient content of the irrigated factory wastewater,
- replacement of site formed bends in the wastewater transfer lines to reduce the potential for leaks.

Management plans

Contingency planning is in place in the form of the Site Stormwater Management Plan. It is a requirement of the consent that the plan is reviewed and updated (if required) annually. The latest plan on record at the Council was issued in April 2022. A Spray Irrigation Plan is required by consents 0922-3.2 and 0923-3. The consent requires that this is updated annually with the updated plan to be provided to Council by 1 July each year. Council has been informed that the irrigation practices at the site have not changed substantially, but the irrigation management plan was updated to a whole farm management plan in June 2019 that covers the irrigation management and the farm management practices to ensure that the operation of these two activities is well integrated. The latest plan on record at the Council was issued in March 2022.

Data provision

Data were collected by the Company and forwarded to the Council regarding the abstraction of water from the Kaupokonui Stream, temperature of the Kaupokonui Stream above and below the discharge of cooling wastes, cooling water discharge rates and temperatures, stormwater pond discharge records, and volume and composition of effluent sprayed to pasture on the two farms. Daily volumes, temperature maxima, and stormwater discharges were reported monthly. Historically, this was all provided in the form of monthly reports, with the upstream and downstream temperatures being provided electronically on a daily basis and irrigation waste composition records forwarded annually upon request. More recently the flow data for the abstraction and cooling water discharge and the cooling water discharge temperature has been provided to Council in the form of electronic data, that were initially also provided on a daily basis. This data is now provided every two hours. This change was made because there is an upstream consent that requires the consent holder to cease abstraction when the temperature of the Kaupokonui Stream, at the monitoring site operated by the Company upstream of their spray cooling water discharge, reaches 22°C. More frequent provision of the Company's monitoring data enables better adherence to this requirement, which was included in the consent at Fonterra's request as an affected party.

In terms of irrigation data, historically total daily data was provided that gave separate volumes for the factory wastewater and DSE volumes irrigated onto each of the farms, along with the two day rolling totals for Farm and for Farms 2 & 3 to enable confirmation of compliance with the discharge rates permitted by the consents. The wastewater composition data was provided annually at the end of each year under review. It had been highlighted for several years that, although not a specific requirement of the current consents, more frequent provision of data in the form of paddock by paddock irrigation volumes, localised rainfall and the nitrogen content of the irrigated wastes would enable more effective evaluation of the actual and potential environmental effects of the wastewater irrigation to be made. Provision of this data commenced in the 2020-2021 year. Records were provided on a monthly basis for the year under review.

The Company's data collection and provision was satisfactory during the year under review. The improved accuracy and precision of the various datasets were maintained and gaps in the data were minimal. Parallel temperature monitoring in the Kaupokonui Stream found very little difference between the data collected by the Company and by the Council. Compliance with consent conditions was demonstrated for abstraction rates, stream temperatures and wastewater/effluent irrigation volumes data provision, with the exception of the abstraction data provided in the early part of the year under review.

Water abstraction and cooling water discharge volumes

It is noted that there had been a general trend of decreasing abstraction since the 2021-2013 year. This has been evident in terms of maximum daily abstraction and annual volume taken. During the year under review, due to the quality of the material received at the site for processing, there was an estimated 17% increase in the annual abstraction volume when compared to the previous year. However, the maximum daily abstraction was 76% of the permitted daily take, with the maximum abstraction rate being only 75% of the maximum permitted take for 99% of the time.

A comparison of the abstraction and discharge data (excluding the months affected by the abstraction rate reporting error), indicates minimal water usage (within the ± 10 % accuracy of the two measuring devices used to determine this differential), though the water losses through evaporation and spray drift at the spray discharge booms is not accounted for here. Losses at the spray discharge booms may have been increased by the addition of the pressure regulated nozzles. Although these benefit reduced temperature effects, they may reduce the volume of water returned to the stream.

Cooling water discharges

The main cooling system was replaced in August 2015. There is a continuously monitored system (conductivity) on the crystallising condensers, which will enable detection of contaminants for informing the discharge to the cooling water system and stream and/or diversion to wastewater irrigation. The Company's operation of the cooling tower and associated systems during the year under review resulted in monthly median temperatures in the range of 28-36˚C and monthly maximums in the range 26-44˚C. The cooling water discharge was at or above 35˚C for 20% of the year and at or above 33˚C for 50% of the time during the times of lower stream flows. Council monitoring found that the cooling water discharge complied with the contaminant concentrations limited by the consent. The operational changes introduced in recent years will have increased the Company's ability to reduce the temperature of the cooling water discharge. However, as the automation of the system is based on aiming for a temperature differential of approximately 0.6°C, on the whole, the discharge temperature has increased over recent years. Whilst this has the benefit of better energy efficiency, it is not known what impact this may have on the stream temperatures within the low flow reach.

Wastewater irrigation

During the year under review, for the first time, the assessment of the data provided to Council was based on summations of the daily paddock by paddock irrigation data. It is noted that this also includes water that

is used to flush the pipes following irrigation events. This was previously included in the irrigation volumes provided, however the wastewater samples collected for analysis would have included this flush water.

The consent holder complied with the prescribed limits on the wastewater irrigation volumes with the exception of a minor exceedance that was notified to Council. This was not considered to be noncompliant as the irrigation volume did not exceed the margin allowed for due to the permitted measurement error of the metering devices. The volume of FWW irrigated during the year under review was 8% more than in the 2020-2021 year, however the volume of DSE was reduced by just under 30%.

The WFMP states that an even distribution over the paddocks is ideal, however this needs to be balanced with irrigation requirements, stock rotation and the weather. During the year under review it was found that annual application rates in mm/year equivalent ranged from 115 mm/year to 404 mm/year. Showing that from a volume and hydraulic loading perspective, the wastewater is not applied evenly across the available farm area.

Across the whole season, the median measured strength of wastewater irrigated onto land increased for nitrogen species for the fourth successive year. There was again also less consistency in the strength of the wastewater when compared to the 2017-2018 year. During the year under review, the combination of the increased wastewater volume and the increase in the amount of nitrogen contained in the waste water when compared to recent years resulted in an additional 11,692 kgN being discharged when compared to the 2020-2021 year. It is noted that there was also an 11,687 kg increase in the mass of phosphorus discharged. As with the wastewater volumes, there was a wide range of nitrogen application rates across the various paddocks that would not be wholly explained by the need to avoid irrigation in the paddocks specified in the WFMP under certain weather conditions. During the year under review, the nitrogen application rates ranged from 151 to 509 kg/ha/year. The average nitrogen application rates on each of the Farms increased by between 48 and 67 kg/ha/y.

There continues to be high nitrogen (and phosphorus) loads applied to the paddocks during months that have a high total rainfall and above mean soil moisture.

Stormwater discharges

The stormwater system to contain and control stormwater from the southern catchment of the factory site, designed to capture a 1 in 100 year flood volume, has provided additional security for the area where road tankers operate and process materials are stored. A similar system (northern pond) was put in place for the remainder of the site during the 2017-2018 year. These continued to be well managed during the year under review.

Riparian

Riparian planting was maintained on the factory site. The financial contributions were not invoiced for in the 2021-2022 year. The 2021-2022 year financial contributions were invoiced in August 2022. Invoicing for the financial contributions for the 2022-2023 year is scheduled to take place in May 2023.

Incidents and investigations

There were three matters arising where additional investigations, or interventions were required by the Council in relation to the Company's activities during the 2021-2022 period. One matter was a consent non-compliance in relation to provision of data, and one was due to a notification of a 1.8% exceedance of the irrigation limit on Farms 2 and 3 that was not considered to be a consent non-compliance as this was within the accepted metering device. Both matters were resolved satisfactorily. In the case of the data provision non-compliance, the fault was identified and repaired. In the case of the irrigation exceedance, this was due to a pump failure and measures have been put in place to provide contingency options in the event of a potential future pump failure. This includes re-introducing the ability to pump the wastewater to multiple farms. Finally the Company was asked to investigate an elevated nitrogen concentration found in one of the

monitoring bores at the time of the February 2022 survey. This is discussed further in Section 3.2, along with other effects on the groundwater in the vicinity of the wastewater and dairy shed effluent discharges.

In the 2020-2021 year self-notification was received regarding a wastewater pipe leak on the corner of Skeet and Manaia Road, Kapuni. The Company had been notified of the leak by the South Taranaki District Council. The wastewater transfer from the site Farm 3 was shut down immediately. There was no discharge to surface water. The Company undertook to replace any site formed bends in the existing wastewater pipelines as these can be subject to damage during installation. This replacement programme is continuing and will be completed in the 2022-2023 monitoring year. In the meantime, wastewater transfer alarms have been reviewed to provide early detection of leaks from the transfer lines.

3.2 Environmental effects of exercise of consents

Water consumption

When looking at the water allocation of the Kaupokonui Stream, Council had made the assumption that the water take was approximately 30% consumptive. In the AEE, based on water balance calculations, Fonterra estimated that approximately 10% of the water take was consumptive. Following the resolution of the issues that affected the cooling water discharge rates provided for the 2016-2019 years, it was found that the data being supplied meet the agreed standards both in terms of completeness and accuracy of ± 5% from September 2019. As a result, a better estimate of the consumptive nature of the water take, and potential effects on the stream could be assessed from a water allocation perspective. However, it is noted that this would account only for the consumptive use within the factory and losses from the cooling tower, and would not account for the losses from evaporation and spray drift at the cooling water discharge booms. Data recorded across the year under review indicated that there was little, if any, consumptive use outside the ± 10% cumulative measurement error of the metering devices. It is noted that changes at the spray discharge booms are likely to have increased the potential for evaporative and spray drift losses that are not currently measured.

Receiving water effects, general

Inspections and sampling did not find any adverse effects in the receiving waters during the monitoring period, and there was good compliance with discharge permit conditions.

Receiving water effects, temperature

Temperature data supplied by the Company showed that the ambient temperature of the receiving water during the monitoring period was not increased by more than the amounts prescribed on consents 0919-3 and 0921-3, that is, by less than 2˚C for 90% of the time with an upper limit of 3˚C. With the improvement in the measurement error of the Company's instream monitoring that were implemented in the 2018-2019 year, there was improved confidence in the accuracy and precision of the data provided. This has been maintained during the year under review. In the 2017-2018 year, due to the measurement error of the temperature probes, temperature reductions were measured for approximately 16% of the time, with a maximum temperature drop of 2.2˚C reported to Council, resulting in a reduction in the tolerance applied during the Company's calibration of the temperature sensors. In the 2018-2021 years temperature reductions of between 0.01 and 1.0˚C have been recorded for between 3 and 13% of the time. During the year under review, a negative temperature differential of up to 0.7°C was reported for 7% of the record. This indicates that the actual instream temperature differentials may be up to 0.7°C higher than measurement reported by the Company due to permitted measurement errors. This needs to be considered in relation to the temperature increase permitted by the reissued consent.

During the year under review, operation of the cooling tower and associated systems resulted in the reported increase in temperature below the cooling water discharge being well below the consented limit,

being at or below 1.0˚C for 89% of the time, with the temperature differential most commonly being between 0.5 and 0.6˚C (14% of the time).

In terms of the potential effects within the relatively long 200 m cooling water discharge mixing zone, there is the potential for there to be elevated temperatures that could present a barrier to fish passage. Based on historical monitoring, the assumption has been made that fish would make use of a cooler flow corridor close to the true right bank in order to negotiate this stretch of the stream. It was requested that the current temperature conditions within the mixing zone and the validity of this assumption be investigated by the Company during the preparation of the AEE for the renewal of the cooling water discharge consent. Although work was undertaken in February 2018, the temperature measurements within the mixing zone were not conducted during worst case conditions within normal operational parameters as cooling water discharges were in the range of 30˚C to 32˚C. From November 2018 to the end of that monitoring year, the Company manually diverted all cooling water through the cooling tower and ran the cooling tower at the maximum cooling capacity. Monitoring from 1 December to 30 June 2019 that this reduced the cooling water discharge temperature (15 minute average) to below 29˚C for 99% of the time. In comparison, the more energy efficient operation of the cooling tower and associated systems that was in place during the year under review (outlined in Table 5) resulted in the cooling water discharge temperature (15 minute average) being above 29˚C for 78% of the time and above 32˚C for 49% of the time during December to June inclusive. The lower cooling water discharge temperatures that were achieved whilst the cooling tower system operated in a way that achieved the maximum cooling capacity would also have resulted in a significant reduction in the temperature effects occurring within the relatively long approximately 200 m mixing zone. However, the cooling water discharge temperatures during the year under review were higher than those prevailing at the time the investigations of the temperature conditions within the mixing zone were undertaken for the AEE for the consent replacement. The potential temperature effects within the low flow reach are therefore difficult to assess.

The cooling water discharge consent also prohibits temperatures in excess of 25˚C downstream of the plant as a result of the cooling water discharges. This limit was complied with.

Incidents and investigations

Three matters arose during the year under review where additional investigations, or interventions were required by the Council in relation to the Company's activities during the 2021-2022 period. One matter was a consent non-compliance in relation to provision of data, and one was due to a notification of a 1.8% exceedance of the irrigation limit on Farms 2 and 3 that was not considered to be a consent non-compliance as this was within the accepted metering device. There were no adverse effects found as a result of these matters.

Localised contamination was found at one of the 12 bores monitoring during the year under review, in which nitrogen concentrations were detected in GND0640 that were in excess of the previous maximum at this monitoring location. This did not contravene conditions of the consent, but the matter was investigated and mitigation measures were put in place as required by the management plan. This is discussed further below, along with other effects on the groundwater in the vicinity of the wastewater and dairy shed effluent discharges.

Effects relating to wastewater irrigation, soil

In general, soil quality was good, with most measures being within the optimum range for pasture growth. No deficiencies in the pasture. There was no threat of soil structure collapse from potential accumulation of the salts from the wastewater irrigation activities. Where the optimal agronomic concentrations were exceeded (potassium, calcium and total nitrogen), these were unlikely to cause any issues with plant or animal health.

With respect to total nitrogen it was noted that the concentrations were classified as very high in irrigated paddocks, but that they were unchanged from the previous year.

With respect to phosphorus it was reported that trends in soil chemistry since records began at the farm show that the accumulation rate of phosphorus appears to be stable and not increasing. This likely indicates that the topsoil is saturated with Olsen-P and it is now moving deeper into the soil. Some transfer of nutrients (by stock) from irrigated to non-irrigated areas appear to be occurring as Olsen-P levels are slightly above the optimum agronomic range (35-45 mg/L) in several control paddocks. In an assessment of the long term impact of the phosphorus loadings undertaken by McDowell (2021) balancing P inputs with P outputs and reducing P loadings to achieve a topsoil Olsen-P of 300 mg/L or less and an eventual Olsen-P of 50 mg/L was recommended.

With respect to calcium it was noted that the soil in irrigated paddocks had all, or nearly all, of the exchange sites filled with cations. Calcium was the dominant ion. Further addition of calcium will have no impact on soil quality because the soils exchange sites are already full.

Effects relating to wastewater irrigation, groundwater

Effects on the groundwater in the vicinity of the farms were varied, but most showed that there was an adverse impact on both mineral and organic component levels. Between the 2014 and 2018 years there were successive decreases in the amount of total nitrogen discharged to the farms. Since then the amount of nitrogen discharged had increased year on year. The average nitrogen application rates during the year under review were the highest since they have been since the irrigation area was expanded in the 2007-2008 monitoring year.

During the year under review, there was only one bore that was consistently above the drinking water standard. This was the control bore at the northern boundary of Farm 2 (GND2049). The reason for the reasonably consistent elevation in this control bore and the occasional elevation in the control bore for Farm 3 (GND2051) is still to be fully investigated. In terms of the impact bores, the Farm 2 impact bore GND0638 was the only bore that had an annual median above the standard. This bore had been impacted to a greater degree during the 2020-2021 year. Following the introduction of mitigation measures that included reducing the wastewater irrigation in three paddocks up gradient of this bore, the nitrate-N reduced to a minimum of 9.4 g/m^3 in April 2022 before increasing again. Analysis of the irrigation data provided during the year under review found that there continued to be a reduced nitrogen load applied to the paddock in which this bore is located. Following a review of the groundwater data a decision was made by the Company that, as the nitrate concentrations in this bore had reduced to a level that was below the control bore, this mitigation measure was no longer necessary. The irrigation loading applied to paddocks 14A and 14B were similar to the average load from a mm/year equivalent, but were above average in terms of kg/ha/y. It is noted that the annual median nitrate nitrogen concentration for GND0638 during the year under review (13.0 g/m^3) was above the historical median for this monitoring site (9.8g/m^3), and therefore a further reduction is still desirable.

Review of the paddock by paddock irrigation data in the time period preceding the groundwater surveys indicated that on a number of occasions (GND0636 on 4 April 2022, GND0250 on 21 December 2021, GND2051 on 15 February 2022, GND0700 and GND0640 on 10 August 2021 and 15 February 2022,) short term increases in the groundwater nitrate-N concentration was likely to have been influenced, to some degree, by preceding irrigation events.

Groundwater data indicated that another contributing effect at some of the bores, on occasion, (GND0637 on 10 August 2021 and 16 June 2022, GND2051 on 15 February 2022, GND0700 and GND0640 on 10 August 2021 and 15 February 2022), was the “collecting” of any subsurface nitrate-N in the soil in the groundwater levels as it rises after rainfall.

The nitrate-N at GND0636 and GND2063 varied inversely with respect to groundwater levels. This would indicate minor effects from localised irrigation of wastewater. This is also supported by the notable increases in chloride and alkalinity in this bore at sampling surveys that followed irrigation events in the up gradient paddock.

In the case of the sample collected from GND0640 on 15 February 2022, the result obtained was the highest on record for this bore. The Company was therefore asked to investigate the reasons for this change, as per consent 0923-3.3 and the WFMP. The results of the initial investigation found that a combination of high soil moistures, pugging and stock urination in the paddock the prior to the irrigation event and a wastewater irrigation event were all contributing factors. This event shows the importance of ensuring that effects caused by stock management practices do not increase the potential for effects from the wastewater irrigation activities.

As discussed in Section 2.1.5.4, there are no known shallow groundwater water users in the immediate vicinity of the spray irrigation area, because of the availability and usage of the Waimate West Rural Water Supply Scheme. However, the Regional Freshwater Plan for Taranaki (2001) does provide for the taking and use of groundwater at a scale that would enable reasonable farm use as a permitted activity. GWR Policy 4 of the Regional Freshwater Plan for Taranaki (2010) also states that groundwater quality will be maintained and enhanced by promoting land use practices that minimise, as far as practicable, the potential adverse effects on groundwater quality. In the 2019-2020 Annual Report it was stated that consideration should therefore be given to changes that could be made to the management of the wastewater irrigation management to reduce the nitrate concentration, initially, at least in the bores that are on the boundary of the site, or that are close to waterways. During the year under review the Company continued to track the nitrogen loadings applied to the irrigation areas from all sources.

At the end of the year under review, the Council was advised that the Company was reviewing practices to improve the management of nutrients at the site. A change that was made from the start of the 2022-2023 year was to ensure that the site would require the quality of the raw materials from the other Fonterra sites be improved to reduce the CIP requirements. Further changes were being investigated in terms of options such as changes in CIP chemicals, recovery of the CIP material, and available technologies to treat the wastewater from the site to reduce the nutrient content of the irrigated factory wastewater.

Biological monitoring

Biological surveys found no significant adverse effects on the stream communities of Kaupokonui Stream in relation to the discharges from the factory site and the presence of the weir, or in the Kaupokonui Stream, Dunns Creek, Motumate and Waiokura Streams in relation to land irrigation of wastewaters.

Fish passage

Following the 2022 fish survey and associated evaluation of the fish passage, overall, it was considered that the activities of the Kapuni Lactose factory were not having a significant adverse effect on the fish communities of the Kaupokonui Stream. However, due to fugitive attractant flows and a lack of a deeper channel catering to larger fish, it is likely that there was currently incomplete passage provision, but that would be challenging to confirm in practice. In general these survey results are unlikely to effectively portray these issues due to the survey methodologies' own limitations. As the riparian planting of the catchment matures, and effects of the passage remediation works at the Glenn Road weir become evident, the diversity and abundance of fish in this stretch of stream will likely improve.

A more comprehensive assessment of the weir and thermal effects of the cooling operation will be required as the stream values increase, and a shift to annual monitoring is recommended as opposed to the current three yearly survey in order to detect the expected changes. It is worthwhile delaying any remedial works until further information can be collected with respect to the changing fish community from the removal of the weir which would be used to inform remediation options. However, it is also important to recognise that

there is a possibility of potentially significant effects through the lack of fish passage and thermal effects, so remediation may need to be undertaken promptly to ensure compliance.

General maintenance of the current fish pass (replacing loose or missing rocks, ensure base is not undercut, surface kept clear of debris etc.) should be carried out in the meantime, as well as potentially positioning large boulders near the top of the fish pass to provide protection from predation for small fish.

Discharges to air

With respect to the Company's discharges to air, the results of the emissions monitoring undertaken on the flash dryer was again well below consent limit of 125 mg/dsm^3 that applies to this discharge only. The Company voluntarily monitors the particulate emissions from the other three stacks. Two of the three average particulate emission rates during the year under review were below the 125 mg/dsm^3 limit that applies to the flash dryer, with the supertab south dryer emission rate being above this at 167 mg/dsm^3.

The lactose deposition rates recorded were above their respective historical medians at AIR002302, AIR002304, and AIR002305, but were below the historical median at sites AIR002301 and AIR002303. It appears that there is an emerging trend of increasing lactose deposition rates at sites AIR002301, and AIR002302, which is supported by increasing 5 year rolling medians for these monitoring locations. The deposition rates did not exceed the guideline value during the year under review. It must be borne in mind that this is a guideline only and the particulate deposition rate is not limited by the Company's consent. No complaints were received by Council in relation to deposited particulates and inspections found no evidence of depositions. No odours were noted off site during the year under review.

3.3 Evaluation of performance

A tabular summary of the consent holder's compliance record for the year under review is set out in Table 51 to Table 67.

Table 51 Summary of performance for Consent 0302-3

Purpose: ***To take and use up to 19,500 m^3 /day (225 L/s) of water from the Kaupokonui Stream for cooling and general purposes associated with lactose manufacturing***		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
1. Undertake ecological monitoring	Biomonitoring surveys	Yes
2. Record daily rates of abstraction	Records received from the Company	Abstraction rate under reported in July, August and September
3. Review of consent conditions	No further provision for review prior to expiry	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		**High**
Overall assessment of administrative performance in respect of this consent		**Good**

N/A = not applicable

Table 52 Summary of performance for Consent 0919-3

Purpose: *To discharge up to 19,500 m^3/day of cooling water from a lactose manufacturing plant via an outfall, cooling tower and/or spray system into the Kaupokonui Stream*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
1. Physicochemical and ecological monitoring of wastes and stream	Collection of samples and review of Company supplied data	Yes
2. Prohibited effects on receiving water	Site inspections, collection of samples, biological surveys	Yes
3. Limits on BOD level in receiving water	Collection of samples	Yes
4. Limits on temperature increase of receiving water	Temperature information supplied by the Company	Yes
5. Limit on downstream temperature of receiving water	Temperature data supplied by the Company and parallel temperature monitoring	Yes
6. Continuous monitoring of temperature of receiving water required	Temperature information supplied by the Company	Yes
7. Review of conditions 4 and 5	No further provision for review	N/A
8. No thermal barrier or growths as a result of discharge within the mixing zone	Temperature information, site inspections	Yes
9. No anti-corrosion agents, biocides, anti-flocculants or other chemicals added to cooling water	Site inspections, sample collection	Yes
10. Maintenance of riparian zone and annual donation to Taranaki Tree Trust	Site inspections. Review of contributions paid to Council	Not invoiced for during the year under review
11. Review of consent conditions	No further provision for review prior to expiry	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		**High**
Overall assessment of administrative performance in respect of this consent		**High**

N/A = not applicable

Table 53 Summary of performance for agreed monitoring additional to consent 0919-3

Purpose: *Additional monitoring proposed by the Company that allowed the notice of review to be withdrawn in August 2014*		
Agreed monitoring	**Means of monitoring during period under review**	**Agreed monitoring standards met**
1. Installation and maintenance of a tamper-proof recording device measuring cooling water discharge rate and flow to	Issues resolved September 2019. Review of Company provided data	Yes

Purpose: *Additional monitoring proposed by the Company that allowed the notice of review to be withdrawn in August 2014*		
Agreed monitoring	**Means of monitoring during period under review**	**Agreed monitoring standards met**
accuracy of ± 5% by 31 August 2015		
2. Installation and maintenance of a tamper proof data logger recording cooling water discharge rate and flow at 15 minute intervals (NZST) by 31 August 2015	Issues resolved September 2019. Review of Company provided data	Yes
3. Provision document from qualified person certifying installation and maintenance is as per manufacturers' instructions, and is operating to an accuracy of ± 5% within 30 days, and at Council's request	As found and after re-installation calibration data and certification will be required to meet the intent of this agreed monitoring standard. . Review of Company provided data	Yes
4. Flow recording devices accessible to Council for inspection, data retrieval and verification of accuracy	Inspection and review of Company provided data	Yes
5. By 31 August 2015, agreed measurements to be transmitted to Council to maintain a real time record in a format suitable for auditing and registering "zero" when no discharge occurring	Issues resolved September 2019. Review of Company provided data	Yes
Overall assessment of consent compliance and environmental performance in respect of this agreement		**High**
Overall assessment of administrative performance in respect of this agreement		**High**

N/A = not applicable

Table 54 Summary of performance for Consent 0920-3

Purpose: *To take up to 700 m^3/day from a bore in the Kaupokonui catchment for factory cooling water using plate heat exchangers*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
1. Records of abstractions kept and supplied to Council	Records received – consent not exercised during monitoring period	Yes
2. Access to bore to be provided		Yes
3. Review of consent conditions	No further provision for review prior to expiry	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		**High**
Overall assessment of administrative performance in respect of this consent		**High**

N/A = not applicable

Table 55 Summary of performance for Consent 0921-3

Purpose: *To discharge up to 850 m^3/day of cooling water from plate heat exchangers and plant cooling system into an unnamed tributary of the Motumate Stream at two different locations*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
1. Effects discharge must not have on receiving water below mixing zone	Site inspections – consent not exercised during monitoring period	N/A
2. Consent holder to monitor daily volume, temperature of discharge	Consent not exercised during monitoring period	N/A
3. Review of consent conditions	No further provision for review	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		**N/A**
Overall assessment of administrative performance in respect of this consent		**N/A**

N/A = not applicable

Table 56 Summary of performance for Consent 0922-3.2

Purpose: *To discharge combined dairy effluent and factory wastewater (evaporator condensate, washings, processing wastes and stormwater) from a lactose manufacturing plant by spray irrigation onto and into land*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
1. Maintenance of effluent spray irrigation plan, with specific matters to be covered in plan	Whole farm plan provided dated March 2021	Yes
2. Limit on maximum two day volumes	Records received	Yes
3. Consent exercised in accordance with procedures set out in effluent spray irrigation plan	Site and farm inspections	Yes
4. Provision for initiation of spray irrigation plan review, with plan reviewed plan by 1 July each year or upon two months' notice by Council	Plan reviewed and updated March 2021	Yes
5. Operation of spray irrigation plan, staff training	Site and farm inspections	Yes
6. No direct discharges of effluent into any watercourse	Farm inspections	Yes
7. No ponding	Farm inspections	Yes
8. 20 m 'buffer zone' to watercourse	Farm inspections	Yes
9. Records available to Council on request of effluent produced, volume irrigated, area and hours pumped	Records viewed at inspection. Volumes irrigated daily provided to Council	Yes

Purpose: *To discharge combined dairy effluent and factory wastewater (evaporator condensate, washings, processing wastes and stormwater) from a lactose manufacturing plant by spray irrigation onto and into land*		
10. Review of consent conditions	No further provision for review prior to expiry	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		**High**
Overall assessment of administrative performance in respect of this consent		**High**

N/A = not applicable

Table 57 Summary of performance for Consent 0923-3.3

Purpose: *To discharge combined dairy effluent and factory wastewater (evaporator condensate, washings, processing wastes and stormwater) from a lactose manufacturing plant by spray irrigation onto and into land*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
1. Consent holder to adopt BPO to prevent or minimise adverse effects	Site and farm inspections, review of Company data, receiving environment monitoring	New maximum nitrate-N recorded for GND0640
2. Maintenance of effluent spray irrigation plan	Plan reviewed and updated March 2021	Yes
3. Limit on maximum two day volumes	Records received	Yes
4. Consent exercised in accordance with procedures set out in plan	Site and farm inspections	Yes
5. Provision for initiation of spray irrigation plan review, with plan reviewed plan by 1 July each year and upon two months' notice by Council	Plan reviewed and updated March 2021	Yes
6. Operation of system in accordance with plan. Staff training	Site and farm inspections	Yes
7. No offensive or objectionable odour	Farm inspections	Yes
8. No spray drift beyond boundaries	Farm inspections	Yes
9. No direct discharge to watercourses	Farm inspections	Yes
10. No ponding	Farm inspections	Yes
11. Spray 'buffer zone' limits	Farm inspections	Yes
12. Remediation in case of contamination of groundwater or roof water supply	Review of monitoring data and liaison with Company. Management of remedial actions put in place re: nitrate-N in GND0638 continued	Contaminant concentrations decreased. Further reduction desirable
13. Installation and maintenance of monitoring bores	Farm inspections	Yes
14. Records provided to Council of effluent produced, volume irrigated, area and hours pumped	Records received	Yes

Purpose: *To discharge combined dairy effluent and factory wastewater (evaporator condensate, washings, processing wastes and stormwater) from a lactose manufacturing plant by spray irrigation onto and into land*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
15. Change of consent conditions	Not sought	N/A
16. Review of consent conditions	No further provision for review prior to expiry	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		**Good**
Overall assessment of administrative performance in respect of this consent		**Good**

N/A = not applicable

Table 58 Summary of performance for Consent 0924-3

Purpose: *To discharge up to 1,440 m³/day of stormwater and cooling water from a lactose manufacturing plant through two outfalls into the Kaupokonui Stream*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
1. Consent holder to undertake physicochemical and ecological monitoring	Consent holder and Council sampling. Old pipeline decommissioned and subsequently removed	Yes
2. Effects discharge must not have on receiving water below mixing zone	Site inspections	Yes
3. BOD of receiving water not to rise above 2 g/m^3	Samples collected	Yes
4. Temperature of receiving water not altered by more 2°C for 90% of time and not rise by more than 3°C	Consent holder data	Yes
5. Temperature of receiving water shall not increase above 25 degrees at the periphery of the mixing zone	Council data logger information, temperature information supplied by the Company. Parallel temperature monitoring	Yes
6. Consent holder to constantly monitor the temperature of the receiving waters	Consent holder maintains temperature probes instream, data forwarded to Council	Yes, with minor loss of record
7. Review of consent in June 2001 to evaluate performance of cooling system		N/A
8. Limits upon levels of contaminants in discharge	Sample collection	Yes
9. Discharge not to create barrier for fish, or undesirable growths within the mixing zone	Site inspections	Yes
10. No anti-corrosion agents, biocides, anti-flocculants or other chemicals added to cooling water	Site inspections, sample collection	Yes

Purpose: *To discharge up to 1,440 m³/day of stormwater and cooling water from a lactose manufacturing plant through two outfalls into the Kaupokonui Stream*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
11. Maintenance of contingency plan. Review and update (if required) annually	Review of Council records. Contained in Stormwater Management Plan. Latest plan on record April 2021	Yes
12. Review of consent conditions	No further provision for review prior to expiry	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		**High**
Overall assessment of administrative performance in respect of this consent		**High**

*The consent specifies an average daily limit- ie a composite sample

N/A = not applicable

Table 59 Summary of performance for Consent 4032-5

Purpose: *To discharge emissions to the air from the manufacture, drying, packaging and storage of lactose and associated processes and from the inhalation grade lactose plant*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
1. Consent holder to adopt BPO to prevent or minimise emissions	Site inspections	Yes
2. Consent holder to fulfil obligations under the RMA	Site inspections	Yes
3. Limits of particulate from wet scrubber	Stack testing in October 2020	Yes
4. No alterations to plant or processes without prior consultation with Council	Site inspections	Yes
5. Discharge not to result in dangerous levels of airborne contaminants at or beyond the boundary	Not monitored during period under review	N/A
6. Discharge not to result in offensive or objectionable dust or odour at or beyond boundary	Site inspections	Yes
7. Change or cancellation of conditions		N/A
8. Discharge not to result in noxious or toxic levels of airborne contaminants at or beyond boundary	Not monitored during period under review	N/A
9. Review of consent conditions	No further provision for review prior to expiry	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		**High**
Overall assessment of administrative performance in respect of this consent		**High**

N/A = not applicable

Table 60 Summary of performance for Consent 4604-2

Purpose: *To discharge up to 280 L/s of stormwater from the factory extension site via a 525 mm diameter pipe into the Kaupokonui Stream*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
1. Effects which must not arise below the 50 m mixing zone	Site inspections, samples, biomonitoring	Yes
2. Limits on oil & grease, pH and suspended solids in discharge	Sample collection	Yes
3. Contingency planning	Review of Council records. Contained in Stormwater Management Plan. Latest plan on record April 2021	Yes
4. Review of consent conditions	No further provision for review prior to expiry	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		**High**
Overall assessment of administrative performance in respect of this consent		**High**

N/A = not applicable

Table 61 Summary of performance for Consent 4623-3

Purpose: *To use a weir in the bed of the Kaupokonui Stream, and to dam water for water supply purposes*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
1. States consent is for on-going use of existing structure. Changes to the structure may need further authorisation under RMA	Inspection. No changes found	N/A
2. Structure to be maintained so it is safe and functions effectively	Inspection. Minor fugitive flows found at the weir. To be addressed along with any fish pass improvements that may be needed following the removal of the Glenn Road weir	Yes
3. Required prior notice of commencement of maintenance work	Inspection, no works found or notified during the period under review	N/A
4. The weir shall not restrict the passage of fish	Inspection and fish survey	Yes
Overall assessment of consent compliance and environmental performance in respect of this consent		**High**
Overall assessment of administrative performance in respect of this consent		**High**

N/A = not applicable

Table 62 Summary of performance for Consent 6423-1

Purpose: *To discharge stormwater from an inhalation grade lactose plant site into the Kaupokonui Stream*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
1. Contingency planning	Review of Council records. Contained in Stormwater Management Plan. Latest plan on record April 2021	Yes
2. Exercise of consent in accordance with application	Site inspections	Yes
3. Best practicable option to minimise environmental impacts	Site inspections	Yes
4. Limits on pH, suspended solids and hydrocarbons in the discharge	Sample collection	Yes
5. Effects which must not arise below the 50 mixing zone	Site inspections, stream sample collection, biomonitoring	Yes
6. Lapse of consent		N/A
7. Review of consent conditions	No further provision for review prior to expiry	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		**High**
Overall assessment of administrative performance in respect of this consent		**High**

N/A = not applicable

Table 63 Summary of performance of Consent 6948-1

Purpose: *To erect, place, maintain and use pipeline crossings over the Motumate and Waiokura Streams, for the purposes of conveying irrigation wastewater*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
1. Best practicable option on adverse effects	Inspection by Council	Yes
2. Exercise in accordance with application	Inspection by Council	Yes
3. Notification prior to installation		N/A
4. Best practicable option to minimise contaminant discharge	Inspection by Council	Yes
5. Minimise disturbance of riverbed	Inspection by Council	Yes
6. Works resulting in downstream discolouration to be undertaken between November and April	Inspection by Council	Yes
7. Reinstatement of structure when no longer required		N/A
8. Lapse of consent		N/A
9. Review of consent conditions	No further opportunities for review	N/A

Purpose: *To erect, place, maintain and use pipeline crossings over the Motumate and Waiokura Streams, for the purposes of conveying irrigation wastewater*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
Overall assessment of consent compliance and environmental performance in respect of this consent		**High**
Overall assessment of administrative performance in respect of this consent		**High**

N/A = not applicable

Table 64 Summary of performance of Consent 9546-1

Purpose: *To install a dual culvert in the Waiokura Stream, including the associated streambed and reclamation*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
1. Notification prior to commencement of works	Liaison with Council. Work last undertaken June 2013	N/A
2. Culverts dimensions defined		N/A
3. Maximum depth of fill over culverts		N/A
4. Shaping of stream banks		N/A
5. Placement of rock rip-rap on upstream and downstream batters		N/A
6. Gradient of rock rip-rap in condition 5		N/A
7. Thickness of rock rip-rap on fill batters		N/A
8. Gradient of rock rip-rap in condition 7		N/A
9. Separation of concrete work from stream		N/A
10. Minimum period for curing of concrete in channel		N/A
11. No instream works between 1 June and 31 October	No maintenance undertaken during review period	N/A
12. Streambed disturbance minimised and reinstated		N/A
13. Fish passage not to be restricted	Inspection by Council	Yes
14. Pipes invert depth set		N/A
15. Gradient of culvert pipes not to exceed that of natural stream bed		N/A

Purpose: *To install a dual culvert in the Waiokura Stream, including the associated streambed and reclamation*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
16. Minimisation and mitigation of sediment discharged to stream	No maintenance undertaken during review period	N/A
17. Earthworks stabilisation to be as soon as practicable		N/A
18. Prevention of blockage and erosion responsibility of consent holder	Inspection by Council. No erosion or scour occurring	Yes
19. Procedure on discovery of archaeological remains		N/A
20. Removal of structure when no longer required		N/A
21. Lapse of consent on 20 June 2018 if not exercised	Consent exercised	N/A
22. Optional review provision for environmental effects	Next review date available 1 June 2023 (Recommendation not to be exercised – see Sections 3.6 and 4)	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		**High**
Overall assessment of administrative performance in respect of this consent		**High**

N/A = not applicable

Table 65 Summary of performance of Consent 10214-1

Purpose: *To discharge solid farm dairy effluent onto and into land*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
1. Effluent and farm dairy definition		N/A
2. Maximum volume of discharge		N/A
3. Notification upon volume exceedance	Check of Council records. No notifications received	N/A
4. Best practicable option on adverse effects	No disposals observed at inspection but no evidence of effects found	N/A
5. Diversion of stormwater		N/A
6. Maintenance of buffer distances	No disposals observed at inspection	N/A
7. Limit on Nitrogen application rate	Not assessed	N/A
8. Keeping of records	Not assessed	N/A

Purpose: *To discharge solid farm dairy effluent onto and into land*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
9. Actions following unauthorised discharge	No effects observed at inspection	N/A
10. Optional review provision for environmental effects	Next review date available 1 June 2023. (Recommendation not to be exercised – see Sections 3.6 and 4)	N/A
11. Optional review provision for Regional Plan		N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		**N/A**
Overall assessment of administrative performance in respect of this consent		**N/A**

N/A = not applicable

Table 66 Summary of performance of Consent 10232-1

Purpose: *To discharge pond sludge from farm dairy effluent onto and into land*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
1. Effluent and farm dairy definition		N/A
2. Maximum volume of discharge	Checking of records. No information provided to Council	N/A
3. Notification upon volume exceedance	Checking of records. No information provided to Council	N/A
4. Best practicable option on adverse effects	No disposals observed at inspection	N/A
5. Diversion of stormwater	Assessment by Council Officers	Yes
6. Maintenance of buffer distances	No disposals observed at inspection	N/A
7. Limit on Nitrogen application rate	Not assessed	N/A
8. Keeping of records	Not assessed	N/A
9. Actions following unauthorised discharge	Check of Council records for notifications received by Council. No notifications received	N/A
10. Optional review provision for environmental effects	Next review date available 1 June 2023. (Recommendation not to be exercised – see Sections 3.6 and 4)	N/A
11. Optional review provision for Regional Plan		N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		**High**
Overall assessment of administrative performance in respect of this consent		**High**

N/A = not applicable

Table 67 Summary of performance of Consent 10412-1

Purpose: *To install a dual culvert in the Waiokura Stream, including the associated disturbance of the stream bed*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
1. Specifies culvert dimensions		N/A
2. Specifies depth of fill over		N/A
3. Notification required 2 days prior to commencement of works	Checking of records and observation at inspection. Works not started	N/A
4. Prohibits work on under water stream bed between 1 May and 31 October		N/A
5. All practicable steps to be taken to minimise streambed disturbance and effects, including specified measures		N/A
6. Gives rock riprap requirements including dimensions, batter and rock grading		N/A
7. Prohibits the restriction of fish passage		N/A
8. Specifies culvert invert		N/A
9. Specifies culvert gradient requirements		N/A
10. Specifies requirements for upstream and downstream stream banks		N/A
11. Specifies culvert maintenance requirements		N/A
12. Notification requirements if archaeological remains are found		N/A
13. Consent lases 31 March 2022 if not given effect to	Inspection, check of Council records and liaison with the Company	Consent not given effect to and therefore has lapsed
14. Provisions for review of consent conditions		N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		**N/A**
Overall assessment of administrative performance in respect of this consent		**N/A**

N/A = not applicable

During the year, the Company generally demonstrated a high level of environmental and high level of administrative performance with the resource consents as defined in Appendix II. However, an improvement is required in the management of the Company's activities in relation to the discharge of wastewater to land on Farms 2 and 3. The concentrations of nitrate-N in one of the groundwater monitoring bores, returned an annual median that was above the drinking water standard. The Company continued to manage the use of the mitigation measures, identified in the 2020-2021 year due to the increased nitrate nitrogen in GND0638. Although a significant reduction has been achieved, further improvement is still desirable in the groundwater quality in the vicinity of this bore. A combination of farm management practices and wastewater irrigation resulted in a new maximum concentration being found at a monitoring bore on Farm 3 that was more than twice the drinking water standard on one occasion. The Company is reviewing the management of nutrients at the site and investigating options for wastewater treatment.

3.4 Recommendations from the 2020-2021 Annual Report

In the 2020-2021 Annual Report, it was recommended:

1. THAT in the first instance, monitoring of consented activities at the Company's Kapuni site in the 2021-2022 year, be amended from that undertaken in the 2020-2021 year by a reduction in the number of site inspections and Kaupokonui Stream samples to six per year with provision for additional inspections should these be required.
2. THAT paddock by paddock discharge to land information be requested from the Company from the start of the 2021-2022 year.
3. THAT macroinvertebrate monitoring sites be introduced in Dunns Creek from the 2021-2022 year onwards to monitor potential impacts of the Company's irrigation of wastewater to land on Farm 1.
4. THAT monitoring of potential barriers to fish passage as a result of the Company's activities following the removal of the Glenn Road weir be carried out by the inclusion of an electric fishing survey and provision for two spotlighting surveys in the 2021-2022 year.
5. THAT consultation occur between the Council and the consent holder during the 2021-2022 year to establish what improvements may need to be made to the weir to rectify identified issues, and what improvements need to be made to the fish passage to address both the current potential issues and those likely to occur following the removal of the Glenn Road weir.
6. THAT should there be issues with environmental or administrative performance in 2021-2022, monitoring may be adjusted to reflect any additional investigation or intervention as found necessary.
7. THAT the Company investigate the reason for the elevated nitrate nitrogen concentrations in the Farm 2 and Farm 3 control bores.
8. THAT the Company investigate the environmental significance of the discrepancy between the sum of anions and sum of cations in the irrigated wastewater.

Recommendations 1, 2, 3, 4 and 5 were implemented. With respect to recommendation 5, it is noted that the fish communities are continuing to re-establish following the removal of the Glenn Road weir and therefore consultation is likely to be on-going in the 2022-2023 year. Recommendation 6 did not require implementation. In relation to recommendation 7, a report has previously been provide detailing a theoretical explanation for these elevated levels, however the Council considered that the matter still needs to be further investigated. No information was received from Fonterra regarding investigations related to recommendation 9 during the year under review.

3.5 Alterations to monitoring programmes for 2022-2023

In designing and implementing the monitoring programmes for air/water discharges in the region, the Council has taken into account:

- the extent of information already made available through monitoring or other means to date;
- its relevance under the RMA;
- the Council's obligations to monitor consented activities and their effects under the RMA;
- the record of administrative and environmental performances of the consent holder; and
- reporting to the regional community.

The Council also takes into account the scope of assessments required at the time of renewal of permits, and the need to maintain a sound understanding of industrial processes within Taranaki exercising resource consents.

It is proposed that for 2022-2023, the monitoring remains unchanged.

It should be noted that the proposed programme represents a reasonable and risk-based level of monitoring for the site in question. The Council reserves the right to subsequently adjust the programme from that initially prepared, should the need arise if potential or actual non-compliance is determined at any time during 2022-2023, a change is made to the activities taking place, or a change is made to any of the consents in place for those activities.

3.6 Exercise of optional review of consent

Resource consents 10214-1.0, 10232-1.0, and 9546-1 each provide for an optional review of the consent in June 2023. Conditions 10, 10, and 22 respectively allow the Council to review the consent, if there are grounds, for the purpose of ensuring that the conditions are adequate to deal with any adverse effects on the environment arising from the exercise of this resource consent, which were either not foreseen at the time the application was considered or which it was not appropriate to deal with at the time that (note to author-note the grounds for review that are set out in the consent.

Based on the results of monitoring in the year under review, and in previous years as set out in earlier annual compliance monitoring reports, it is considered that there are no grounds that require any of the reviews to be pursued.

4 Recommendations

1. THAT in the first instance, monitoring of consented activities at the Company's Kapuni site in the 2022-2023 year, continue at the same level as in 2021-2022.
2. THAT consultation continue between the Council and the consent holder during the 2022-2023 year to establish what improvements may need to be made to the weir to rectify identified issues, and what improvements need to be made to the fish passage to address both the current potential issues and those likely to occur following the removal of the Glenn Road weir.
3. THAT the option for a review of resource consents 10214-1.0, 10232-1.0, and 9546-1 in June 2023, as set out in condition 10, 10, and 22 of the consents, not be exercised, on the grounds that the current conditions of the consent are adequate.
4. THAT consent 10412-1.0 be removed from the 2022-2023 monitoring programme as this consent lapsed on 31 March 2022.
5. THAT should there be issues with environmental or administrative performance in 2022-2023, monitoring may be adjusted to reflect any additional investigation or intervention as found necessary.
6. THAT the Company investigate the reason for the elevated nitrate nitrogen concentrations in the Farm 2 and Farm 3 control bores.
7. THAT the Company investigate the environmental significance of the discrepancy between the sum of anions and sum of cations in the irrigated wastewater.

Glossary of common terms and abbreviations

The following abbreviations and terms may be used within this report:

Biomonitoring	Assessing the health of the environment using aquatic organisms.
BOD	Biochemical oxygen demand. A measure of the presence of degradable organic matter, taking into account the biological conversion of ammonia to nitrate.
BODF	Biochemical oxygen demand of a filtered sample.
Bund	A wall around a tank to contain its contents in the case of a leak.
Cl	Chloride.
COD	Chemical oxygen demand. A measure of the oxygen required to oxidise all matter in a sample by chemical reaction.
Condy	Conductivity, an indication of the level of dissolved salts in a sample, usually measured at 25˚C and expressed in mS/m or µS/cm.
DSE	Dairy shed effluent.
Fresh	Elevated flow in a stream, such as after heavy rainfall.
g/m^3	Grams per cubic metre, and equivalent to milligrams per litre (mg/L). In water, this is also equivalent to parts per million (ppm), but the same does not apply to gaseous mixtures.
Ha	Hectare. A unit of land area.
Incident	An event that is alleged or is found to have occurred that may have actual or potential environmental consequences or may involve non-compliance with a consent or rule in a regional plan. Registration of an incident by the Council does not automatically mean such an outcome had actually occurred.
Intervention	Action/s taken by Council to instruct or direct actions be taken to avoid or reduce the likelihood of an incident occurring.
Investigation	Action taken by Council to establish what were the circumstances/events surrounding an incident including any allegations of an incident.
K	Potassium.
kg/ha/y	Kilograms per hectare per year.
kg/hr	Kilograms per hour.
L/s	Litres per second.
m^3	Cubic metres, a measure of volume.
MALF	Mean annual low flow. A statistic that describes the average amount of water in a river during times of low flow.
MCI	Macroinvertebrate community index; a numerical indication of the state of biological life in a stream that takes into account the sensitivity of the taxa present to organic pollution in stony habitats.
Mg	Magnesium.
mg/dsm^3	Milligrams per cubic meter as measured at (or converted to) 0˚C and 1 atmosphere of pressure.

$mg/m^2/day$	Milligrams per square meter per day.
mS/m	Millisiemens per metre.
Mixing zone	The zone below a discharge point where the discharge is not fully mixed with the receiving environment. For a stream, conventionally taken as a length equivalent to 7 times the width of the stream at the discharge point.
Na	Sodium.
NH_4	Ammonium, normally expressed in terms of the mass of nitrogen (N).
NH_3	Unionised ammonia.
NO_2	Nitrite, normally expressed in terms of the mass of nitrogen (N).
NO_3	Nitrate, normally expressed in terms of the mass of nitrogen (N).
NTU	Nephelometric Turbidity Unit, a measure of the turbidity of water.
O&G	Oil and grease, defined as anything that will dissolve into a particular organic solvent (e.g. hexane). May include both animal material (fats) and mineral matter (hydrocarbons).
pH	A numerical system for measuring acidity in solutions, with 7 as neutral. Numbers lower than 7 are increasingly acidic and higher than 7 are increasingly alkaline. The scale is logarithmic i.e. a change of 1 represents a ten-fold change in strength. For example, a pH of 4 is ten times more acidic than a pH of 5.
Physicochemical	Measurement of both physical properties (e.g. temperature, clarity, density) and chemical determinants (e.g. metals and nutrients) to characterise the state of the environment.
Resource consent	Refer Section 87 of the RMA. Resource consents include land use consents (refer Sections 9 and 13 of the RMA), coastal permits (Sections 12, 14 and 15), water permits (Section 14) and discharge permits (Section 15).
RMA	Resource Management Act 1991 and including all subsequent amendments.
SAR	Sodium adsorption ratio is a ratio of the concentration of sodium ions to the concentration of calcium plus magnesium ions. It is used to assess the likelihood that the amount of sodium present in irrigation water will cause permeability problems. An SAR greater than 10 to 15 can cause permeability problems in some soil types.
SIMP	Spray irrigation management plan.
SS	Suspended solids.
Temp	Temperature, measured in ˚C (degrees Celsius).
t/hr	Tonnes per hour.
TKN	Total Kjeldahl Nitrogen. A measure of the total concentration of organic nitrogen and ammonia, normally expressed in terms of the mass of nitrogen (N).
Turb	Turbidity, expressed in NTU.
UI	Unauthorised Incident.

For further information on analytical methods, contact an Environment Quality Manager.

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Appendix I

Resource consents held by Fonterra Limited

(For a copy of the signed resource consent
please contact the TRC Consents department)

Water abstraction permits

Section 14 of the RMA stipulates that no person may take, use, dam or divert any water, unless the activity is expressly allowed for by a resource consent or a rule in a regional plan, or it falls within some particular categories set out in Section 14. Permits authorising the abstraction of water are issued by the Council under Section 87(d) of the RMA.

Water discharge permits

Section 15(1)(a) of the RMA stipulates that no person may discharge any contaminant into water, unless the activity is expressly allowed for by a resource consent or a rule in a regional plan, or by national regulations. Permits authorising discharges to water are issued by the Council under Section 87(e) of the RMA.

Air discharge permits

Section 15(1)(c) of the RMA stipulates that no person may discharge any contaminant from any industrial or trade premises into air, unless the activity is expressly allowed for by a resource consent, a rule in a regional plan, or by national regulations. Permits authorising discharges to air are issued by the Council under Section 87(e) of the RMA.

Discharges of wastes to land

Sections 15(1)(b) and (d) of the RMA stipulate that no person may discharge any contaminant onto land if it may then enter water, or from any industrial or trade premises onto land under any circumstances, unless the activity is expressly allowed for by a resource consent, a rule in a regional plan, or by national regulations. Permits authorising the discharge of wastes to land are issued by the Council under Section 87(e) of the RMA.

Land use permits

Section 13(1)(a) of the RMA stipulates that no person may in relation to the bed of any lake or river use, erect, reconstruct, place, alter, extend, remove, or demolish any structure or part of any structure in, on, under, or over the bed, unless the activity is expressly allowed for by a resource consent, a rule in a regional plan, or by national regulations. Land use permits are issued by the Council under Section 87(a) of the RMA.

Coastal permits

Section 12(1)(b) of the RMA stipulates that no person may erect, reconstruct, place, alter, extend, remove, or demolish any structure that is fixed in, on, under, or over any foreshore or seabed, unless the activity is expressly allowed for by a resource consent, a rule in a regional plan, or by national regulations. Coastal permits are issued by the Council under Section 87(c) of the RMA.

Water Permit

Pursuant to the Resource Management Act 1991
a resource consent is hereby granted by the
Taranaki Regional Council

Name of Consent Holder:	Fonterra Limited PO Box 424 Hawera 4640
Decision Date:	9 June 1999
Commencement Date:	9 June 1999

Conditions of Consent

Consent Granted:	To take and use up to 19,500 cubic metres/day [225 litres/second] of water from the Kaupokonui Stream for cooling water and general purposes associated with lactose manufacturing
Expiry Date:	1 June 2019
Site Location:	Kaupokonui Stream, Manaia Road, Kapuni Kapuni
Legal Description:	Lot 1 DP 6157 Blk XV Kaupokonui SD
Grid Reference (NZTM)	1697840E-5629660N
Catchment:	Kaupokonui

For General, Standard and Special conditions
pertaining to this consent please see reverse side of this document

General conditions

a) That on receipt of a requirement from the Chief Executive, Taranaki Regional Council (hereinafter the Chief Executive), the consent holder shall, within the time specified in the requirement, supply the information required relating to the exercise of this consent.

b) That unless it is otherwise specified in the conditions of this consent, compliance with any monitoring requirement imposed by this consent must be at the consent holder's own expense.

c) That the consent holder shall pay to the Council all required administrative charges fixed by the Council pursuant to section 36 in relation to:

i) the administration, monitoring and supervision of this consent; and
ii) charges authorised by regulations.

Special conditions

1. That the consent holder shall, in conjunction with the Taranaki Regional Council, undertake such ecological monitoring associated with the abstraction of water from the Kaupokonui Stream as deemed necessary by the Chief Executive, Taranaki Regional Council, subject to section 35(2)(d) and section 36 of the Resource Management Act 1991.

2. That the consent holder shall operate and maintain a measuring device capable of accurately recording daily rates of abstraction and shall measure, record and make such records available to the Chief Executive, Taranaki Regional Council, on a monthly basis.

3. That the Taranaki Regional Council may review any or all of the conditions of this consent by giving notice of review during the month of June 2004, June 2009 and/or June 2014, for the purpose of ensuring that the conditions are adequate to deal with any significant adverse effects on the environment arising from the exercise of this consent, which were either not foreseen at the time the application was considered or which it was not appropriate to deal with at the time.

Transferred at Stratford on 13 April 2015

For and on behalf of
Taranaki Regional Council

_____

A D McLay
Director - Resource Management

Discharge Permit

Pursuant to the Resource Management Act 1991
a resource consent is hereby granted by the
Taranaki Regional Council

Name of Consent Holder:	Fonterra Limited PO Box 424 Hawera 4640
Decision Date:	9 June 1999
Commencement Date:	9 June 1999

Conditions of Consent

Consent Granted:	To discharge up to 19,500 cubic metres/day of cooling water from a lactose manufacturing plant via an outfall, cooling tower and/or spray system into the Kaupokonui Stream
Expiry Date:	1 June 2019
Site Location:	Manaia Road Kapuni
Legal Description:	Lot 1 DP 6157 Blk XV Kaupokonui SD
Grid Reference (NZTM)	1697740E-5629660N
Catchment:	Kaupokonui

For General, Standard and Special conditions
pertaining to this consent please see reverse side of this document

General conditions

a) That on receipt of a requirement from the Chief Executive, Taranaki Regional Council (hereinafter the Chief Executive), the consent holder shall, within the time specified in the requirement, supply the information required relating to the exercise of this consent.

b) That unless it is otherwise specified in the conditions of this consent, compliance with any monitoring requirement imposed by this consent must be at the consent holder's own expense.

c) That the consent holder shall pay to the Council all required administrative charges fixed by the Council pursuant to section 36 in relation to:

i) the administration, monitoring and supervision of this consent; and
ii) charges authorised by regulations.

Special conditions

1. That the consent holder shall, in conjunction with the Taranaki Regional Council, undertake such physicochemical and ecological monitoring of the cooling water wastes, and the receiving waters (Kaupokonui Stream) as deemed necessary by the Chief Executive, Taranaki Regional Council, subject to section 35(2)(d) and section 36 of the Resource Management Act 1991.

2. That allowing for a mixing zone of 150 metres extending downstream of the periphery of the spray discharge zone, the discharge (in conjunction with any other discharges pertaining to the same site) shall not give rise to all or any of the following effects in the receiving water:

(a) the production of any conspicuous oil or grease films, scums or foams, or floatable or suspended materials;
(b) any conspicuous change in the colour or visual clarity;
(c) any emission of objectionable odour;
(d) the rendering of fresh water unsuitable for consumption by farm animals;
(e) any significant adverse effects on aquatic life, habitats, or ecology;
(f) any visible bacterial and/or fungal growths in the receiving water.

3. That the discharge (in conjunction with any other discharges pertaining to the same site) shall not raise the average daily GFC (glass fibre) filtered five day biochemical oxygen demand of the receiving water above 2 gm^{-3} when measured at a site 150 metres downstream of the periphery of the spray discharge zone.

4. That the discharge (in conjunction with any discharges pertaining to the same site) shall not:

   a) alter the ambient temperature of the receiving water by more than 2 degrees Celsius for 90% of the time that the discharge is occurring on an annual basis; and

   b) alter the ambient temperature of the receiving water by more than 3 degrees Celsius at all times;

   when measured simultaneously immediately upstream and 150 metres downstream of the periphery of the spray discharge zone.

5. That the discharge shall not increase the temperature of the receiving water above 25 degrees Celsius at the periphery of the mixing zone defined in condition 2.

6. That the consent holder shall continuously monitor the temperature of the receiving waters in compliance with conditions 4 and 5, and forward the results of this monitoring to the Chief Executive, Taranaki Regional Council, at monthly intervals.

7. That the Taranaki Regional Council may review conditions 4 and 5 of this consent in June 2001, for the purpose of evaluating the performance of the cooling system in achieving compliance with these conditions.

8. That within the designated mixing zone, and including those waters of the Kaupokonui Stream directly receiving the cooling water discharge, the discharge (in conjunction with any other discharges pertaining to the same site) shall not give rise to:

   a) a thermal barrier preventing the movement of fish species; and/or
   b) any visible bacterial and/or fungal slime growths.

9. That no anti-corrosion agents, biocides, anti-flocculants or other chemicals shall be added to the cooling water without the written permission of the Chief Executive, Taranaki Regional Council.

10. That by the agreement of the consent holder, the consent holder shall mitigate the effects of the discharge by:

    a) the maintenance of existing riparian planting; and

    b) by donating annually to the Taranaki Tree Trust $3,000 (goods and services tax exclusive) for the purpose of providing long term riparian management in the Kaupokonui Stream catchment above the discharge. The amount shall be adjusted annually according to the consumer price index, or similar index, to account for the effects of inflation.

11. That the Taranaki Regional Council may review any or all of the conditions of this consent by giving notice or review during the month of June 2004, June 2009 and/or June 2014, for the purpose of ensuring that the conditions are adequate to deal with any significant adverse effects on the environment arising from the exercise of this consent, which were either not foreseen at the time the application was considered or which it was not appropriate to deal with at the time.

Transferred at Stratford on 13 April 2015

For and on behalf of
Taranaki Regional Council

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A D McLay
Director - Resource Management

Water Permit

Pursuant to the Resource Management Act 1991
a resource consent is hereby granted by the
Taranaki Regional Council

Name of Consent Holder:	Fonterra Limited PO Box 424 Hawera 4640
Decision Date:	4 February 1999
Commencement Date:	4 February 1999

Conditions of Consent

Consent Granted:	To take up to 700 cubic metres/day of water from a bore in the Kaupokonui catchment for factory cooling water using plate heat exchangers
Expiry Date:	1 June 2017
Site Location:	Manaia Road Kapuni
Legal Description:	Lot 1 DP 6157 Blk XV Kaupokonui SD
Grid Reference (NZTM)	1697740E-5629660N
Catchment:	Kaupokonui

For General, Standard and Special conditions
pertaining to this consent please see reverse side of this document

General conditions

a) That on receipt of a requirement from the Chief Executive, Taranaki Regional Council (hereinafter the Chief Executive), the consent holder shall, within the time specified in the requirement, supply the information required relating to the exercise of this consent.

b) That unless it is otherwise specified in the conditions of this consent, compliance with any monitoring requirement imposed by this consent must be at the consent holder's own expense.

c) That the consent holder shall pay to the Council all required administrative charges fixed by the Council pursuant to section 36 in relation to:

i) the administration, monitoring and supervision of this consent; and
ii) charges authorised by regulations.

Special conditions

1. That the consent holder shall operate, to the satisfaction of the Chief Executive, Taranaki Regional Council, a measuring device capable of recording groundwater levels and daily and continuous rates of abstraction and shall make records available to the Chief Executive, Taranaki Regional Council.

2. That the consent holder shall allow the Taranaki Regional Council, its employees or agents, access to the bore at all reasonable times, for the purpose of inspecting the bore and/or taking samples of water or other material for analytical purposes.

3. That the Taranaki Regional Council may review any or all of the conditions of this consent by giving notice of review during the month of June 2005 and/or June 2011, for the purpose of ensuring that the conditions are adequate to deal with any significant adverse effects on the environment arising from the exercise of this consent, which either were not foreseen at the time the application was considered or which it was not appropriate to deal with at the time.

Transferred at Stratford on 13 April 2015

For and on behalf of
Taranaki Regional Council

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A D McLay
Director - Resource Management

Discharge Permit

Pursuant to the Resource Management Act 1991
a resource consent is hereby granted by the
Taranaki Regional Council

Name of Consent Holder:	Fonterra Limited PO Box 424 Hawera 4640
Decision Date:	4 February 1999
Commencement Date:	4 February 1999

Conditions of Consent

Consent Granted:	To discharge up to 850 cubic metres/day of cooling water from plate heat exchangers and plant cooling system into an unnamed tributary of the Motumate Stream at two different locations
Expiry Date:	1 June 2017
Site Location:	Manaia Road Kapuni
Legal Description:	Pt Sec 14 Blk XV Kaupokonui SD
Grid Reference (NZTM)	1697930E-5629670N
Catchment:	Motumate

For General, Standard and Special conditions
pertaining to this consent please see reverse side of this document

General conditions

a) That on receipt of a requirement from the Chief Executive, Taranaki Regional Council (hereinafter the Chief Executive), the consent holder shall, within the time specified in the requirement, supply the information required relating to the exercise of this consent.

b) That unless it is otherwise specified in the conditions of this consent, compliance with any monitoring requirement imposed by this consent must be at the consent holder's own expense.

c) That the consent holder shall pay to the Council all required administrative charges fixed by the Council pursuant to section 36 in relation to:

i) the administration, monitoring and supervision of this consent; and
ii) charges authorised by regulations.

Special conditions

1. That beyond a reasonable mixing zone extending to the confluence of the unnamed tributary and the Motumate Stream, the discharges shall not give rise to all or any of the following effects in the receiving water:

(i) the production of any conspicuous oil or grease films, scums or foams, or floatable or suspended materials;
(ii) any conspicuous change in the colour or visual clarity;
(iii) any emission of objectionable odour;
(iv) the rendering of freshwater unsuitable for consumption by farm animals, and;
(v) any significant adverse effects on aquatic life, habitats, or ecology.

2. That the consent holder shall monitor the daily volume and temperature of the discharge, to the satisfaction of the Chief Executive, Taranaki Regional Council, and shall make such records available to the Chief Executive, Taranaki Regional Council, on a monthly basis.

3. That the Taranaki Regional Council may review any or all of the conditions of this consent by giving notice of review during the month of June 2005 and/or June 2011, for the purpose of ensuring that the conditions are adequate to deal with any significant adverse effects on the environment arising from the exercise of this consent, which either were not foreseen at the time the application was considered or which it was not appropriate to deal with at the time.

Transferred at Stratford on 13 April 2015

For and on behalf of
Taranaki Regional Council

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A D McLay
Director - Resource Management

Discharge Permit

Pursuant to the Resource Management Act 1991
a resource consent is hereby granted by the
Taranaki Regional Council

Name of Consent Holder:	Fonterra Limited PO Box 444 Hawera 4640
Decision Date (Change):	15 July 2015
Commencement Date (Change):	15 July 2015 (Granted Date: 9 June 1999)

Conditions of Consent

Consent Granted:	To discharge combined dairy effluent and factory wastewater (evaporator condensate, washings, processing wastes and stormwater) from a lactose manufacturing plant by spray irrigation onto and into land
Expiry Date:	1 June 2019
Site Location:	893-911 Manaia Road, Kapuni
Legal Description:	Lot 1 DP 4509 Sec 1 SO 11967 Blk XV Kaupokonui SD
Grid Reference (NZTM)	1697240E-5630126N
Catchment:	Kaupokonui

For General, Standard and Special conditions
pertaining to this consent please see reverse side of this document

General conditions

a) On receipt of a requirement from the Chief Executive, Taranaki Regional Council the consent holder shall, within the time specified in the requirement, supply the information required relating to the exercise of this consent.

b) Unless it is otherwise specified in the conditions of this consent, compliance with any monitoring requirement imposed by this consent must be at the consent holder's own expense.

c) The consent holder shall pay to the Council all required administrative charges fixed by the Council pursuant to section 36 in relation to:

    i) the administration, monitoring and supervision of this consent; and
    ii) charges authorised by regulations.

Special conditions

1. The consent holder shall maintain an effluent spray irrigation management plan, to the satisfaction of the Chief Executive, Taranaki Regional Council, which shall address the following matters:

    a) control of effluent application rate;
    b) monitoring of the effluent (physicochemical);
    c) monitoring of groundwater beneath the irrigated area (physicochemical);
    d) monitoring of drainage water downslope of the irrigated area (physicochemical);
    e) monitoring of the Kaupokonui Stream (physicochemical and biological);
    f) livestock management;
    g) irrigator maintenance and rotation;
    h) farm management and operator training;
    i) contingency events;
    j) the dairy industry guidelines;
    k) riparian planting and management; and
    l) the inclusion of dairy effluent.

2. The maximum volume of discharge shall not exceed 2,630 cubic metres over two consecutive days, including a maximum 120 cubic metres per day of dairy effluent.

3. The consent shall be exercised in accordance with the procedures set out in the effluent spray irrigation management plan, and the consent holder shall subsequently adhere to and comply with the procedures, requirements, obligations and all other matters specified in the effluent spray irrigation management plan, except by the specific agreement of the Chief Executive, Taranaki Regional Council. In case of any contradiction between the effluent spray irrigation management plan and the conditions of this resource consent, the conditions of this resource consent shall prevail.

4. The spray irrigation management plan described in special condition 1 of this consent shall be subject to review upon two months' notice by either the consent holder or the Taranaki Regional Council. Further, the consent holder shall review the spray irrigation management plan annually and shall provide the reviewed plan to the Chief Executive, Taranaki Regional Council, by 1 July each year.

5. The consent holder shall ensure that:

   a) the operation of the spray irrigation system shall be carried out at all times in accordance with the requirements of the effluent spray irrigation management plan required in special condition 1 or subsequent version of that document which does not lessen environmental protection standards;

   b) all relevant site staff are to be regularly trained on the content and implementation of the effluent spray irrigation management plan, the maximum period between training sessions being 12 months. Relevant new staff are to be trained on recruitment and the training record made available to the Chief Executive, Taranaki Regional Council, upon request; and

   c) all relevant site staff are advised immediately of any revision or additions to the effluent spray irrigation management plan.

6. There shall be no direct discharge of effluent into any watercourse.

7. The spray irrigation system shall not be operated in a manner that causes ponding.

8. From the edge of the spray zone there shall be at least 20 metres to the bank of any watercourse.

9. The consent holder shall monitor and record on a daily basis the volume of effluent produced, the volume of effluent spray irrigated, the area spray irrigated and the hours the irrigation pumps are working; and shall make such records, together with groundwater monitoring data, available to the Chief Executive, Taranaki Regional Council, upon request.

10. The Taranaki Regional Council may review any or all of the conditions of this consent by giving notice of review during the month of June 2004 and/or June 2009 and/or June 2014, for the purpose of ensuring that the conditions are adequate to deal with any significant adverse effects on the environment arising from the exercise of this consent, which were either not foreseen at the time the application was considered or which it was not appropriate to deal with at the time.

Signed at Stratford on 15 July 2015

For and on behalf of
Taranaki Regional Council

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A D McLay
Director - Resource Management

Discharge Permit

Pursuant to the Resource Management Act 1991
a resource consent is hereby granted by the
Taranaki Regional Council

Name of Consent Holder:	Fonterra Limited PO Box 444 Hawera 4640
Decision Date (Change):	15 July 2015
Commencement Date (Change):	15 July 2015 (Granted Date: 9 June 1999)

Conditions of Consent

Consent Granted:	To discharge combined dairy effluent and factory wastewater (evaporator condensate, washings, processing wastes and stormwater) from a lactose manufacturing plant by spray irrigation onto and into land
Expiry Date:	1 June 2019
Site Location:	560A & 586 Manaia Road & 1319 Skeet Road, Kapuni
Legal Description:	Lot 2 DP 5897 Lots 1 & 2 6039 Lot 6 DP 2903 Lot 3 DP 3601 Blk XV Kaupokonui SD
Grid Reference (NZTM)	1697811E-5627168N
Catchment:	Waiokura Motumate

For General, Standard and Special conditions
pertaining to this consent please see reverse side of this document

General conditions

a) On receipt of a requirement from the Chief Executive, Taranaki Regional Council the consent holder shall, within the time specified in the requirement, supply the information required relating to the exercise of this consent.

b) Unless it is otherwise specified in the conditions of this consent, compliance with any monitoring requirement imposed by this consent must be at the consent holder's own expense.

c) The consent holder shall pay to the Council all required administrative charges fixed by the Council pursuant to section 36 in relation to:

    i) the administration, monitoring and supervision of this consent; and
    ii) charges authorised by regulations.

Special conditions

1. The consent holder shall at all times adopt the best practicable option, as defined in section 2 of the Resource Management Act 1991, to prevent or minimise any adverse effects on the environment from the exercise of this consent.

2. The consent holder shall maintain an effluent spray irrigation management plan, to the satisfaction of the Chief Executive, Taranaki Regional Council, which shall address the following matters:

    a) control of effluent application rate and duration;
    b) application frequency
    c) designated application areas;
    d) prevention of runoff and ponding
    e) monitoring of the effluent (physicochemical);
    f) monitoring of groundwater beneath the irrigated area (physicochemical);
    g) monitoring of drainage water downslope of the irrigated area (physicochemical);
    h) monitoring of the Waiokura and Motumate Streams (physicochemical and biological);
    i) monitoring of soils and herbage (physicochemical);
    j) minimisation and control of odour effects offsite;
    k) livestock management;
    l) soil and herbage management;
    m) irrigator maintenance and rotation;
    n) farm management and operator training;
    o) contingency events;
    p) reporting monitoring data;
    q) notification to the council of non-compliance with conditions of this consent;
    r) the dairy industry guidelines;
    s) riparian planting and management; and
    t) the inclusion of dairy effluent.

3. The maximum volume of discharge shall not exceed 3,834 cubic metres over two consecutive days, including a maximum 168 cubic metres per day of dairy effluent.

4. The consent shall be exercised in accordance with the procedures set out in the effluent spray irrigation management plan, and the consent holder shall subsequently adhere to and comply with the procedures, requirements, obligations and all other matters specified in the effluent spray irrigation management plan, except by the specific agreement of the Chief Executive, Taranaki Regional Council. In case of any contradiction between the effluent spray irrigation management plan and the conditions of this resource consent, the conditions of this resource consent shall prevail.

5. The spray irrigation management plan described in special condition 2 of this consent shall be subject to review upon two months' notice by either the consent holder or the Taranaki Regional Council. Further, the consent holder shall review the spray irrigation management plan annually and shall provide the reviewed plan to the Chief Executive, Taranaki Regional Council, by 1 July each year.

6. The consent holder shall ensure that:

   a) the operation of the spray irrigation system shall be carried out at all times in accordance with the requirements of the effluent spray irrigation management plan required in special condition 2 or subsequent version of that document which does not lessen environmental protection standards;

   b) all relevant site staff are to be regularly trained on the content and implementation of the effluent spray irrigation management plan, the maximum period between training sessions being 12 months. Relevant new staff are to be trained on recruitment and the training record made available to the Chief Executive, Taranaki Regional Council, upon request; and

   c) all relevant site staff are advised immediately of any revision or additions to the effluent spray irrigation management plan.

7. There shall be no offensive or objectionable odour as a result of the exercise of this consent at or beyond the boundary of the property or properties on which spray irrigation is occurring.

8. There shall be no spray drift as a result of the exercise of this consent at or beyond the boundary of the property or properties on which spray irrigation is occurring.

9. There shall be no direct discharge of any type of effluent into any watercourse.

10. The spray irrigation system shall not be operated in a manner that causes ponding.

11. The edge of the spray zone shall be at least:

   (a) 20 metres from the bank of any watercourse;
   (b) 10 metres from any property boundary, except as detailed in c);
   (c) 20 metres from the boundary with the property described as Lot 1 DP3601, Blk XV, Kaupokonui SD, unless the written approval of the occupier has been obtained to allow the discharge at a lesser distance.

12. Should monitoring of the discharge under conditions 13 and 14 indicate, in the opinion of the Chief Executive, Taranaki Regional Council, contamination of local groundwater or a water supply from the roof of a dwelling house as a result of the exercise of this consent the consent holder shall:

    (a) undertake appropriate remedial action as soon as practicable as described in the wastewater irrigation management plan prepared under condition 2, or other such action reasonably required by the Chief Executive, Taranaki Regional Council;

    (b) shall review the wastewater irrigation management plan and incorporate such reasonable modifications as are considered necessary by the Chief Executive, Taranaki Regional Council; and

    (c) where water supplies are significantly affected immediately provide alternative supplies as reasonably required by the Chief Executive, Taranaki Regional Council.

13. The consent holder shall site, install and maintain to the satisfaction of the Chief Executive, Taranaki Regional Council, monitoring bores for the purpose of determining groundwater quality in the vicinity of the discharge.

14. The consent holder shall monitor and record on a daily basis the volume of effluent produced, the volume of effluent spray irrigated, the area spray irrigated and the hours the irrigation pumps are working; and shall make such records, together with groundwater monitoring data, available to the Chief Executive, Taranaki Regional Council, upon request.

15. The consent holder may apply to the Taranaki Regional Council for a change or cancellation of the conditions of this consent, in accordance with section 127(1)(a) of the Resource Management Act 1991, to take into account of operational requirements, the results of monitoring, or irrigation scheme expansion.

16. The Taranaki Regional Council may review any or all of the conditions of this consent by giving notice of review during the month of June 2009 and/or June 2014, for the purpose of ensuring that the conditions are adequate to deal with any significant adverse effects on the environment arising from the exercise of this consent, which were either not foreseen at the time the application was considered or which it was not appropriate to deal with at the time.

Signed at Stratford on 15 July 2015

For and on behalf of
Taranaki Regional Council

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A D McLay
Director - Resource Management

Discharge Permit

Pursuant to the Resource Management Act 1991
a resource consent is hereby granted by the
Taranaki Regional Council

Name of Consent Holder:	Fonterra Limited PO Box 424 Hawera 4640
Decision Date:	9 June 1999
Commencement Date:	9 June 1999

Conditions of Consent

Consent Granted:	To discharge up to 1,440 cubic metres/day of stormwater and cooling water from a lactose manufacturing plant through two outfalls into the Kaupokonui Stream
Expiry Date:	1 June 2019
Site Location:	Manaia Road Kapuni
Legal Description:	Lot 1 DP 6157 Blk XV Kaupokonui SD
Grid Reference (NZTM)	1697740E-5629560N
Catchment:	Kaupokonui

For General, Standard and Special conditions
pertaining to this consent please see reverse side of this document

General conditions

a) That on receipt of a requirement from the Chief Executive, Taranaki Regional Council (hereinafter the Chief Executive), the consent holder shall, within the time specified in the requirement, supply the information required relating to the exercise of this consent.

b) That unless it is otherwise specified in the conditions of this consent, compliance with any monitoring requirement imposed by this consent must be at the consent holder's own expense.

c) That the consent holder shall pay to the Council all required administrative charges fixed by the Council pursuant to section 36 in relation to:

i) the administration, monitoring and supervision of this consent; and
ii) charges authorised by regulations.

Special conditions

1. That the consent holder shall, in conjunction with the Taranaki Regional Council, undertake such physicochemical and ecological monitoring of the stormwater and cooling water discharges, and the receiving waters (Kaupokonui Stream) as deemed necessary by the Chief Executive, Taranaki Regional Council, subject to section 35(2)(d) and section 36 of the Resource Management Act 1991.

2. That allowing for a mixing zone of 150 metres extending downstream of the periphery of the spray discharge zone, the discharge (in conjunction with any other discharges pertaining to the same site) shall not give rise to all or any of the following effects in the receiving water:

a) the production of any conspicuous oil or grease films, scums or foams, or floatable or suspended materials;

b) any conspicuous change in the colour or visual clarity;

c) any emission of objectionable odour;

d) the rendering of fresh water unsuitable for consumption by farm animals;

e) any significant adverse effects on aquatic life, habitats, or ecology;

f) any visible biological and/or fungal growths in the receiving water.

3. That the discharge (in conjunction with any other discharges pertaining to the same site) shall not raise the average daily GFC (glass fibre) filtered five day biochemical oxygen demand (BOD(5)) of the receiving water above 2 gm^{-3} when measured at a site 150 metres downstream of the periphery of the spray discharge zone.

4. That the discharge (in conjunction with any other discharges pertaining to the same site) shall not:

   a) alter the ambient temperature of the receiving water by more than 2 degrees Celsius for 90% of the time that the discharge is occurring on an annual basis; and

   b) alter the ambient temperature of the receiving water by more than 3 degrees Celsius at all times;

   when measured simultaneously immediately upstream and 150 metres downstream of the periphery of the spray discharge zone.

5. That the discharge shall not increase the temperature of the receiving water above 25 degrees Celsius at the periphery of the mixing zone defined in condition 2.

6. That the consent holder shall continuously monitor the temperature of the receiving waters in compliance with conditions 4 and 5, and forward the results of this monitoring to the Chief Executive, Taranaki Regional Council, at monthly intervals.

7. That the Taranaki Regional Council may review conditions 4 and 5 of this consent in June 2001, for the purpose of evaluating the performance of the cooling system in achieving compliance with these conditions.

8. That the discharge shall comply with the following limits at all times:

a)	oil and grease (Freon extractable)	<15 gm^{-3}
b)	pH (within the range)	6.0 - 8.5
c)	suspended solids	<100 gm^{-3}

9. That within the designated mixing zone, and including those waters of the Kaupokonui Stream directly receiving the discharge (in conjunction with any other discharges pertaining to the same site) shall not give rise to:

   i) a barrier preventing the movement of fish species and/or;
   ii) any visible bacterial and/or fungal slime growths.

10. That no anti-corrosion agents, biocides, anti-flocculants or other chemicals shall be added to the cooling water without the written permission of the Chief Executive, Taranaki Regional Council.

11. That the consent holder shall maintain a contingency plan, outlining measures and procedures to be undertaken to prevent spillage or accidental discharge of contaminants not licensed by this consent, and measures to avoid, remedy or mitigate the environmental effects of such a spillage or discharge. This contingency plan shall be reviewed and updated (if necessary) on an annual basis.

12. That the Taranaki Regional Council may review any or all of the conditions of this consent by giving notice of review during the month of June 2004, June 2009 and/or June 2014, for the purpose of ensuring that the conditions are adequate to deal with any significant adverse effects on the environment arising from the exercise of this consent, which were either not foreseen at the time the application was considered or which it was not appropriate to deal with at the time.

Transferred at Stratford on 13 April 2015

For and on behalf of
Taranaki Regional Council

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A D McLay
Director - Resource Management

Discharge Permit

Pursuant to the Resource Management Act 1991
a resource consent is hereby granted by the
Taranaki Regional Council

Name of Consent Holder:	Fonterra Limited PO Box 424 Hawera 4640
Decision Date (Change):	2 June 2004
Commencement Date (Change):	2 June 2004 (Granted Date: 17 April 2000)

Conditions of Consent

Consent Granted:	To discharge emissions into the air from the manufacture, drying, packaging and storage of lactose and associated processes and from the inhalation grade lactose plant
Expiry Date:	1 June 2019
Site Location:	Manaia Road, Kapuni
Legal Description:	Pt Lot 1 DP 6157 Lots 1-9 DP 6588 Lot 1 DP 9769 Blk XV Kaupokonui SD Lot 1 DP 4509 Sec 1 SO 11967 Blk XV Kaupokonui SD
Grid Reference (NZTM)	1697840E-5629860N

For General, Standard and Special conditions
pertaining to this consent please see reverse side of this document

General conditions

a) On receipt of a requirement from the Chief Executive, Taranaki Regional Council the consent holder shall, within the time specified in the requirement, supply the information required relating to the exercise of this consent.

b) Unless it is otherwise specified in the conditions of this consent, compliance with any monitoring requirement imposed by this consent must be at the consent holder's own expense.

c) The consent holder shall pay to the Council all required administrative charges fixed by the Council pursuant to section 36 in relation to:

   i) the administration, monitoring and supervision of this consent; and
   ii) charges authorised by regulations.

Special conditions

1. The consent holder shall adopt the best practicable option, as defined in section 2 of the Resource Management Act 1991, to prevent or minimise any emissions of particulate matter during loading, processing, unloading, packaging, drying, transport or any other site operation.

2. Nothing in these conditions shall remove from the consent holder the obligations, liabilities, duties and/or responsibilities specified in section 17 of the Resource Management Act 1991 or any other part of the Act.

3. The particulate from the wet scrubber system, which treats the exhaust streams from the pre-drier stack and the refined fluid bed drier, shall not exceed 125 milligrams per cubic metre of air, adjusted to 0 degrees Celsius, 1 atmosphere pressure and calculated as a dry gas.

4. No alteration shall be made to plant or process which may substantially change the nature or quality of contaminants emitted without prior consultation with the Chief Executive, Taranaki Regional Council.

5. The discharge shall not result in dangerous levels of airborne contaminants at or beyond the boundary of the property, including but not limited to any risk of fire or explosion.

6. The discharge shall not result in offensive or objectionable dust or odour at or beyond the boundary of the property.

7. The consent holder may apply to the Council for a change or cancellation of any of the conditions of this consent in accordance with section 127(1)(a) of the Resource Management Act 1991 to take account of operational requirements or the results of monitoring.

8. The discharge shall not result in noxious or toxic levels of airborne contaminants at or beyond the boundary of the property.

9. Subject to the provisions of this condition, the Taranaki Regional Council may in June 2004 and/or June 2009 and/or June 2014, serve notice that it intends to review any condition of the resource consent, in accordance with section 128(1)(a) of the Resource Management Act 1991, for the purpose of:

   a) dealing with any significant adverse effect on the environment arising from the exercise of this consent which was not foreseen at the time the application was considered or which it was not appropriate to deal with at the time; or

   b) further specifying the best practicable option to remove or reduce any adverse effect on the environment caused by any discharge to air; or

   c) to add limits on discharge or ambient concentration of any contaminant or contaminants.

Transferred at Stratford on 13 April 2015

For and on behalf of
Taranaki Regional Council

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A D McLay
Director - Resource Management

Discharge Permit

Pursuant to the Resource Management Act 1991
a resource consent is hereby granted by the
Taranaki Regional Council

Name of Consent Holder:	Fonterra Limited PO Box 424 Hawera 4640
Decision Date:	4 February 1999
Commencement Date:	4 February 1999

Conditions of Consent

Consent Granted:	To discharge up to 280 litres/second of stormwater from the factory extension site via a 525 mm diameter pipe into the Kaupokonui Stream
Expiry Date:	1 June 2017
Site Location:	Factory Extension Site, Manaia Road Kapuni
Legal Description:	Lot 1 DP 6157 Blk XV Kaupokonui SD
Grid Reference (NZTM)	1697740E-5629860N
Catchment:	Kaupokonui

For General, Standard and Special conditions
pertaining to this consent please see reverse side of this document

General conditions

a) That on receipt of a requirement from the Chief Executive, Taranaki Regional Council (hereinafter the Chief Executive), the consent holder shall, within the time specified in the requirement, supply the information required relating to the exercise of this consent.

b) That unless it is otherwise specified in the conditions of this consent, compliance with any monitoring requirement imposed by this consent must be at the consent holder's own expense.

c) That the consent holder shall pay to the Council all required administrative charges fixed by the Council pursuant to section 36 in relation to:

i) the administration, monitoring and supervision of this consent; and
ii) charges authorised by regulations.

Special conditions

1. That allowing for a reasonable mixing zone of 50 metres extending downstream of the discharge point, the discharge shall not give rise to all or any of the following effects in the receiving water:

(i) the production of any conspicuous oil or grease films, scums or foams, or floatable or suspended materials;
(ii) any conspicuous change in the colour or visual clarity;
(iii) any emission of objectionable odour;
(iv) the rendering of fresh water unsuitable for consumption by farm animals; and
(v) any significant adverse effects on aquatic life, habitats or ecology.

2. That the discharge shall not exceed the following parameters:

(i)	oil and grease	<15 g/m^3
(ii)	pH [within the range]	6.0 - 8.5
(iii)	suspended solids	100 gm^3

3. That prior to the exercise of this consent, the consent holder shall prepare a contingency plan to be approved by the Chief Executive, Taranaki Regional Council, outlining measures and procedures to be undertaken to prevent spillage or accidental discharge of contaminants not licensed by this consent and measures to avoid, remedy or mitigate the environmental effects of such a spillage or discharge.

4. That the Taranaki Regional Council may review any or all of the conditions of this consent by giving notice of review during the month of June 2005 and/or June 2011, for the purpose of ensuring that the conditions are adequate to deal with any significant adverse effects on the environment arising from the exercise of this consent, which either were not foreseen at the time the application was considered or which it was not appropriate to deal with at the time.

Transferred at Stratford on 13 April 2015

For and on behalf of
Taranaki Regional Council

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A D McLay
Director - Resource Management

Land Use Consent

Pursuant to the Resource Management Act 1991
a resource consent is hereby granted by the
Taranaki Regional Council

Name of Consent Holder:	Fonterra Limited PO Box 444 Hawera 4640
Decision Date:	14 December 2017
Commencement Date:	14 December 2017

Conditions of Consent

Consent Granted:	To use a weir in the bed of the Kaupokonui Stream, and to dam water for water supply purposes
Expiry Date:	1 June 2019
Site Location:	879 Manaia Road, Kapuni
Grid Reference (NZTM)	1697665E-5629707N
Catchment:	Kaupokonui

For General, Standard and Special conditions
pertaining to this consent please see reverse side of this document

General condition

a. The consent holder shall pay to the Taranaki Regional Council all the administration, monitoring and supervision costs of this consent, fixed in accordance with section 36 of the Resource Management Act 1991.

Special conditions

1. This consent authorises the ongoing use of the weir existing at the time the application for this consent was lodged, and as described in the application. Any change to the nature or scale of the structure may therefore need to be authorised by a formal process in accordance with the Resource Management Act, 1991.

2. The consent holder shall maintain the structure in a safe and sound condition such that it continues to function effectively.

3. The consent holder shall notify the Chief Executive, Taranaki Regional Council, in writing at least 48 hours prior to commencement of maintenance work that involves disturbance of, or deposition to the stream bed, or discharges to water. Notification shall include the consent number and a brief description of the activity consented and be emailed to worknotification@trc.govt.nz.

4. The weir shall not restrict the passage of fish.

Signed at Stratford on 14 December 2017

For and on behalf of
Taranaki Regional Council

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A D McLay
Director - Resource Management

Discharge Permit

Pursuant to the Resource Management Act 1991
a resource consent is hereby granted by the
Taranaki Regional Council

Name of Consent Holder:	Fonterra Limited PO Box 424 Hawera 4640
Decision Date:	13 July 2004
Commencement Date:	13 July 2004

Conditions of Consent

Consent Granted:	To discharge stormwater from an inhalation grade lactose plant site into the Kaupokonui Stream
Expiry Date:	1 June 2017
Site Location:	Manaia Road, Kapuni
Legal Description:	Lot 1 DP 4509 Sec 1 SO 11967 Blk XV Kaupokonui SD
Grid Reference (NZTM)	1697810E-5629840N
Catchment:	Kaupokonui

For General, Standard and Special conditions
pertaining to this consent please see reverse side of this document

General conditions

a) On receipt of a requirement from the Chief Executive, Taranaki Regional Council the consent holder shall, within the time specified in the requirement, supply the information required relating to the exercise of this consent.

b) Unless it is otherwise specified in the conditions of this consent, compliance with any monitoring requirement imposed by this consent must be at the consent holder's own expense.

c) The consent holder shall pay to the Council all required administrative charges fixed by the Council pursuant to section 36 in relation to:

   i) the administration, monitoring and supervision of this consent; and
   ii) charges authorised by regulations.

Special conditions

1. Prior to the exercise of this consent, the consent holder shall prepare a contingency plan to be approved by the Chief Executive, Taranaki Regional Council, outlining measures and procedures to be undertaken to prevent spillage or accidental discharge of contaminants not licensed by this consent and measures to avoid, remedy or mitigate the environmental effects of such a spillage or discharge.

2. The exercise of this consent shall be conducted in general accordance with the information submitted in support of application 3198, and to ensure that the conditions of this consent are met at all times. In the case of any contradiction between the documentation submitted in support of application 3198 and the conditions of this consent, the conditions of this consent shall prevail.

3. The consent holder shall at all times adopt the best practicable option, as defined in section 2 of the Resource Management Act 1991, to prevent or minimise any adverse effects of the discharge on any water body.

4. The following concentrations shall not be exceeded in the discharge:

Component	**Concentration**
pH (range)	6.5 - 8.5
suspended solids	100 gm^{-3}
total recoverable hydrocarbons [infrared spectroscopic technique]	15 gm^{-3}

This condition shall apply prior to the entry of the stormwater into the Kaupokonui Stream at a designated sampling point approved by the Chief Executive, Taranaki Regional Council.

5. After allowing for reasonable mixing, within a mixing zone extending 50 metres downstream of the discharge point, the discharge shall not give rise to any of the following effects in the receiving waters of the Kaupokonui Stream:

   a) the production of any conspicuous oil or grease films, scums or foams, or floatable or suspended materials;
   b) any conspicuous change in the colour or visual clarity;
   c) any emission of objectionable odour;
   d) the rendering of fresh water unsuitable for consumption by farm animals;
   e) any significant adverse effects on aquatic life.

6. This consent shall lapse on the expiry of five years after the date of issue of this consent, unless the consent is given effect to before the end of that period or the Taranaki Regional Council fixes a longer period pursuant to section 125(1)(b) of the Resource Management Act 1991.

7. In accordance with section 128 and section 129 of the Resource Management Act 1991, the Taranaki Regional Council may serve notice of its intention to review, amend, delete or add to the conditions of this resource consent by giving notice of review during the month of June 2005 and/or June 2011, for the purpose of ensuring that the conditions are adequate to deal with any adverse effects on the environment arising from the exercise of this resource consent, which were either not foreseen at the time the application was considered or which it was not appropriate to deal with at the time.

Transferred at Stratford on 13 April 2015

For and on behalf of
Taranaki Regional Council

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A D McLay
Director - Resource Management

Land Use Consent

Pursuant to the Resource Management Act 1991
a resource consent is hereby granted by the
Taranaki Regional Council

Name of Consent Holder:	Fonterra Limited PO Box 424 Hawera 4640
Decision Date:	18 September 2006
Commencement Date:	18 September 2006

Conditions of Consent

Consent Granted:	To erect, place, maintain and use pipeline crossings over the Motumate and Waiokura Streams, for the purposes of conveying irrigation wastewater
Expiry Date:	01 June 2023
Review Date(s):	June 2017
Site Location:	Skeet and Manaia Roads, Kapuni
Legal Description:	Lot 6 DP 2903 Lot 3 DP 3601 Blk XV Kaupokonui SD, Lots 1 & 2 DP 6039 Blk III Waimate SD, Lot 2 DP 5897 Pt Secs 25 & 26 Blk III Waimate SD
Grid Reference (NZTM)	1697950E-5627960N
Catchment:	Motumate

For General, Standard and Special conditions
pertaining to this consent please see reverse side of this document

General conditions

a) On receipt of a requirement from the Chief Executive, Taranaki Regional Council the consent holder shall, within the time specified in the requirement, supply the information required relating to the exercise of this consent.

b) Unless it is otherwise specified in the conditions of this consent, compliance with any monitoring requirement imposed by this consent must be at the consent holder's own expense.

c) The consent holder shall pay to the Council all required administrative charges fixed by the Council pursuant to section 36 in relation to:

i) the administration, monitoring and supervision of this consent; and
ii) charges authorised by regulations.

Special conditions

1. The consent holder shall at all times adopt the best practicable option, as defined in section 2 of the Resource Management Act 1991, to prevent or minimise any adverse effects on the environment from the exercise of this consent.

2. The exercise of this consent shall be undertaken generally in accordance with the documentation submitted in support of application 4339. In the case of any contradiction between the documentation submitted in support of application 4339 and the conditions of this consent, the conditions of this consent shall prevail.

3. The consent holder shall notify the Chief Executive, Taranaki Regional Council, in writing at least seven days prior to the exercise of this consent.

4. The consent holder shall adopt the best practicable option to avoid or minimise the discharge of silt or other contaminants into water or onto the riverbed and to avoid or minimise the disturbance of the riverbed and any adverse effects on water quality.

5. The consent holder shall ensure that the area and volume of riverbed disturbance shall, so far as is practicable, be minimised and any areas which are disturbed shall, so far as is practicable, be reinstated.

6. Any disturbance of parts of the river bed covered by water and/or any maintenance works which may result in downstream discolouration of water shall be undertaken only between 1 November and 30 April except where this requirement is waived in writing by the Chief Executive, Taranaki Regional Council.

7. The structure[s] authorised by this consent shall be removed and the area reinstated, if and when the structure[s] are no longer required. The consent holder shall notify the Taranaki Regional Council at least 48 hours prior to structure[s] removal and reinstatement.

8. This consent shall lapse on the expiry of five years after the date of issue of this consent, unless the consent is given effect to before the end of that period or the Taranaki Regional Council fixes a longer period pursuant to section 125(1)(b) of the Resource Management Act 1991.

9. In accordance with section 128 and section 129 of the Resource Management Act 1991, the Taranaki Regional Council may serve notice of its intention to review, amend, delete or add to the conditions of this resource consent by giving notice of review during the month of June 2011 and/or June 2017, for the purpose of ensuring that the conditions are adequate to deal with any adverse effects on the environment arising from the exercise of this resource consent, which were either not foreseen at the time the application was considered or which it was not appropriate to deal with at the time.

Transferred at Stratford on 13 April 2015

For and on behalf of
Taranaki Regional Council

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A D McLay
Director - Resource Management

Land Use Consent

Pursuant to the Resource Management Act 1991
a resource consent is hereby granted by the
Taranaki Regional Council

Name of Consent Holder:	Fonterra Limited PO Box 424 Hawera 4640
Decision Date:	23 May 2007
Commencement Date:	23 May 2007

Conditions of Consent

Consent Granted:	To erect, place and maintain a stone lined bank on the left bank of Dunns Creek for erosion control purpose
Expiry Date:	1 June 2023
Review Date(s):	June 2017
Site Location:	901 Manaia Road, Kapuni - Fonterra Kapuni No 1 Farn
Legal Description:	Lot 1 DP 45096 Sec 1 SO 11967 Blk XV Kaupokonui SD
Grid Reference (NZTM)	1697230E-5630180N
Catchment:	Kaupokonui
Tributary:	Dunns Creek

For General, Standard and Special conditions
pertaining to this consent please see reverse side of this document

General conditions

a) On receipt of a requirement from the Chief Executive, Taranaki Regional Council the consent holder shall, within the time specified in the requirement, supply the information required relating to the exercise of this consent.

b) Unless it is otherwise specified in the conditions of this consent, compliance with any monitoring requirement imposed by this consent must be at the consent holder's own expense.

c) The consent holder shall pay to the Council all required administrative charges fixed by the Council pursuant to section 36 in relation to:

i) the administration, monitoring and supervision of this consent; and
ii) charges authorised by regulations.

Special conditions

1. The exercise of this consent shall be undertaken generally in accordance with the documentation submitted in support of application 4650. In the case of any contradiction between the documentation submitted in support of application 4650 and the conditions of this consent, the conditions of this consent shall prevail.

2. The consent holder shall notify the Chief Executive, Taranaki Regional Council, in writing at least seven days prior to the exercise of this consent. Notification shall include the consent number and a brief description of the activity consented and be emailed to worknotification@trc.govt.nz. Notification by fax or post is acceptable only if the consent holder does not have access to email.

3. The consent holder shall adopt the best practicable option, as defined in section 2 of the Resource Management Act 1991, to avoid or minimise the discharge of silt or other contaminants into water or onto the riverbed and to avoid or minimise the disturbance of the riverbed and any adverse effects on water quality.

4. Except with the written agreement of the Chief Executive, Taranaki Regional Council, the structure[s] authorised by this consent shall be removed and the area reinstated, if and when the structure[s] are no longer required. The consent holder shall notify the Taranaki Regional Council at least 48 hours prior to structure[s] removal and reinstatement.

5. This consent shall lapse on the expiry of five years after the date of issue of this consent, unless the consent is given effect to before the end of that period or the Taranaki Regional Council fixes a longer period pursuant to section 125(1)(b) of the Resource Management Act 1991.

6. In accordance with section 128 and section 129 of the Resource Management Act 1991, the Taranaki Regional Council may serve notice of its intention to review, amend, delete or add to the conditions of this resource consent by giving notice of review during the month of June 2011 and/or June 2017, for the purpose of ensuring that the conditions are adequate to deal with any adverse effects on the environment arising from the exercise of this resource consent, which were either not foreseen at the time the application was considered or which it was not appropriate to deal with at the time.

Transferred at Stratford on 13 April 2015

For and on behalf of
Taranaki Regional Council

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A D McLay
Director - Resource Management

Land Use Consent

Pursuant to the Resource Management Act 1991
a resource consent is hereby granted by the
Taranaki Regional Council

Name of Consent Holder:	Fonterra Limited PO Box 424 Hawera 4640
Decision Date:	18 April 2013
Commencement Date:	18 April 2013

Conditions of Consent

Consent Granted:	To install a dual culvert in the Waiokura Stream, including the associated streambed and reclamation
Expiry Date:	1 June 2029
Review Date(s):	June 2017, June 2023
Site Location:	586 Manaia Road, Kapuni
Legal Description:	Lot 1 DP 6039 Blk III Waimate SD (Site of structure)
Grid Reference (NZTM)	1698317E-5627432N
Catchment:	Waiokura

For General, Standard and Special conditions
pertaining to this consent please see reverse side of this document

General condition

a. The consent holder shall pay to the Taranaki Regional Council all the administration, monitoring and supervision costs of this consent, fixed in accordance with section 36 of the Resource Management Act 1991.

Special conditions

1. The consent holder shall notify the Chief Executive, Taranaki Regional Council, in writing at least 2 working days prior to the commencement of work. Notification shall include the consent number and a brief description of the activity consented and be emailed to worknotification@trc.govt.nz.

2. Installation shall include two culvert pipes with a diameter no less than 1.35 metres, and a total length no greater than 17.5 metres.

3. The fill over the top of the twin culvert pipes shall be no deeper than 3 metres.

4. The stream banks shall be shaped both upstream and downstream of the twin culvert to form a gradual transition between the existing channel width and the twin culvert.

5. The consent holder shall ensure that rock rip rap armouring is placed on the reshaped channel batters and the streambed, for at least 5 metres, both upstream and downstream of the culvert.

6. The rock rip rap required by condition 5 shall be placed at a slope no steeper than 1.5 horizontal to 1 vertical, and shall have the following grading:

    - 100% less than 800 mm diameter
    - 50% greater than 600 mm diameter
    - 90% greater than 350 mm diameter

7. The consent holder shall ensure that a layer of rock rip rap, at least 500 mm thick, is placed on the batters of the fill embankment.

8. The rock rip rap required by condition 7 shall be placed at a slope no steeper than 1.5 horizontal to 1 vertical, and shall have the following grading:

    - 100% less than 450 mm diameter
    - 50% greater than 300 mm diameter
    - 90% greater than 310 mm diameter

9. Any concrete work carried out in the river bed shall be completely separated from running water, by a temporary coffer-dam and/or diversion using sand bags or some other form of contained of fill.

10. The consent holder shall ensure that any concrete placed in the channel is not exposed to flowing water for a period of 48 hours after it has been placed.

11. No instream works shall take place between 1 June and 31 October inclusive.

12. The consent holder shall ensure that the area and volume of stream bed disturbance is, as far as practicable, minimised and any areas that are disturbed are, as far as practicable, reinstated.

13. The culvert shall not obstruct fish passage.

14. The invert of each culvert pipe shall be set 300 mm below the natural streambed.

15. The gradient of each culvert pipe shall be no steeper than the natural gradient of the stream bed at the site.

16. The consent holder shall take all reasonable steps to:

    a. minimise the amount of sediment discharged to the stream;
    b. minimise the amount of sediment that becomes suspended in the stream; and
    c. mitigate the effects of any sediment in the stream.

    Undertaking work in accordance with *Guidelines for Earthworks in the Taranaki region,* by the Taranaki Regional Council, will achieve compliance with this condition.

17. All earthwork areas shall be stabilised as soon as is practicable immediately following completion of soil disturbance activities.

    Note: For the purpose of this condition "stabilised" in relation to any site or area means inherently resistant to erosion or rendered resistant, such as by using indurated rock or by the application of basecourse, colluvium, grassing, mulch, or another method to the reasonable satisfaction of the Chief Executive, Taranaki Regional Council and as specified in Taranaki Regional Council's Guidelines for Earthworks in the Taranaki Region, 2006. Where seeding or grassing is used on a surface that is not otherwise resistant to erosion, the surface is considered stabilised once, on reasonable visual inspection by an Investigating Officer, Taranaki Regional Council, an 80% vegetative cover has been established.

18. The works shall remain the responsibility of the consent holder and be maintained so that:

    a. it does not become blocked and at all times allows the free flow of water through it;
    b. any erosion, scour or instability of the stream bed or banks that is attributable to the works carried out as part of this consent is remedied by the consent holder.

19. In the event that any archaeological remains are discovered as a result of works authorised by this consent, the works shall cease immediately at the affected site and tangata whenua and the Chief Executive, Taranaki Regional Council, shall be notified within one working day. Works may recommence at the affected area when advised to do so by the Chief Executive, Taranaki Regional Council. Such advice shall be given after the Chief Executive has considered: tangata whenua interest and values, the consent holder's interests, the interests of the public generally, and any archaeological or scientific evidence. The New Zealand Police, Coroner, and Historic Places Trust shall also be contacted as appropriate, and the work shall not recommence in the affected area until any necessary statutory authorisations or consents have been obtained.

20. Except with the written agreement of the Chief Executive, Taranaki Regional Council, the culvert shall be removed and the area reinstated, if and when it is no longer required. A further resource consent may be required to authorise the removal of the structure, and the consent holder is advised to seek advice from the Council on this matter.

21. This consent shall lapse on 30 June 2018, unless the consent is given effect to before the end of that period or the Taranaki Regional Council fixes a longer period pursuant to section 125(1)(b) of the Resource Management Act 1991.

22. In accordance with section 128 and section 129 of the Resource Management Act 1991, the Taranaki Regional Council may serve notice of its intention to review, amend, delete or add to the conditions of this resource consent by giving notice of review during the month of June 2017 and/or June 2023, for the purpose of ensuring that the conditions are adequate to deal with any adverse effects on the environment arising from the exercise of this resource consent, which were either not foreseen at the time the application was considered or which it was not appropriate to deal with at the time.

Transferred at Stratford on 13 April 2015

For and on behalf of
Taranaki Regional Council

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A D McLay
Director - Resource Management

Appendix II

Categories used to evaluate environmental and administrative performance

Categories used to evaluate environmental and administrative performance

Environmental performance is concerned with actual or likely effects on the receiving environment from the activities during the monitoring year. Administrative performance is concerned with the Company's approach to demonstrating consent compliance in site operations and management including the timely provision of information to Council (such as contingency plans and water take data) in accordance with consent conditions.

Events that were beyond the control of the consent holder and unforeseeable (that is a defence under the provisions of the RMA can be established) may be excluded with regard to the performance rating applied. For example loss of data due to a flood destroying deployed field equipment.

The categories used by the Council for this monitoring period, and their interpretation, are as follows:

Environmental Performance

High: No or inconsequential (short-term duration, less than minor in severity) breaches of consent or regional plan parameters resulting from the activity; no adverse effects of significance noted or likely in the receiving environment. The Council did not record any verified unauthorised incidents involving environmental impacts and was not obliged to issue any abatement notices or infringement notices in relation to such impacts.

Good: Likely or actual adverse effects of activities on the receiving environment were negligible or minor at most. There were some such issues noted during monitoring, from self-reports, or during investigations of incidents reported to the Council by a third party but these items were not critical, and follow-up inspections showed they have been dealt with. These minor issues were resolved positively, co-operatively, and quickly. The Council was not obliged to issue any abatement notices or infringement notices in relation to the minor non-compliant effects; however abatement notices may have been issued to mitigate an identified potential for an environmental effect to occur.

For example:

- High suspended solid values recorded in discharge samples, however the discharge was to land or to receiving waters that were in high flow at the time;
- Strong odour beyond boundary but no residential properties or other recipient nearby.

Improvement required: Likely or actual adverse effects of activities on the receiving environment were more than minor, but not substantial. There were some issues noted during monitoring, from self-reports, or during investigations of incidents reported to the Council by a third party. Cumulative adverse effects of a persistent minor non-compliant activity could elevate a minor issue to this level. Abatement notices and infringement notices may have been issued in respect of effects.

Poor: Likely or actual adverse effects of activities on the receiving environment were significant. There were some items noted during monitoring, from self-reports, or during investigations of incidents reported to the Council by a third party. Cumulative adverse effects of a persistent moderate non-compliant activity could elevate an 'improvement required' issue to this level. Typically there were grounds for either a prosecution or an infringement notice in respect of effects.

Administrative performance

High: The administrative requirements of the resource consents were met, or any failure to do this had trivial consequences and were addressed promptly and co-operatively.

Good: Perhaps some administrative requirements of the resource consents were not met at a particular time, however this was addressed without repeated interventions from the Council staff. Alternatively

adequate reason was provided for matters such as the no or late provision of information, interpretation of 'best practical option' for avoiding potential effects, etc.

Improvement required: Repeated interventions to meet the administrative requirements of the resource consents were made by Council staff. These matters took some time to resolve, or remained unresolved at the end of the period under review. The Council may have issued an abatement notice to attain compliance.

Poor: Material failings to meet the administrative requirements of the resource consents. Significant intervention by the Council was required. Typically there were grounds for an infringement notice.