Fonterra Kapuni Air and Water Monitoring Programme Annual Report 2015-2016

Technical Report 2016–52

ISSN:1178-1467 (Online)
Document: 1720873 (Word)
Document: 1742294 (Pdf)

Taranaki Regional Council
Private Bag 713
STRATFORD

November 2016

Executive summary

Fonterra Limited (the Company) operates a lactose manufacturing factory and inhalation grade lactose plant located on Manaia Road at Kapuni, in the Kaupokonui catchment. The plant processes whey and permeate from dairy product manufacture around the North Island. This report for the period July 2015-June 2016 describes the monitoring programme implemented by the Taranaki Regional Council (the Council) to assess the Company's environmental performance during the period under review, and the results and environmental effects of the Company's activities.

The Company holds a total of 19 resource consents, which include a total of 161 conditions setting out the requirements that the Company must satisfy. The Company holds two consents to allow it to take and use water, six consents to discharge stormwater and/or cooling water into the Kaupokonui and Motumate Streams, five consents to discharge wastes to land, six 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.

During the monitoring period, Fonterra Limited demonstrated an overall high level of environmental performance.

The Council's monitoring programmes for the period under review together included 12 inspections, 178 water samples collected for physico-chemical analysis, two bio-monitoring surveys of receiving waters, and five ambient air quality analyses.

Cooling water discharge volume metering was introduced, in relation to future water allocation for the Kaupokonui Stream. Telemetry of abstraction from and discharge to the Stream was installed, with ongoing transmission problems that are being addressed.

Ecological monitoring did not note any problems in regard to the abstraction of water from the Kaupokonui Stream for cooling water and general purposes.

Temperature increase limits on cooling water discharged to the Kaupokonui Stream were complied with throughout the review period. The main cooling system was replaced in August 2015, with towers designed to achieve a discharge temperature of less than the maximum limit of 25°C that is allowed in the receiving water. Riparian planting was maintained on the factory site and a donation was received by the Council as per consent conditions.

Irrigation onto the two dairy farms was, in general, well managed, including the new dairy shed effluent. Nitrogen loading on the farms remained similar to that previously, as the addition of dairy shed effluent was approximately off-set by a reduction in loading from factory wastewater. No effect from irrigation was found from biological monitoring of the Kaupokonui and Waiokura Streams. A 20 m buffer to the bank of water courses was maintained during irrigation.

Effects on the groundwater in the vicinity of the farms were varied, but most showed some impact on both mineral and organic component levels. This has been addressed through

extension of the irrigation disposal system in 2007-2008, and by more intensive wastewater and groundwater monitoring. The monitoring results in some areas continue to show an increase in total nitrogen loading on irrigation areas, although with the increase in the area utilised, concentrations are showing no increase overall.

No effects were noted on the Kaupokonui Stream as a result of the stormwater discharges from the northern and southern stormwater outfalls, Inhalable Grade Lactose plant, and stormwater detention pond. Sample results were within those prescribed by consent conditions.

One complaint was reported by the Company, in August 2015 about odour from the sewage soakage field for the disposal of septic tank effluent from the factory. Sewage was tankered off site until the treatment and disposal system was replaced, work being completed in February 2016. The discharge meets the standards of Rule 22 of the Regional Freshwater Plan, and as such is classed as a permitted activity.

Particulate deposition from air emissions was similar to the previous monitoring periods. Visual inspections found no evidence of depositions, and odour surveys continued to note low levels of odour off site, with some odour observed around the effluent tank and in the vicinity of this depending on the direction of the wind.

Overall, during the period under review, the Company demonstrated a high level of environmental performance and compliance with the resource consents. There were no unauthorised incidents during the period under review.

For reference, in the 2015-2016 year, 71% of consent holders in Taranaki monitored through tailored compliance monitoring programmes achieved a high level of environmental performance and compliance with their consents, while another 24% demonstrated a good level of environmental performance and compliance with their consents.

This report includes recommendations for the 2016-2017 year.

Table of contents

List of tables

List of figures

List of photographs

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 2015 to June 2016 by the Taranaki Regional Council (the Council) on the monitoring programme associated with resource consents formerly held by Fonterra Limited (Fonterra). The Company operates a whey processing facility situated on Manaia Road at Kapuni, in the Kaupokonui catchment (Figure 1).

This 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 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 twenty-fourth combined report and twenty-eighth 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 through annual programmes,
- the resource consents held by Fonterra,
- 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.

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

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

Section 4 presents recommendations to be implemented in the 2016-2017 monitoring year.

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

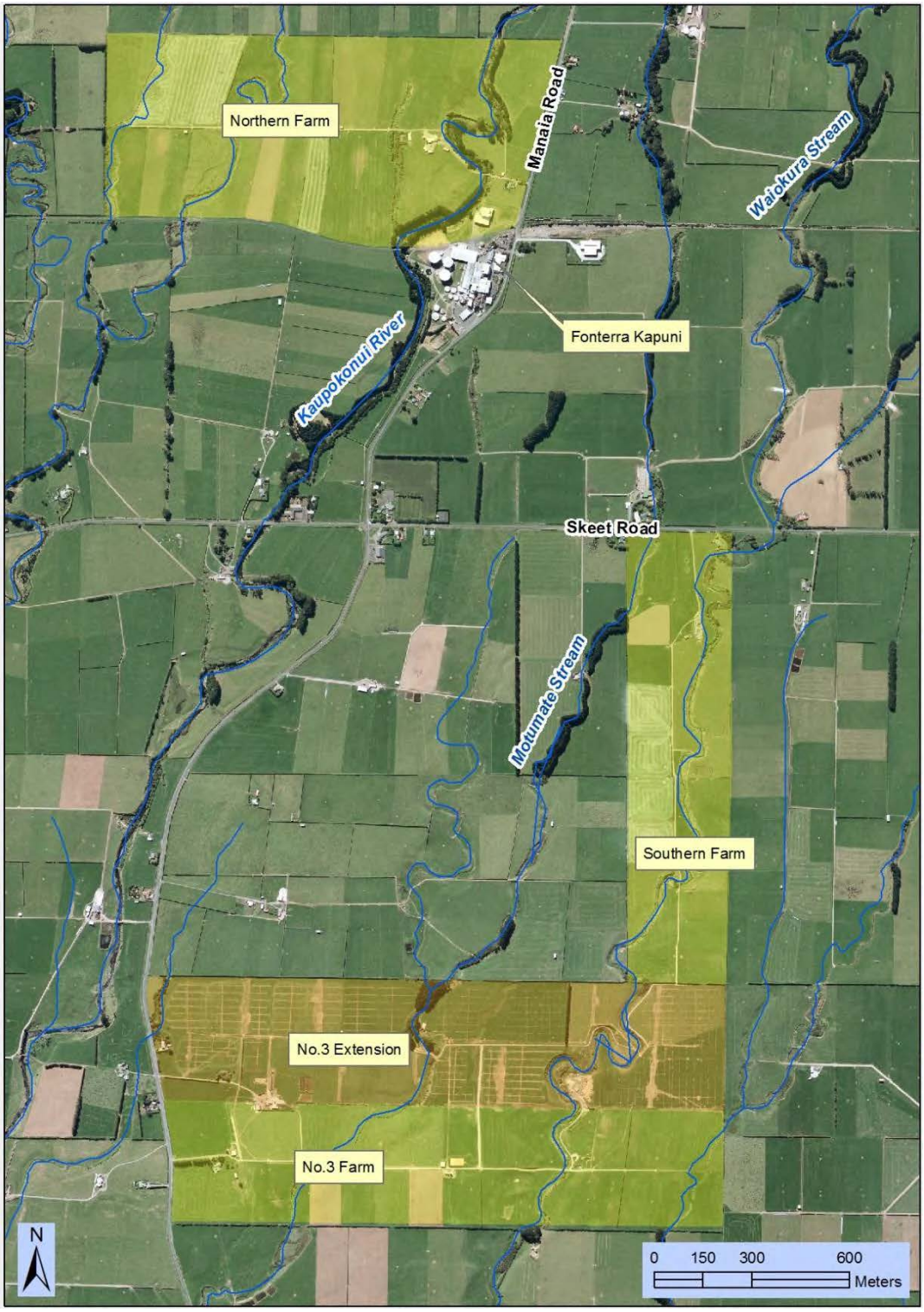

Figure 1 Fonterra Kapuni lactose factory, North, South and (extended) No 3 farms and the Kaupokonui, Motumate and Waiokura Streams

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 socio-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 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 performance

Besides discussing the various details of the performance and extent of compliance by the Company, this report also assigns them a rating for their environmental and administrative performance during the period under review.

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 significant 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 in response to unauthorised incident reports, 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 in response to unauthorised incident reports. 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 in response to unauthorised incident reports. 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.

For reference, in the 2015-2016 year, 75% of consent holders in Taranaki monitored through tailored compliance monitoring programmes achieved a high level of environmental performance and compliance with their consents, while another 21% demonstrated a good level of environmental performance and compliance with their consents.

1.2 Process description

The manufacturing of lactose is based on the processing of whey permeate, the by-product of the production of cheese and casein. Whey permeate contains most of the lactose present in the original milk source, and, through a process which includes evaporation and crystallization, lactose is extracted out and purified. The lactose is then dried and packed into different grades that meet a diverse range of customer needs and requirements.

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 is discharged to the stream via spray nozzles that reduce 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 Vector Gas Treatment Plant (Vector) at Kapuni. The first delivery of steam was in December 1997. This has reduced the 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 Vector via a pipeline for reprocessing.

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

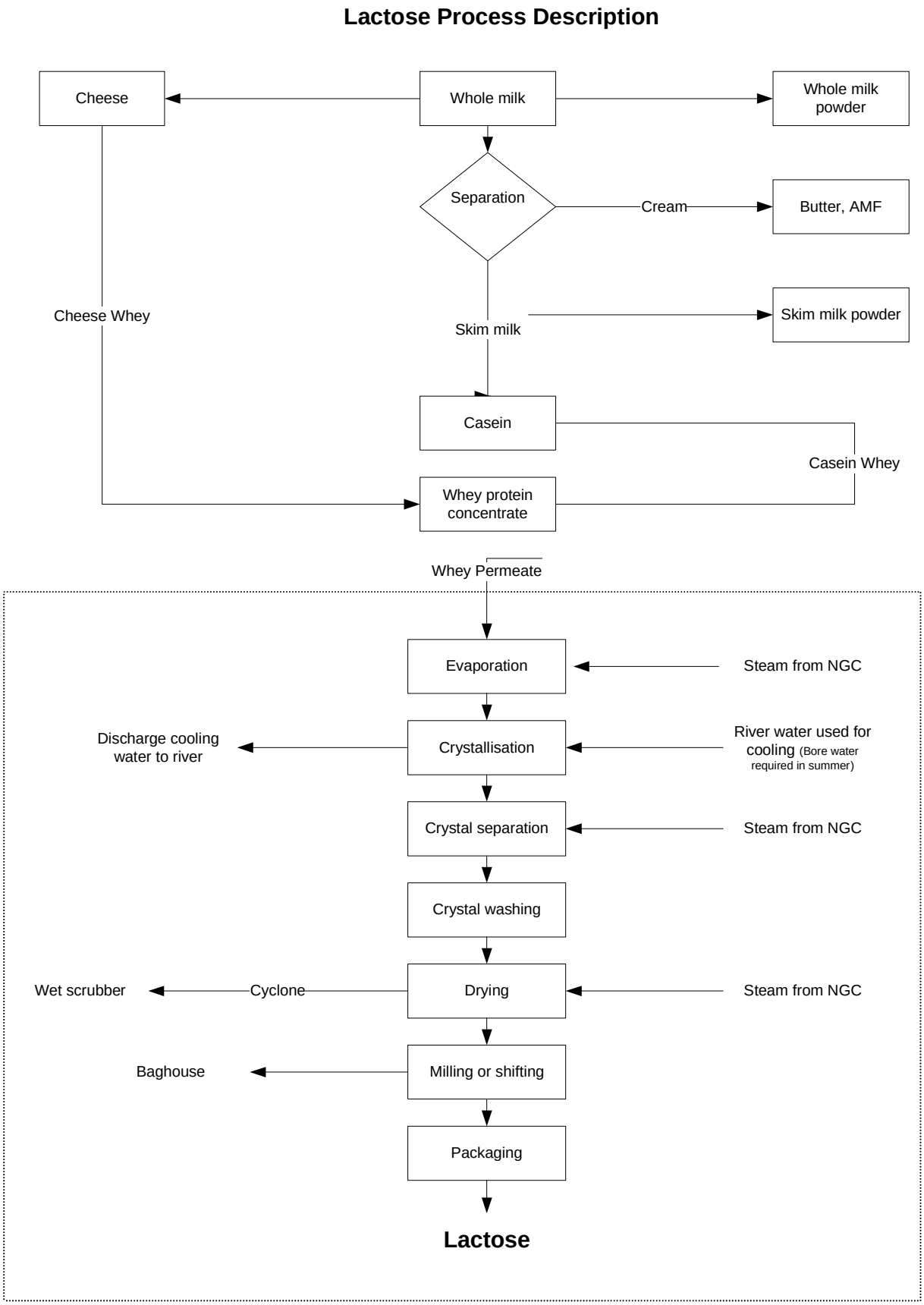

Figure 2 Lactose process diagram

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

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

For 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". For the purposes of describing the wastewater system the old farm designations are occasionally used in this report.

1.3 Resource consents

A summary of the consents held by Fonterra in relation to activities at its Kapuni plant is given in Table 1 below, and the consents are discussed in Sections 1.3.1 to 1.3.5. A copy of each of the consents can be found in Appendix I.

Table 1 Summary of resource consents held by Fonterra Limited for the lactose plant at Kapuni

Consent number	Purpose	Volume	Next review date	Expiry date
0302-3	Take from Kaupokonui	19,500 m^3/day (225 L/s)	-	2019
0919-3	Discharge cooling water to Kaupokonui	19,500 m^3/day	-	2019
0920-3	Take from bore	700 m^3/day	-	2017
0921-3	Discharge cooling water to trib. of Motumate Stream	850 m^3/day	-	2017
0922-3	Discharge factory wastewater and DSE to land (North)	2,630 m^3/2 days, 168 m^3/d DSE	-	2019
0923-3	Discharge factory wastewater and DSE to land (South)	3,834 m^3/2 days, 120 m^3/d DSE	-	2019
0924-3	Discharge storm & cooling water to Kaupokonui	1,440 m^3/day	-	2019
4032-5	Discharge emissions to air		-	2019
4235-2	Discharge stormwater during factory shutdown periods	240 m^3/day	-	2017
4604-2	Discharge stormwater from extension to Kaupokonui	280 L/s	-	2017
4623-2	Structures for spray, stormwater, irrigation and take		-	2017
5368-1	Structure over Little Dunn's Creek		-	2017
6422-1	Structure for stormwater outlet (IGL plant)		-	2017
6423-1	Discharge stormwater to Kaupokonui (IGL plant)		-	2017
6885-1	Structure for stormwater (pond) outlet		-	2017
6948-1	Structure for pipeline over Motumate and Waiokura		2017	2023
9546-1	Install culvert in Waiokura Stream		2017	2029
10214-1	Discharge solid dairy farm effluent to land		2023	2041
10232-1	Discharge pond sludge from farm dairy effluent to land		2023	2041

m^3/day = cubic metres per day; L/s = litres per second; DSE = dairy shed effluent

Consent 5629-1, held by Fonterra to provide for the discharge of treated domestic effluent into land, was surrendered in March 2015, as the discharge met the standards of Rule 22 of the Regional Freshwater Plan as a permitted activity.

1.3.1 Water abstraction permits

Section 14 of the RMA stipulates that no person may take, use, dam of 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.

Kaupokonui Stream

Fonterra Limited holds water permit **0302-3** to take and use up to 19,500 m^3/day (225 litres/second) of water from the Kaupokonui Stream for cooling water and general purposes associated with lactose manufacturing. This permit was issued by the Council on 9 June 1999 under Section 87(d) of the RMA. It is due to expire on 1 June 2019.

There are three special conditions attached to the consent.

Condition 1 requires that the consent holder, in conjunction with the Council, to undertake ecological monitoring associated with the abstraction.

Condition 2 stipulates that the consent holder records the daily rates of abstraction and make these records available to the Council.

Condition 3 deals with review procedures.

Groundwater

Fonterra Limited also holds water permit **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. This permit was issued by the Council on 4 February 1999 under Section 87(d) of the RMA. It is due to expire on 1 June 2017.

There are three special conditions attached to the consent.

Condition 1 requires the consent holder to record groundwater levels and rates of abstraction and make these records available to the Council.

Condition 2 stipulates that the consent holder allows the Council access to the bore for inspection or sampling purposes.

Condition 3 deals with review procedures.

1.3.2 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.

Fonterra Limited holds six permits to discharge to surface water, three in relation to cooling water, and four to stormwater, one that provides for both types of discharge. All of the discharges are directly to Kaupokonui Stream at the plant site, except one, of cooling water to a tributary of Motumate Stream across Manaia Road.

1.3.2.1 Cooling water

Cooling towers and sprayers

Fonterra Limited holds water discharge permit **0919-3** to cover the discharge of 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. This permit was issued by the Council on 9 June 1999 under Section 87(e) of the RMA. It is due to expire on 1 June 2019.

There are eleven special conditions attached to the consent.

Condition 1 requires the consent holder to undertake physicochemical and ecological monitoring of the wastes and receiving waters.

Condition 2 describes effects which the discharge shall not give rise to in the receiving waters.

Condition 3 stipulates that the biochemical oxygen demand (BOD) shall not rise above 2 g/m^3 below the discharge.

Condition 4 requires that the discharge does not alter the temperature of the receiving water by more than 2 degrees Celsius for 90% of the time, and by more than 3 degrees at all times.

Condition 5 stipulates that the temperature of the receiving water shall not increase above 25 degrees.

Condition 6 requires the consent holder to continuously monitor the temperature of the receiving waters, and to forward this information to the Council.

Condition 7 allowed the Council to review conditions 4 and 5 of the consent in June 2001 for the purpose of evaluating the performance of the cooling system.

Condition 8 stipulates that the discharge not give rise to a thermal barrier to fish or any visible bacterial and/or fungal slime growths.

Condition 9 requires that no anti-corrosion agents, biocides, anti-flocculants or other chemicals be added to the cooling water without permission of the Council.

Condition 10 requires mitigation of the effects of the discharge by maintenance of existing riparian planting, and an annual donation to the Taranaki Tree Trust of $3,000.

Condition 11 deals with review of the conditions of the consent.

Motumate tributary

Fonterra Limited holds water discharge permit **0921-3** to cover the discharge of 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. This permit was issued by the Council on 4 February 1999 under Section 87(e) of the RMA. It is due to expire on 1 June 2017.

There are three special conditions attached to the consent.

Condition 1 describes effects which must not arise below the mixing zone in the receiving waters.

Condition 2 requires that the consent holder monitor the daily volume and temperature of the discharge.

Condition 3 deals with review of the conditions of the consent.

Combined cooling and original (southern) storm waters

Fonterra Limited holds water discharge permit **0924-3** to cover the discharge of up to 1,440 m^3/day of stormwater and cooling water from a lactose manufacturing plant through two outfalls into the Kaupokonui Stream. This permit was issued by the Council on 9 June 1999 under Section 87(e) of the RMA. It is due to expire on 1 June 2019.

There are twelve special conditions attached to the consent.

Condition 1 requires the consent holder to undertake physicochemical and ecological monitoring of the wastes and receiving waters.

Conditions 2 describes effects which the discharge shall not give rise to in the receiving water.

Condition 3 stipulates that the filtered BOD shall not rise above 2 g/m^3 below the discharge.

Condition 4 requires that the discharge does not alter the temperature of the receiving water by more than 2 degrees Celsius for 90% of the time and by more than 3 degrees at all times.

Condition 5 stipulates that the temperature of the receiving water not increase above 25 degrees.

Condition 6 requires the consent holder to continuously monitor the temperature of the receiving waters, and to forward this information to the Council.

Condition 7 allowed the Council to review conditions 4 and 5 of the consent in June 2001 for the purpose of evaluating the performance of the cooling system.

Condition 8 sets limits on levels of oil and grease, pH and suspended solids in the discharge.

Condition 9 stipulates that the discharge not give rise to a thermal barrier to fish or any visible bacterial and/or fungal slime growths.

Condition 10 requires that no anti-corrosion agents, biocides, anti-flocculants or other chemicals be added to the cooling water without the permission of the Council.

Condition 11 requires the consent holder to maintain a contingency plan outlining measures and procedures to prevent spillage and remedy or mitigate effects of such a spillage.

Condition 12 deals with review of the conditions of the consent.

1.3.2.1.1 Notice to review consents 0919-3 and 0924-3

On 27 June 2014, Council invoked the review conditions on consents 0919-3 and 0924-3, that provide for discharge back to Kaupokonui Stream of cooling water taken under consent 0302-3. The reason for review was to impose five new monitoring conditions on both consents to obtain information on the amount of water that is returned to the stream, for water allocation purposes, and for assessment of the effects of the abstraction on the stream. The data gathered were also necessary for the preparation of an assessment of environmental effects in the consents replacement process due to be carried out by 2019.

After consultation, Fonterra agreed to implement the required monitoring measures by 31 August 2015, and Council withdrew the notice of review.

The agreed monitoring measures related to (1) installation and maintenance of flow recording devices and (2) dataloggers, (3) certification of and (4) access to equipment, and (5) transmission to Council of a real time record of discharge volumes.

The agreed monitoring measures are as follows:

1. By 31 August 2015 the consent holder shall install, and thereafter maintain a flow recording device(s). The device shall be tamper-proof and shall measure and record the rate and volume of cooling water discharge to an accuracy of ±5%.

   Note: flow recording devices must be installed, and regularly maintained, in accordance with manufacturer's specifications in order to ensure that they meet the required accuracy. Even with proper maintenance flow recording devices have a limited lifespan.

2. By 31 August 2015, the consent holder shall install, and thereafter maintain a datalogger to automatically record discharge volumes from the flow recording devices(s). The datalogger shall be tamper-proof and shall record the date, the time (in New Zealand Standard Time) and the rate and volume of water discharge at intervals not exceeding 15 minutes.

   Note: dataloggers must be installed, and regularly maintained, in accordance with manufacturer's specifications in order to ensure that they meet the required accuracy. Even with proper maintenance flow recording devices and dataloggers have a limited lifespan.

3. Within 30 days of the installation of a flow recording device or datalogger, and at other times when reasonable notice is given, the consent holder shall provide the Chief Executive, Taranaki Regional Council with a document from a suitably qualified person certifying that:
   a. water measuring or recording equipment required by the conditions of this consent has been installed and/or maintained in accordance with the manufactures specifications; and/or

b. water measuring or recording equipment required by the conditions of this consent has been tested and shown to be operating to an accuracy of ±5%.

4. The flow recording device(s) shall be accessible to Taranaki Regional Council officers at all reasonable times for inspection and/or data retrieval. In addition the data logger shall be designed and installed so that Council officers can readily verify that it is accurately recording the required information.

5. From a date no later than 31 August 2015, the measurements made in accordance with condition 1 of this consent, shall be transmitted to the Taranaki Regional Councils computer system, in a format to be advised by the Chief Executive, Taranaki Regional Council, to maintain 'real time' record of the discharge volumes. The records shall:

   a. be in a format that, in the opinion of the Chief Executive, Taranaki Regional Council, is suitable for auditing; and
   b. specifically record the water discharged as 'zero' when no discharge(s) occurs.

   In August 2015, the implementation period was extended to 30 September 2015, following delays associated with the installation of a new cooling tower system.

1.3.2.2 Stormwater

Shutdown periods

Fonterra Limited holds water discharge permit **4235-2** to cover the discharge of up to 240 m^3/day of stormwater from the factory site via the existing stormwater system into the Kaupokonui Stream only during factory shutdown periods. This permit was issued by the Council on 4 February 1999 under Section 87(e) of the RMA. It is due to expire on 1 June 2017.

There are five special conditions attached to the consent.

Condition 1 describes effects which must not arise below the mixing zone.

Condition 2 sets limits on levels of oil and grease, pH and suspended solids in the discharge.

Condition 3 requires the consent holder to prepare and maintain a contingency plan outlining measures and procedures to be undertaken to prevent a spillage and measures to remedy or mitigate environmental effects of such a discharge.

Condition 4 defines factory shut down as being when no whey is being processed.

Condition 5 deals with review of the conditions of the consent.

Northern factory extension

Fonterra Limited holds water discharge permit **4604-2** to cover the discharge of up to 280 litres/second of stormwater from the factory extension site via a 525 mm diameter pipe into the Kaupokonui Stream. This permit was issued by the Council on 4 February 1999 under Section 87(e) of the RMA. It is due to expire on 1 June 2017.

There are four special conditions attached to the consent.

Condition 1 describes effects which must not arise below the mixing zone.

Condition 2 sets limits on levels of oil and grease, pH and suspended solids in the discharge.

Condition 3 requires the consent holder to prepare and maintain a contingency plan outlining measures and procedures to be undertaken to prevent a spillage and measures to remedy or mitigate environmental effects of such a discharge.

Condition 4 deals with review of the consent conditions.

IGL plant

Fonterra holds water discharge permit **6423-1** to cover the discharge of stormwater from an inhalation grade lactose plant (IGL) site into the Kaupokonui Stream. This permit was issued by the Council on 13 July 2004 under Section 87(e) of the RMA. It is due to expire on 1 June 2017.

There are seven special conditions attached to this consent.

Condition 1 requires the consent holder to prepare and maintain a contingency plan outlining measures and procedures to be undertaken to prevent a spillage and measures to remedy or mitigate environmental effects of such a discharge.

Condition 2 stipulates that the consent be conducted in accordance with the information submitted in support of the application.

Condition 3 requires that the consent holder adopt the best practicable option to prevent or minimise any adverse effects of the discharge on any water body.

Condition 4 sets limits on the levels of pH, suspended solids, and hydrocarbons in the discharge.

Condition 5 describes effects which must not arise below the mixing zone.

Conditions 6 and 7 deal with lapse of consent and review of consent conditions.

1.3.3 Air discharge permit

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.

Fonterra Limited holds air discharge permit **4032-5** to cover the discharge of emissions to air from the manufacture, drying, packing and storage of lactose and associated processes and from an inhalation grade lactose plant. This permit was issued by the Council on 17 April 2000 under Section 87(e) of the RMA. It is due to expire on 1 June 2019. A change to the conditions of consent 4032-5 was made on 2 June 2004 to include the IGL plant.

There are nine special conditions attached to the consent.

Condition 1 requires the consent holder to adopt the best practicable option to prevent or minimise emissions of particulate matter.

Condition 2 emphasises that the consent holder is bound by the obligations and duties specified in the RMA.

Condition 3 stipulates that particulate from the wet scrubber system not exceed 125 mg/m^3 of air.

Condition 4 requires that the consent holder consult with the Council prior to making alterations to the plant.

Conditions 5, 6 and 8 stipulate that the discharge not give rise to dangerous levels of airborne contaminants, offensive or objectionable dust or odour, or noxious levels of airborne contaminants at or beyond the boundary of the property.

Condition 7 allows the consent holder to apply for a change or cancellation to any of the conditions of the consent.

Condition 9 deals with review provisions.

1.3.4 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.

1.3.4.1 Factory wastewater and dairy shed effluent (DSE)

Fonterra Limited holds discharge permits **0922-3** and **0923-3** to cover the discharge of 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. Consent **0922-3** covers up to 2,600 m^3/two consecutive days and refers to the Kaupokonui catchment, while **0923-3** covers the discharge of up to 3750 m^3/two consecutive days and refers to the Waiokura and Motumate catchments. Both permits were issued by the Council on 9 June 1999 under Section 87(e) of the RMA to provide for a lactose manufacturing plant. They are due to expire on 1 June 2019. A change to the conditions of consent 0923-3 was made on 21 August 2006 to provide for extension of the land disposal area. Changes to conditions on both permits were made on 15 July 2015 to allow the inclusion of dairy shed effluent.

There are nine special conditions attached to consent **0922-3.**

Condition 1 requires the consent holder to maintain an effluent spray irrigation management plan (SIMP), and matters which it should address are listed.

Condition 2 was inserted in July 2015 to set limits on volume of lactose manufacturing and of dairy effluents discharged.

Condition 3 stipulates that the consent be exercised in accordance with the procedures set out in the SIMP.

Condition 4 allows the SIMP to be reviewed on two months' notice, either by the consent holder or Council. This condition also stipulates that the SIMP is reviewed annually by the consent holder and provided to the Council by 1 July each year.

Condition 5 requires that the operation of the spray irrigation system is carried out in accordance with the SIMP, that relevant staff are regularly trained on the content and implementation of the plan and staff are advised immediately of revisions or additions to the SIMP.

Condition 6 stipulates that there be no direct discharge of effluent to any watercourse.

Condition 7 requires that the system be operated in a manner which does not cause ponding.

Condition 8 stipulates that there be at least 20 metres from the edge of the spray zone to the bank of any watercourse.

Condition 9 requires the consent holder to monitor and collect various data on the spray irrigation system, with this is to be made available to the Council.

Condition 10 deals with review provisions.

There are sixteen special conditions attached to consent **0923-3,** nine of which were the same as those on consent **0922-3,** when the two consents were issued. The change of consent on 21 August 2006 added six conditions, that address: adoption of the best practicable option to minimise adverse effects (condition 1); prohibition of offensive or objectionable odour (condition 6); control of spray drift (condition 7); contamination of water supplies (condition 11); groundwater monitoring (condition 12); and change or cancellation of conditions (condition 14). A condition was inserted on 15 July 2015 to set limits on volume of lactose manufacturing and of dairy effluents discharged.

1.3.4.2 Dairy solids and ponds sludge

Fonterra Limited holds discharge permits **10214-1** and **10232-**1 to cover the discharge onto and into land of solid farm dairy effluent, and pond sludge from farm dairy effluent, respectively. Consent **10214-1** refers to the Waiokura and Motumate catchments, while consent **10232-1** refers to the Kaupokonui catchment. These

consents were issued by the Council on 5 February 2016 under Section 87(e) of the RMA. Both are due to expire in June 2041.

There are 11 special conditions attached to both consents, which differ only on the limits set on volume of effluent allowed and on area of land required.

Condition 1 defines the effluent that is to be discharged. Condition 2 sets limits on the amount of effluent and the area of land receiving it. Condition 3 requires Council to be notified if the effluent volume limit is exceeded.

Condition 4 requires the consent holder to adopt the best practicable option to minimise adverse effects on the environment.

Condition 5 requires the use of a stormwater diversion system and a sand trap.

Condition 6 sets buffer distances from surface water bodies, urupa, water supply sources and dwellings.

Condition 7 limits Total Nitrogen application rate. Condition 8 addresses the keeping of records.

Condition 9 deals with unauthorised discharges.

Conditions 10 and 11 are review conditions.

1.3.5 Land use consents

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 by a rule in a regional plan or by a resource consent.

Structures in Kaupokonui Stream

Fonterra Limited holds land use consent **4623-2** to erect, place, use and maintain various spray, stormwater, irrigation and intake structures in the bed of the Kaupokonui Stream. This permit was issued by the Council on 4 February 1999 under Section 87(a) of the RMA. It is due to expire on 1 June 2017.

There are seven special conditions attached to the consent.

Condition 1 requires the consent holder to notify the Council at least 48 hours prior to undertaking significant maintenance works. Condition 5 stipulates that such works be carried out only between 1 November and 30 April.

Condition 2 stipulates that the structures are constructed generally in accordance with the application.

Condition 3 requires the consent holder adopt the best practicable option to minimise adverse effects on water quality.

Condition 4 stipulates that fish passage is not obstructed.

Condition 6 requires that if the structures are no longer required they are removed and the area reinstated.

Condition 7 deals with provisions for review.

Dunn's Creek bridge

Fonterra Limited holds land use consent **5368-1** to erect, place, use and maintain a bridge over Little Dunn's Creek a tributary of Dunn's Creek in the Kaupokonui catchment for access purposes. This permit was issued by the Council on 21 July 1998 under Section 87(a) of the RMA. It is due to expire on 1 June 2017.

There are six conditions attached to the consent.

Condition 1 addresses notification of works.

Condition 2 stipulates that construction and maintenance be according to the documentation submitted.

Condition 3 covers measures to prevent contamination of the watercourse.

Condition 4 requires that the structure is removed and the area reinstated, if and when it is no longer required.

Condition 5 prohibits the discharge of contaminated stormwater from the bridge or its approaches to the water course.

Condition 6 is a review provision.

Northern stormwater outfall

Fonterra Limited holds land use consent **6422-1** to erect, place, and maintain a stormwater outlet structure in the bed of the Kaupokonui Stream. This permit was issued by the Council on 13 July 2004 under Section 87(a) of the RMA. It is due to expire on 1 June 2017.

There are seven special conditions attached to the consent.

Conditions 1 to 4 deal with construction and maintenance of the structure.

Condition 5 requires that the structure is removed and the area reinstated, if and when it is no longer required.

Conditions 6 and 7 deal with lapse and expiry of consent.

Southern stormwater outfall

Fonterra Limited holds land use consent **6885-1** to erect, place, use and maintain an outlet structure in the Kaupokonui Stream for stormwater discharge purposes. This permit was issued by the Council on 12 May 2006 under Section 87(a) of the RMA. It is due to expire on 1 June 2017.

There are seven special conditions attached to the consent.

Condition 1 requires the consent holder to adopt the best practicable option to minimise effects on water quality.

Condition 2 stipulates that the consent is undertaken in accordance with documentation submitted in support of the application.
Condition 3 requires the consent holder to notify the Council prior to commencing installation.

Condition 4 stipulates that riverbed disturbance be kept to a minimum.

Condition 5 requires the structure(s) be removed when no longer required.

Condition 6 and 7 deal with expiry and review of the consent.

Motumate and Waiokura pipeline crossings
Fonterra Limited holds land use consent **6948-1** to erect, place, use and maintain and use pipeline crossings over the Motumate and Waiokura Streams, for the purpose of conveying irrigation wastewater. This permit was issued by the Council on 18 September 2006 under Section 87(a) of the RMA. It is due to expire on 1 June 2023.

There are nine special conditions attached to the consent.

Condition 1 requires the consent holder to adopt the best practicable option to minimise effects on water quality.

Condition 2 stipulates that the consent is undertaken in accordance with documentation submitted in support of the application.

Condition 3 requires the consent holder to notify the Council prior to commencing installation.

Condition 4 requires the adoption of the best practicable option to minimise discharge of silt and other contaminants, and to minimise riverbed disturbance.

Condition 5 deals with riverbed disturbance and reinstatement.

Conditions 6 and 7 relate to the timing and notification of works.

Conditions 8 and 9 relate to lapse and review of consent.

Waiokura culvert
Fonterra Limited holds land use consent **9546-1** to install a dual culvert in the Waiokura Stream, including the associated streambed and reclamation. This permit was issued by the Council on 18 April 2013 under Section 87(a) of the RMA. It is due to expire on 1 June 2029.

There are 22 conditions attached to the consent.

Condition 1 addresses notification of works.

Conditions 2 to 10, 14, 15, and 18 address the design, construction and maintenance of works.

Condition 11 prohibits works between 1 June and 31 October.

Condition 12 deals with riverbed disturbance and reinstatement.

Condition 13 prohibits the obstruction of fish passage.

Conditions 16 and 17 address the minimisation of sedimentation in the stream, and stabilisation of earthworks.

Condition 19 addresses the discovery of archaeological remains.

Condition 20 deals with removal of the structure.

Conditions 21 and 22 relate to lapse and review of the consent.

1.4 Monitoring programme

1.4.1 Introduction

Section 35 of the RMA sets out an obligation for 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 Fonterra Limited 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 reviews;
- renewals;
- new consents;
- advice on the Council's environmental management strategies and content of regional plans and;
- consultation on associated matters.

1.4.3 Site inspections

The Company's site was visited twelve times during the monitoring year. 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 and land, including contaminated stormwater and process wastewaters. Air inspections focussed on plant processes with associated actual and potential emission sources and characteristics, including potential odour, dust, noxious or offensive emissions. 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.

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 waste water on 10 occasions and of the combined stormwater/cooling water discharge on 11 occasions, and the samples analysed for BOD_5 (total and filtered), pH, conductivity and turbidity. The stormwater discharge was also analysed for suspended solids, pH and oil and grease.

The Kaupokonui Stream was sampled on 11 occasions at three sites, and the samples analysed for temperature, BOD_5 (total and filtered), pH, conductivity, turbidity and ammonia-N. The Waiokura Stream was sampled at three sites on 12 occasions, and the samples analysed for temperature, conductivity, nitrate and sodium.

Ten samples were collected from the stormwater outfall from the factory extensions, one sample was collected from the stormwater outfall from the IGL plant and another four were collected from the outlet of the stormwater pond. Stormwater samples were analysed for total BOD_5, conductivity, pH, turbidity, suspended solids and oil and grease.

Some additional stormwater sampling was undertaken, as part of the consents replacement process, to measure components not normally monitored. Three sets of samples from up to four stormwater outfalls to the Kaupokonui Stream, including the combined cooling/stormwater discharge, were collected by Council (June 2015) and Fonterra (December 2015 and April 2016) at the time of rainfall events. The samples were analysed for nutrients (ammonia, oxidised nitrogen and dissolved reactive phosphorus), trace metals (copper, lead and zinc) and faecal indicator bacteria (faecal coliforms), as well as for conductivity, pH and suspended solids.

Groundwater from eight bores on the three farms was sampled on six occasions and analysed for temperature, conductivity, pH, and nitrate. In addition, filtered COD, ammonia, sodium and chloride were tested for on six of the occasions.

Deposition gauges were placed at selected sites in the vicinity on one occasion. The collected samples analysed for COD.

1.4.5 Biomonitoring surveys

A biological survey was performed on two occasions in the Kaupokonui Stream to determine whether or not the discharge of stormwater, evaporator condensate, washings, processing and cooling wastes from the site has had a detrimental effect upon the communities of the stream. A biological survey was also performed in the Waiokura Stream to monitor the effects from irrigation of wastewater and stormwater onto land in the Waiokura catchment.

A triennial four-site fish survey was undertaken in the Kaupokonui Stream in January 2014, 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 fish communities were surveyed using the electric fishing technique, with all fish identified where possible, counted, and lengths estimated.

1.4.6 Review of consent holder's data

A large amount of data are supplied by the Company in relation to stream abstraction records, irrigation records, receiving water and coolant temperatures, and wastewater composition. These data are assessed by Council staff to confirm compliance with consent conditions.

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. These reports cover information in relation to calibration of the consent holder's instream temperature monitors, stream temperature compliance data, effluent irrigation volumes, effluent production, stream and bore extraction volumes and rainfall levels. 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 these 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 average) 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.

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 by 31 July each year the record 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 undertaken on 27 August 2014.

Table 2 Summary of water abstraction volumes from the Kaupokonui Stream, 2015-2016

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
July 2015	1,198	21	6,808	0
August 2015	6,208	2,382	9,807	0
September 2015	10,068	6,765	13,501	0
October 2015	12,926	11,461	14,812	0
November 2015	10,884	6,333	14,053	0
December 2015	11,056	6,996	14,917	0
January 2016	7,195	2,745	12,189	0
February 2016	9,964	5,163	15,146	0
March 2016	9,986	6,447	15,070	0
April 2016	6,775	4,855	9,568	0
May 2016	5,115	3,383	7,055	0
June 2016	2,646	0	9,321	0

The daily stream abstraction data summary in Table 2 illustrates that the Company continued to take a significant volume of water from the stream during the 2015-2016 monitoring period.

The total volume of 2,861,796 m^3 abstracted during 2015-2016 was 10% less than the amount taken in 2014-2015. All abstractions were within the consent limits, with the daily volume abstracted maintained well below the 19,500 m^3 daily limit. During 2015-2016, a maximum daily abstraction of 15,146 m^3 was recorded, 78% of the consent limit, on 26 February 2016.

Abstraction volumes were lower in November and January than in previous years, as a result of short partial plant shut–downs (two weeks in November and one week in January) that were instituted in 2015-2016 to carry out maintenance works that previously had occurred in winter.

Fonterra's abstraction of water from the Kaupokonui Stream was undertaken in a satisfactory manner and there were no obvious problems. The abstraction information supplied by the Company complied with the conditions of consent **0302-1** and the Resource Management Regulations, 2010.

Telemetry of the abstraction data, directly to Council, was installed on 14 January 2016**.** Daily batches of data, comprising 15-minute average values, were sent electronically at 0700 NZST. Ongoing problems, with missing data (up to about 25%) and with scaling factors, were unresolved at the end of the review period. In the interim, the daily total values that are supplied by the Company in its monthly report were used to determine compliance with the volume limit, and to comply with the Regulations.

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.

During the 2015-2016 monitoring period, the bore was not used.

2.1.1.3 Irrigation records

In relation to the Company's spray irrigation of wastewater onto land (that is, the exercise of consents **0922-3** and **0923-3**) the Company supplied the Council with monitoring data relating to the daily volume of factory and dairy shed effluent (DSE) spray irrigated. This information is summarised in Table 3.

Table 3 Wastes irrigation records supplied by Fonterra, 2015-2016

Month	Northern Farm (Kapuni Farm 1)							Southern Farms (Kapuni Farms 2 & 3)						
	Factory			DSE			Total	Factory			DSE			
	Days	Volume, m/d		Days	Volume, m³/d		Days 2-day volume >2630	Days	Volume, m³/d		Days	Volume, m³/d		Days 2-day volume >3834
		Av.	Max		Av.	Max.			Av.	Max.		Av.	Max.	
July 2015	24	174	350	0	0	0	0	29	355	876	0	0	0	0
August 2015	26	335	670	0	0	0	0	31	1,049	1,512	0	0	0	0
September 2015	30	512	802	0	0	0	0	30	1,475	1,798	21	103	**170**	0
October 2015	31	643	810	0	0	0	0	31	1,727	1,885	29	57	132	0
November 2015	29	478	847	0	0	0	0	30	1,545	1,898	18	73	159	0
December 2015	31	438	723	0	0	0	0	31	1,359	1,593	28	86	167	0
January 2016	31	432	830	0	0	0	0	31	881	1,374	25	88	167	0
February 2016	29	469	1000	0	0	0	0	29	1,173	1,582	26	39	60	0
March 2016	31	473	918	0	0	0	0	31	1,319	1,826	30	56	120	0
April 2016	30	389	643	0	0	0	0	30	1,089	1,280	26	69	167	0
May 2016	31	385	853	18	71	120	0	31	980	1,364	27	42	120	0
June 2016	19	330	633	18	77	120	0	30	630	1,256	24	106	167	0

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

The Company continued to irrigate a large volume of wastewater during the 2015-2016 monitoring period. Consents **0922** and **0923** permit a maximum volume of 2,630 m³ (Northern farm, or Kapuni Farm1) and 3,834 m³ (Southern farms, or Kapuni Farms 2 and3) of factory effluent and dairy effluent combined to be spray irrigated per two consecutive days, with a maximum daily volume for dairy effluent of 120 and 168 m³, respectively.

Irrigation of factory effluent occurred almost daily during the monitoring year. A total volume of 557,866 m³ was irrigated during 2015-2016, with a distribution between farms of 26%, 16% and 58% for Farm 1, (old) Farm 2 and (old) Farm 3, respectively. This was an increase of 3.7% from the volume of 538,074 m³ irrigated in 2014-2015, with similar distribution between farms.

Disposal of dairy shed effluent to land via the factory effluent spray irrigation system was established in 2015-2016, replacing the oxidation pond treatment systems which had discharged to Kaupokonui and Motumate Streams. On (the southern) Kapuni Farms, where irrigation commenced on 4 September 2015, a total volume of 17,835 m³ was discharged over the year to 30 June 2016. On (the northern) Kapuni Farm, where irrigation commenced on 11 May 2016, a total volume of 2,651 m³ was discharged.

The record shows that the volume limits on both consents were complied with throughout the 2015-2016 monitoring period, with one minor exception. On the first full day of dairy effluent irrigation to land on Kapuni Farm, 5 September 2015, the recorded volume exceeded the limit of 168 m³ by 2 m³, or 1.2%. Fonterra informed Council immediately and, as the measurement was within the error of the meter, no further action was taken.

2.1.1.4 Receiving water and coolant 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 spray coolant water temperature. 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. Calibration was generally performed at weekly intervals by Company personnel, and checks were made by Council staff during monthly receiving water sampling surveys. From 19 March 2014, the upstream and downstream temperature data were sent directly to Council by telemetry, on a daily basis, of 15-minute average values.

The temperature record over the 2015-2016 reporting period for the Kaupokonui Stream upstream and downstream of the lactose plant discharge is presented in Figure 3 and Figure 4. The increase in temperature is given in Figure 5.

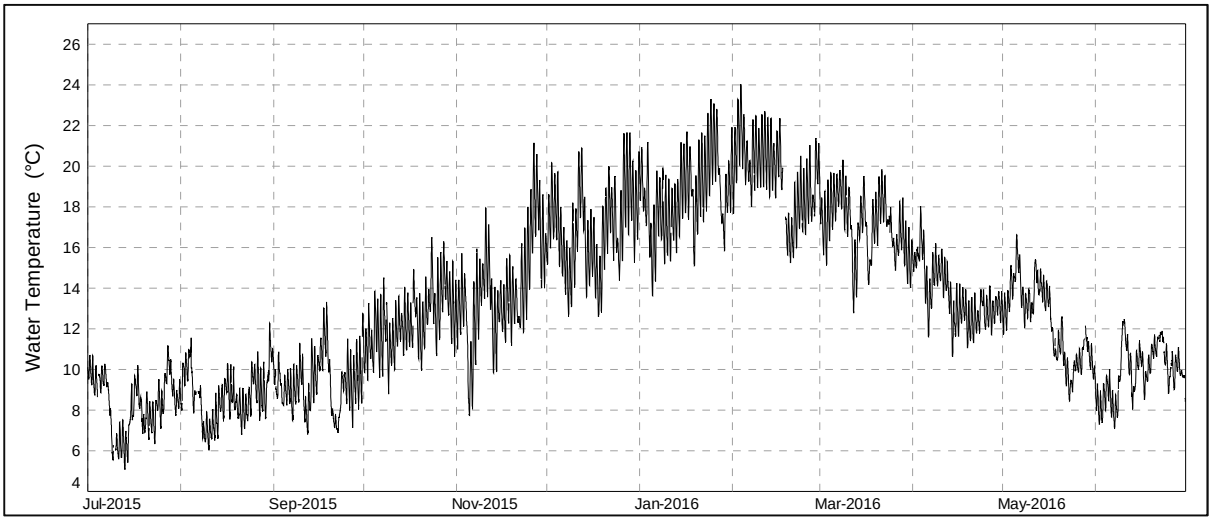

Figure 3 Water temperature (°C) records for the Kaupokonui Stream upstream of lactose plant during the period 1 July 2015 to 30 June 2016

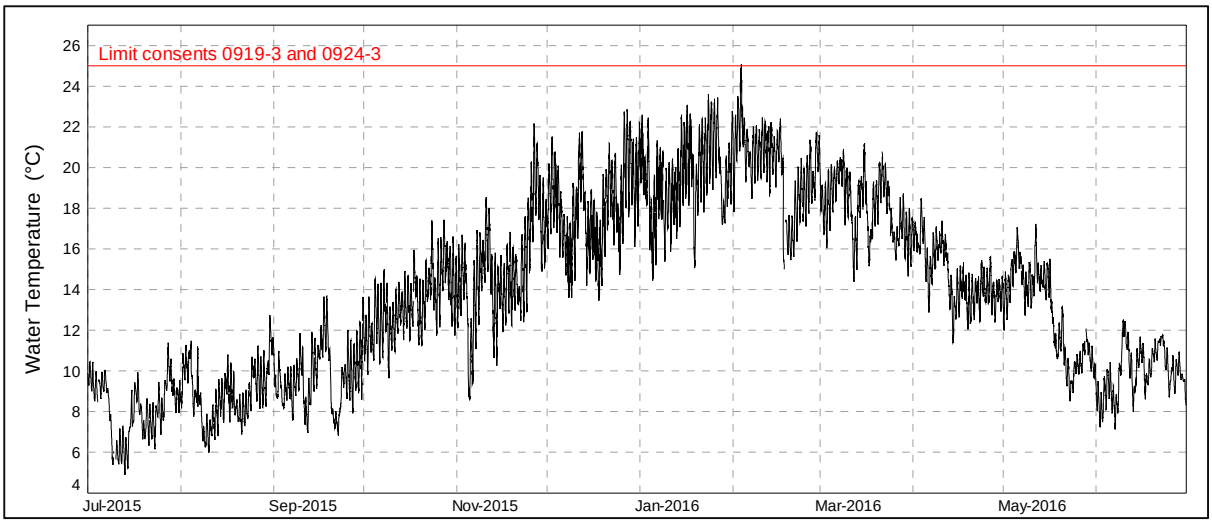

Figure 4 Water temperature (°C) records for the Kaupokonui Stream downstream of lactose plant during the period 1 July 2015 to 30 June 2016

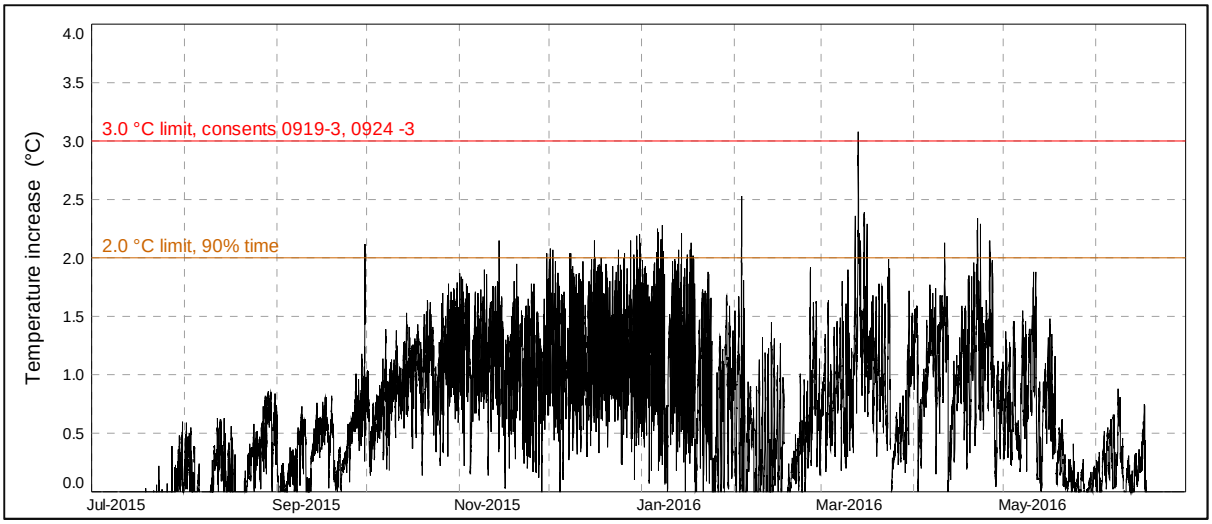

Figure 5 Kaupokonui Stream temperature increase below lactose plant for period 1 July 2015 to 30 June 2016

A summary of the temperature increase and maximum temperature data for 2015-2016 is given in **Table 4**. On a monthly basis, recorded percentage of time the increase was above 2.0°C, 2.5°C and 3.0°C is given, together with the maximum increase and the maximum downstream temperature.

Table 4 Summary of Fonterra continuous water temperature records (°C) from two monitoring probes in the Kaupokonui Stream, July 2015 to June 2016

Month	% Time* Increase			Downstream temperature			
	>2˚C	>2.5˚C	>3˚C	Max Increase (˚C)	Days in excess of 3˚C	Max downstream temp	Days in excess of 25˚C
July 2015	0.0	0.0	0.0	0.6	0	11.4	0
August 2015	0.0	0.0	0.0	0.9	0	12.7	0
September 2015	0.0	0.0	0.0	1.2	0	13.7	0
October 2015	0.0	0.0	0.0	1.8	0	17.4	0
November 2015	0.0	0.0	0.0	2.2	0	22.2	0
December 2015	0.0	0.0	0.0	2.2	0	22.9	0
January 2016	0.13	0.0	0.0	2.3	0	23.6	0
February 2016	0.37	0.0	0.0	2.5	0	25.1	1
March 2016	0.91	0.07	0.0	3.1	1	20.9	0
April 2016	0.09	0.0	0.0	2.3	0	18.5	0
May 2016	0.0	0.0	0.0	1.9	0	17.2	0
June 2016	0.0	0.0	0.0	0.9	0	12.5	0
Total 2015-2016	0.10	0.02	0.00	3.1	1	25.1	1

Note:* = % of actual record

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). During 2015-2016, there were brief periods before the null switch was activated during which temperature spikes exceeded the 3°C increase limit. These temperature values, while the probes were out of the water, were not included in the data analysis.

There were occasions when temperature differences reached or exceeded 2˚C, during periods of low flow in Kaupokonui Stream.

Condition 4(b) of consents **0919-3** and **0924-3** 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. These limits were not exceeded during the 2015-2016 monitoring period, with the exception of one period of less than 15 minutes on 14 March 2016, in which a maximum value of 3.06°C was recorded. (Downstream temperature was 17.8°C). The Company notified Council the next day, reporting that a belt in the cooling tower had failed, resulting in loss of 25% of cooling capacity. The equipment had been repaired.

Condition 5 of consents 0919-3 and 0924-3 requires that the discharge shall not raise the temperature of the receiving water above 25°C at the boundary of the mixing zone. Figure 4 shows that this occurred on one occasion on 3 February 2016 at 1915 NZST. It is noted that the upstream temperature reached the annual maximum that day, of 24.02°C at 1800 NZST. Temperatures recorded further downstream that day reached levels of up to 27.9 °C, at 1630 NZST at Glenn Road.

2.1.1.5 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. In 2015-2016, composite samples of refrigerated grabs, taken automatically at five-minute intervals over the week at the filter on the line from the plant wastewater tank whenever wastewater was pumped to the farms. The samples were sent to an outside laboratory (Industrial Chemistry Services Ltd) for analysis of pH, organic strength, major mineral components, and nutrients, including nitrogen species. The results for the 47 samples taken between 3 August 2015 and 28 June 2016 are summarised in Table 5.

Table 5 Results of factory wastewater monitoring by Fonterra 2013-2015

Parameter	Unit	2015-2016		% change	2014-2015		% change	2013-2014	
		Median N = 47	Range		Median N = 46	Range		Median N = 46	Range
pH	pH	4.4	4.2 – 8.9		4.4	4.1 – 4.7	-	4.5	4.3 – 5.4
Chemical oxygen demand	g/m^3	7,600	517 – 20,940	-10	8,435	5,150 – 14,106	- 4	8,747	5,218 – 19,926
Lactose	%	0.37	0.0 – 4.10	-35	0.57	0.32 – 14.5	+19	0.48	0.00 – 1.37
Nitrate-	g/m^{3}N	42	7 - 148	-12	48	5 – 130	+37	35	6 - 83
Nitrite-	g/m^{3}N	2,3	0.2 – 4.9	+77	1.3	0.1 – 8.8	-64	3.7	0.6 – 14.8
Total Kjeldahl Nitrogen (TKN)	g/m^{3}N	44	7 - 148	+7	41	5 – 130	-11	46	22 - 110
Total Nitrogen	g/m^{3}N	94	12 - 191	-12	107	41 – 176	+23	87	41 - 143
Total Phosphorus	g/m^{3}P	100	3 - 302	+8	93	25 – 278	-28	129	41 - 275
Sodium	g/m^3	131	27 - 201	+17	112	57 – 189	- 8	122	51 - 176
Potassium	g/m^3	140	16 - 440	-3	145	54 – 320	- 3	150	60 - 245
Calcium	g/m^3	165	67 ‘ 276	-16	196	137 – 352	- 17	235	143 - 392
Magnesium	g/m^3	19	2 - 86	-10	21	5 – 183	0	21	5 - 90
Sodium adsorption ratio		3.5	1.1 – 5.1	+22	2.7	1.7 – 4.2	0	2.7	1.2 – 4.2
Ash	g/m^3								

The lactose plant wastewater typically has high organic strength and is acidic. A comparison can be made between results for the 2013-2014, 2014-2015 and 2015-2016 monitoring years on the basis of median values, as described in Table 5. Wastewater organic strength reduced in 2015-2016, by 10% for COD and by 35% for lactose. Total nitrogen reduced by 12%, reducing the 23% increase of the previous year. A reduction in use of the nitric acid-based clean–in-place (CIP) system may have been a factor in this. Total nitrogen concentration agreed reasonably well with individual nitrogen species in 2015-2016, unlike the previous season. Sodium adsorption ratio was the highest recorded, though well within the safe range for soil stability.

With respect to mass discharge rate of wastewater components, factory wastewater volume has changed little since 2011-2012. Therefore, the mass discharge rate of the wastewater components has increased or reduced by about the same proportion as their respective concentrations. Thus, it appears that the total mass of nitrogen applied to irrigation decreased in 2015-2016. The annual volume of factory wastewater produced since 2009-2010, together with the annual mass of factory Nitrogen irrigated, is presented in Figure 6.

Within the production season, measured wastewater strength was significantly higher from mid-August to early December, in terms of COD, total nitrogen, and minerals. This coincided with peak production periods.

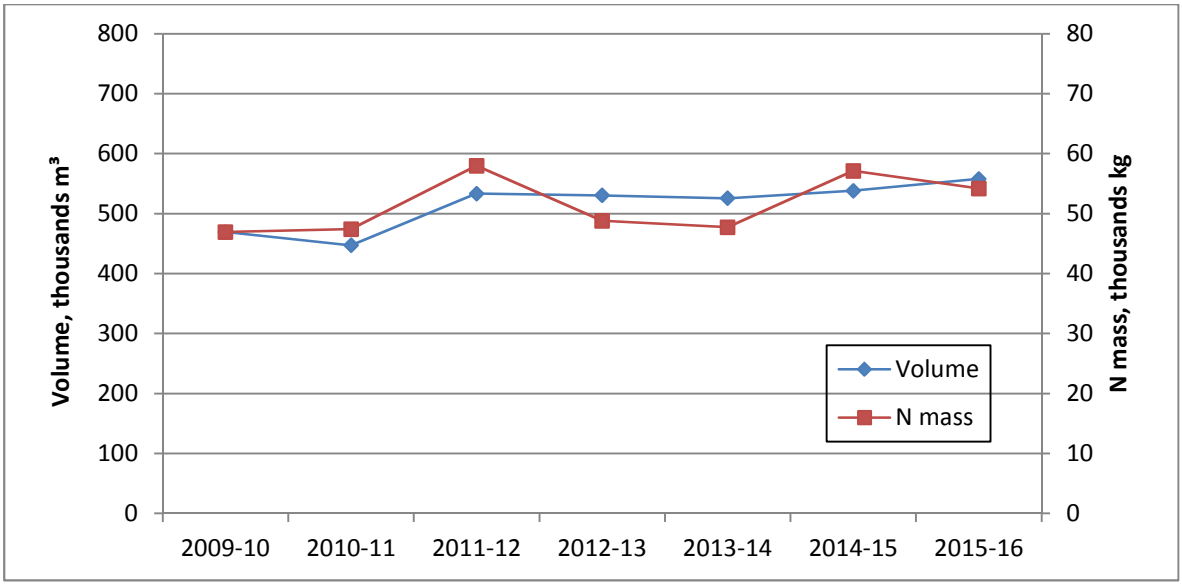

Figure 6 Annual volume of factory wastewater and factory Nitrogen mass irrigated, 2009 - 2016

Dairy shed effluent (DSE)

The Company began weekly analysis of dairy shed effluent (DSE) during the 2015-2016 season upon the commencement of spray irrigation of DSE to land, together with factory wastewater. Automatic solenoid samplers, located beside the storage pond pump at each farm, collect composite samples over 24 hours, whenever DSE pumping occurs. Analysis is as for factory wastewater, without lactose, plus biochemical oxygen demand (BOD). A total of 36 samples were taken between 30 September 2015 and 28 June 2016 for Kapuni Farms, and four samples were taken between 24 May and 24 June 2016 for Kapuni Farm 1. The results are summarised in Table 6.

Table 6 Results of dairy shed effluent monitoring by Fonterra 2015-2016

Parameter	Unit	Kapuni Farm 1		Kapuni Farms (Farms 2 and 3)	
		Median N = 4	Range	Median N = 36	Range
pH	pH	8.0	7.8 – 8.5	7.8	7.4 – 8.2
Chemical oxygen demand	g/m³	200	160 – 240	756	24 – 1226
Nitrate	g/m³N	0.80	0.44 – 1.19	0.44	<0.02 – 2.25
Nitrite	g/m³N	0.05	<0.01 – 0.22	0.05	<0.01 – 0.20
Total Kjeldahl Nitrogen (TKN)	g/m³N	54	30 - 59	186	51 – 264
Total Nitrogen	g/m³N	55	31 - 60	186	51 – 268
Total Phosphorus	g/m³P	2.3	1.2 – 3.1	88	30 – 113
Sodium	g/m³	63	25 – 68	81	33 – 111
Potassium	g/m³	355	240 - 380	705	38 - 860
Calcium	g/m³	58	44 – 67	108	55 – 153
Magnesium	g/m³	2.2 - 82	13	36	5 - 105
Sodium adsorption ratio		2.3	1.2 – 3.1	2.4	1.1 – 3.3
Ash	g/m³	917	490 - 1017	1869	557 – 2231

Parameter	Unit	Kapuni Farm 1		Kapuni Farms (Farms 2 and 3)	
		Median N = 4	Range	Median N = 36	Range
pH	pH	8.0	7.8 – 8.5	7.8	7.4 – 8.2
Chemical oxygen demand	g/m³	200	160 – 240	756	24 – 1226
Nitrate	g/m³N	0.80	0.44 – 1.19	0.44	<0.02 – 2.25
Nitrite	g/m³N	0.05	<0.01 – 0.22	0.05	<0.01 – 0.20
Total Kjeldahl Nitrogen (TKN)	g/m³N	54	30 - 59	186	51 – 264
Total Nitrogen	g/m³N	55	31 - 60	186	51 – 268
Total Phosphorus	g/m³P	2.3	1.2 – 3.1	88	30 – 113
Sodium	g/m³	63	25 – 68	81	33 – 111
Potassium	g/m³	355	240 - 380	705	38 - 860
Calcium	g/m³	58	44 – 67	108	55 – 153
Magnesium	g/m³	2.2 - 82	13	36	5 - 105
Sodium adsorption ratio		2.3	1.2 – 3.1	2.4	1.1 – 3.3
Ash	g/m³	917	490 - 1017	1869	557 – 2231

The DSE has lower organic (COD) and higher mineral (conductivity) strength than factory wastewater, and is slightly alkaline. The effluent from Kapuni Farm 1 had lower component concentrations than that of Kapuni Farms, possibly owing to a larger presence of stormwater in the former, although relatively few samples of it were taken, late in the dairy season. The median total nitrogen concentration in Kapuni Farms effluent (186 g/m³), was more than triple that of Kapuni Farm 1 effluent (55 g/m³), and about double that of factory wastewater (94 g/m³).

Interlaboratory comparison

An inter-laboratory comparison exercise was carried out on 20 May 2016 on **24-hour composite** samples taken by Fonterra of factory wastewater and Kapuni Farms DSE. The results are given in Table 7.

Table 7 Results of inter-laboratory comparison on factory and dairy effluents, 20 May 2016

Parameter	Unit	Factory wastewater		Dairy shed effluent	
		Fonterra (ICS)	TRC	Fonterra (ICS)	TRC
Conductivity, 20°C	mS/m		139		331
pH	pH	4.4	4.3	7.7	7.8
Alkalinity, total to pH 4.5	g/m³ CaCO		0.		1130
Suspended solids	g/m³		480		1100
Ash	g/m³	931		1816	
Oil and grease	g/m³		3.8		9.7
Chemical oxygen demand (COD)	g/m³	6920	6100		2300
Biochemical oxygen demand (BOD)	g/m³		3100	1240	960
Ammonia, total	g/m³N		5.7		171
Nitrite	g/m³N	0.91		<0.02	

Nitrate	g/m^{3}N	39		0.24	
Nitrate + nitrite	g/m^{3}N		54		0.44
Total Kjeldahl Nitrogen (TKN)	g/m^{3}N	55	16	220	240
Total Nitrogen	g/m^{3}N	95	70	220	240
Total Phosphorus	g/m^{3}P	42	64	83	105
Bicarbonate	g/m^3 HCO_3				
Chloride	g/m^3		74		370
Sulphate	g/m^3		40		32
Calcium	g/m^3	166	134	119	64
Magnesium	g/m^3	43	15	58	26
Potassium	g/m^3	100	90	800	560
Sodium	g/m^3	137	62	100	128
Sodium adsorption ratio					
Potassium adsorption ratio					

Agreement between laboratories was poor, apart from on pH, which has lead to revision of the methods of sample compositing, splitting and identification. The exercise will be repeated.

However, a wide range of parameters was tested by Council, for future reference. For nitrogen species, it was determined that nitrate was the major component in factory wastewater, whereas ammonia and organics (together TKN) comprised almost all in DSE.

2.1.2 Council monitoring

2.1.2.1 General inspections of factory premises

Twelve scheduled inspections of the premises, treatment system and Kaupokonui Stream were performed during the 2015-2016 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 made liaison with the Council officer and provided an update on the Company's performance on each inspection occasion.

2.1.2.1.1 General site

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

2.1.2.1.2 Intake from the Kaupokonui Stream

The monthly inspections showed that both the Company's weir and intake system worked well during the period under review. The intake structure was cleaned of silt in July 2015, without incident.

The fish pass installed by the Company under the guidance of the Council in March 2004, contained an adequate level of water during all inspections.

2.1.2.1.3 Spray cooling wastes discharges to the Kaupokonui Stream

New cooling towers were constructed and commissioned in August and September 2015, designed to achieve a temperature of less than 25°C for water entering Kaupokonui Stream after going through the towers and existing spray system, that is, below the maximum temperature allowed in the receiving water under consent 0919-3. Flow and temperature meters were installed on the inflow line to the towers. A flow meter was also placed on the line through which combined recovery condenser cooling water and stormwater is discharged directly to the stream under consent 0924-3. The installation of telemetry for the monitoring data from these meters was delayed until December 2015, while landscaping around the towers was carried out.

The cooling water discharge system had variable performance during the monitoring year. The Company's recording system had some malfunctions, resulting in periods of missing records with regard to stream temperatures. General problems with electronic transmission of monitoring data to Council are covered in section 3.1.

The most common cause of missing (or inaccurate) data in the temperature record was due to one or both instream temperature probes being removed from the stream during fresh conditions to prevent damage, or during calibration exercises. During these times a null switch is activated to avoid recording inaccurate data.

The growth in riparian vegetation continued to be effective at preventing spray drift of cooling water beyond the property.

2.1.2.1.4 Other discharges to the Kaupokonui Stream

The stormwater outfalls, from the IGL plant installed upstream of the old rail bridge and the detention pond downstream of the cooling water sprayers, did not cause concern during the monitoring period, due to either very low discharge rates or limited contamination of the discharge.

Photo 1 Valve on northern storm drain, and Reno mattresses laid out below storm drains to Kaupokonui Stream

A valve is installed on this stormwater outfall, in case of accidental spillage of chemicals, and Reno mattresses for erosion control were laid below both northern

stormwater outlets, as shown in Photo 1. The valve was not required to be used in the 2015-2016 review period.

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.

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, is also discharged back to the Motumate catchment via a tributary immediately opposite the factory across Manaia Road.

2.1.2.1.7 Spray irrigation of wastewater

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

Spray irrigation 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 (Figure 1), of which 44 ha is reticulated with in-ground irrigators. The total area farmed is 244 ha.

For 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". For the purposes of describing the wastewater system the old farm designations are occasionally used in this report.

The majority of inspections noted spraying of wastewater onto paddocks well away from stock. No spray drift across streams was observed. Care is required while irrigating near watercourses particularly during windy conditions. Spraying is not to occur within 20 m of a watercourse (condition 6 of consent **0923**). A weather station with telemetry to the pump station on Kapuni Farms was installed in August 2015, allowing faster response to changes in wind direction.

No leakage of wastewater/stormwater from the underground transfer and distribution pipelines to surface water was recorded. A set of standard operating procedures is in place for monitoring of the system. Pumping is stopped automatically, and restarts must be made manually, when the pressure set point is exceeded.

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 Fonterra farms, which improved the performance of these areas in their ability to receive and assimilate the irrigated wastewater. Testing undertaken in May 2010 indicated that aeration is no longer required, unless there is visible sign of ponding. Some aeration was undertaken in February 2016.

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 Northern Farm cowshed to the downstream farm boundary, which were planted during the 1997 and 1998 winter periods, continued to be maintained during the 2016 monitoring period. The Company is currently investing around $20,000 a year in planting and fencing of waterways around the factory and Company farms, and a further $2,000 a year on maintenance of these areas, such as spraying. This includes an annual donation of $3.000 to the Taranaki Tree Trust in accordance with condition 10 (b) of consent **0919.** At the end of the review period, a total of $52,080.00 had been donated to the Trust.

An example of riparian planting is given in Photo 2, 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.

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

In a separate project initiated by Fonterra 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 metres, at a cost of $6,224. The roadside plantings will 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 Kapuni 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. All plantings were maintained in 2016.

2.1.2.1.9 Disposal of solid wastes

Solid wastes from annual cleaning of the waste effluent tank and lime silo have been disposed of by burial on Kapuni Farms during the winter maintenance shut-down for a number of years. This activity is 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 is 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.

2.1.3 Results of discharge monitoring

2.1.3.1 Physicochemical

2.1.3.1.1 Cooling waters' quality

Monthly sampling of the spray cooling water discharge (authorised by discharge permit **0919-3**) and the combined stormwater/cooling water pipe discharge (permit **0924-3**) involved the collection by the Company of one representative 24-hour composite sample of each waste, to be analysed by the Council. The results of these analyses for 2015-2016 are presented in Table 8.

Table 8 Results of the analysis of stormwater/cooling water and spray cooling water discharge, 2015-2016

Waste	Spray cooling water					Stormwater/cooling water						
Site code	STW 002017					STW 002018						
Date	BOD_5		Condy @ 20°C	Turbidity	pH	BOD_5		Condy @ 20°C	Turbid-ity	Susp-ended solids	pH	O&G
	Total	Filtered				Total	Filtered					
	g/m³	g/m³	mS/m	NTU		g/m³	g/m³	mS/m	NTU	g/m³	pH	g/m³
16-Jul-15°	-	-	-	-	-	5.8	2.0	44.5	6.8	<2	6.9	<0.5
20-Aug-15	1.8	-	11.8	1.1	6.9	1.0	<0.5	7.3	2.1	2	6.9	<0.5
17-Sep-15	1.1	<0.5	10.2	1.0	7.6	1.8	<0.5	11.2	2.4	7	7.5	<0.5
16-Oct-15*^	1.6	1.4	10.9	1.6	7.5	11	9.8	13.8	4.0	8	7.0	<0.5
20-Nov-15°^	-	-	-	-	-	3.5	3.2	11.4	0.7	<2	7.6	<0.5
17-Dec-15	1.3	0.6	10.7	1.4	7.7	81	67	11.0	1.4	9	7.0	<0.5
17-Dec-15*	16		10.9	52	7.6							
28-Jan-16	1.2	0.7	10.6	1.6	7.5	4.7	0.6	10.3	4.2	14	7.3	<0.5
18-Feb-16	1.0	0.6	10.4	0.9	7.5	9.5	3.2	7.5	36	46	7.1	<0.5
24-Mar-16	-	-	-	-	-	-	-	-	-	-	-	-
22-Apr-16	<0.5	<0.5	9.5	1.0	7.5	2.8	2.5	9.4	0.8	<2	7.3	<0.5
19-May-16	2.0	1.3	7.1	6.2	7.4	6.0	3.0	7.6	12	13	7.1	<0.5
22-Jun-16^	<0.5	<0.5	11.6	0.51	7.5	1.7	0.7	13.2	2.0	6	6.8	<0.5
Range	<0.5 -16	<0.5- 1.4	7.1 – 11.8	0.5 - 52	6.9 - 7.7	1.0 – 81	<0.5 – 67	7.3-44.5	0.74–36	<2 – 46	6.8– 7.6	<0.5
Median	1.2	0.6	10.6	1.2	7.4	4.7	2.5	11.0	2.4	7	7.1	<0.5

°No spray cooling water discharge, as plant not operating

* Grab sample of spray cooling water collected due to absent or insufficient composite

^ Grab sample of stormwater/cooling water collected due to absent or insufficient composite

No samples were taken on 24 March 2016, under heavy rainfall conditions. Composite samples of the spray cooling water discharge were either not collected or of insufficient volume on two out of 11 monitoring occasions in 2015-2016, because the samplers had either not been set up properly or failed, in which case a grab sample was taken. On two occasions, no sample was taken as the main plant was not operating. Similarly, for stormwater/cooling water, grab instead of composite samples were taken on three occasions in 2015-2016.

Both discharges have been sampled (mainly as 24-hour composites) and analysed by the Council during previous monitoring periods. A summary of these results is presented in Table 9.

Table 9 Summary of cooling water discharge quality from the Council surveys during the period March 1992 to June 2015

Waste	Spray cooling water				'Stormwater/cooling' water		
Parameter	Unit	No. of samples	Range	Median	No. of samples	Range	Median
Conductivity at 20˚C	mS/m	195	3.1 – 46.8	9.8	213	5.4 - 132	10.8
Turbidity	NTU	192	0.4 - 450	1.7	207	0.3- 110	2.5
BOD_5	g/m^3	194	0.4 - 460	2.6	208	<0.5 - 1100	2.4
BOD_5 (filtered)	g/m^3	179	0.4 - 91	1.2	189	<0.5 - 1100	1.4
pH	pH	76	5.8 – 8.2	7.4	117	4.6 – 10.6	7.2
Oil and grease	g/m	2	<0.5	<0.5	83	<0.5 – 4.3	<0.5

For the spray cooling water, the seasonal increase in total and filtered BOD in spring/summer that was noted in the previous three years was not repeated in 2015-2016. Median total BOD decreased significantly, for the second successive year, to the long-term median of 1.2 g/m^3 from 4.7 g/m^3 in 2014-2015 and 7.2 g/m^3 in 2013-2014. One grab sample, taken on 17 December 2015 because composite sample volume was low, had a relatively high BOD of 16 g/m^3, indicating some variability in cooling water composition.

For the stormwater/cooling water, median BOD (organics) and conductivity (minerals) values were similar to those for the previous four seasons. An elevated total BOD of 81 g/m^3 was found in the composite sample taken on 17 December 2016, while conductivity and turbidity were normal. No significant effect of the discharge was found in the receiving water, either as BOD increase or as visible biological growth.

Normally, contaminated 'stormwater/cooling water' is dealt with by diversion to the effluent irrigation system (by means of Fonterra's internal conductivity/turbidity-based alarm system) or by the location and elimination of a major contamination source.

In comparison with historical data, the 'stormwater/cooling water' discharge results were within ranges previously recorded.

2.1.3.1.2 Stormwater quality

Discharges from stormwater pipe outlets to the stream were sampled at four locations: from the northern (STW001062) and southern (STW002018) areas of the lactose plant, the IGL plant (STW001109), and the stormwater pond (STW002078), as shown in Figure 6. The discharge from the southern area of the lactose plant is combined with cooling water and has been addressed in section 2.1.3.1.1 above.

Discharges were found to be occurring on most inspections, however some of these were very small volumes.

Some additional sampling was undertaken, as part of the consents replacement process, to measure stormwater components not normally monitored. Three sets of stormwater samples were collected between June 2015 and April 2016, the last two

by Fonterra, which were analysed for nutrients, trace metals and faecal indicator bacteria.

2.1.3.1.2.1 Northern outfall

A grab sample was collected from the discharge (STW001062, see Table 12) on 10 occasions during 2015-2016 and analysed by the Council's laboratory. These results are presented in Table 10 below. Rain was falling or had recently occurred on six occasions. There was typically a small discharge.

Table 10 Results of the analysis of monthly grab samples of the stormwater from the northern factory extensions outfall discharge during the 2015-2016 monitoring period

Date	Flow rate (estimated)	BOD_5	Conductivity at 20˚C	Turbidity	O&G	pH	Suspended solids	Chlorine	
								Free	Total
	L/s	g/m³	mS/m	NTU	g/m³		g/m³	g/m³	g/m³
16-Jul-15	0.1	<0.5	14.8	0.70	<0.5	7.0	<2	0.6	0.6
20-Aug-15	0.1	1.8	18.9	0.54	<0.5	6.9	2	-	-
17-Sep-15	0.2	5.9	14.4	0.82	<0.5	7.5	<2	-	-
16-Oct-15	0.1	1.2	17.1	0.41	<0.5	7.0	<2	<0.1	0.1
20-Nov-15	<0.1	3.4	18.8	0.77	<0.5	7.2	<2	<0.1	<0.1
17-Dec-15	0.1	17	11.3	2.2	<0.5	7.6	9	<0.1	<0.1
28-Jan-16	0.1	14	30.4	1.8	<0.5	6.6	<2	<0.1	<0.1
22-Apr-16	0.1	5.7	11.8	3.0	<0.5	7.3	3	<0.1	<0.1
19-May-16	0.1	18	12.7	7.6	<0.5	6.8	4	<0.1	<0.1
22-Jun-16	0.1	1.8	9.8	1.0	<0.5	7.3	2	<0.1	<0.1
Consent limit					**15**	**6.0 – 8.5**	**100**		
1995-2015									
No of samples		100	102	96	63	91	73	6	6
Range		<0.5 – 1400	0.6 – 38.4	0.20 – 29	<0.5 – 2.2	3.8 – 8.7	<2 – 32	<0.1 – 1.6	<0.1 – 1.6
Median		6.0	10.6	3.4	<0.5	7.0	3	0.1	0.2

BOD_5 was elevated seven of the ten occasions monitored, indicating some organic contamination. This may have been a result of lactose powder deposition within the stormwater catchment. A slight organic odour was noticed on several occasions. Chlorine odour was noticeable on one occasion (in July 2015, which probably affected the BOD test, de-chlorination then being instituted), and slight on two others.

The limits on pH, oil and grease, and suspended solids prescribed by conditions on consent **4604-2** were complied with.

The results from additional sampling to characterise the stormwater are given in Table 11.

Table 11 Results of the analysis of additional grab samples of the stormwater from the northern factory extensions outfall discharge

Date	Conduct-ivity at 20˚C	pH	Ammonia	Nitrate	DRP	Copper	Lead	Zinc	Susp. Solids	Faecal coliforms
	mS/m		g/m³N	g/m³N	g/m³P	g/m³	g/m³	g/m³	g/m³	cfu/100ml
25-Jun-15*	21.8	6.9	<0.003	5.6	0.016	<0.01	<0.05	0.090	<2	<2
4-Dec-15	3.0	6.5	0.22	0.10	0.050	0.02	<0.05	0.35	32	8,000
4/5-Apr-16	10.1	7.4	0.128	0.06	0.012	<0.01	<0.05	0.012	<2	(9)
Range	3.0 – 21.8	6.5 – 7.4	<0.003 – 0.22	0.06 – 5.6	0.016 – 0.50	<0.01 – 0.02	<0.05	0.012 – 0.35	<2 - 32	<2 - 8,000

* Total and free chlorine, 1.6 g/m³

Nutrient, trace metal and faecal indicator bacteria levels were within the ranges typical of discharges of this type, and would not be expected to impact adversely on the receiving water under storm flow conditions. On 25 June 2015, the discharge of about 0.2 litres/second was clear (0.17 NTU) and had a noticeable chlorine odour (1.6 g/m³ free), possibly from a release of treated process water during the annual maintenance shutdown.

2.1.3.1.2.2 IGL plant outfall

The IGL plant stormwater outfall (STW001109, Table 13) was discharging during one inspection in 2015-2016. The results of the grab sample collected are presented in Table 12 below.

Table 12 Results of the analysis of grab sample of the stormwater from the IGL outfall discharge during the 2015-2016 monitoring period

Date	Flow rate (estimated)	BOD_5	Conductivity at 20˚C	Turbidity	O&G	pH	Suspended solids
	L/s	g/m³	mS/m	NTU	g/m³		g/m³
19-May-16	<0.1	1.6	14.2	2.5	<0.5	6.8	4
Consent limit		-	-	-	**15**	**6.5 – 8.5**	**100**
2005-2015							
No of samples		21	22	22	14	22	20
Range		<0.5 – 41	0.6 – 22.6	1.1 – 230	<0.5 – 0.8	6.5 – 8.0	<2 – 62
Median		4.4	7.2	6.1	<0.5	7.0	6

A small amount of activated carbon was present in the sample, and slight foaming at the outfall. There was no sign of undesirable biological growths in the receiving waters below the discharge point.

Limits prescribed by conditions of consent **6423-1** were complied with.

The results from additional sampling to characterise the stormwater are given in Table 13.

Table 13 Results of the analysis of additional grab samples of the stormwater from the IGL outfall discharge

Date	Conduct-ivity at 20˚C	pH	Ammonia	Nitrate	DRP	Copper	Lead	Zinc	Susp. Solids	Faecal coliforms

	mS/m		g/m³N	g/m³N	g/m³P	g/m³	g/m³	g/m³	g/m³	cfu/100ml
4-Dec-16	2.5	7.7	0.45	0.20	0.083	<0.01	<0.05	0.048	15	11,000

Nutrient, trace metal and faecal indicator bacteria levels were within the ranges typical of discharges of this type, and would not be expected to impact adversely on the receiving water under storm flow conditions.

2.1.3.1.2.3 Stormwater pond outfall

Samples were also collected from the outlet of the stormwater pond (Site STW002078, Table 14 and Photo 3) on four occasions during 2015-2016. The results of the grab samples collected are presented in Table 14. There had been a recent rainfall event prior to the collection of each sample. The stormwater pond outlet valve was closed on all but the last sampling occasion, suggesting groundwater seepage. On 18 February 2016, the stormwater pond contents were being discharged; there was a slight organic odour.

Photo 3 Outfall from stormwater pond to Kaupokonui Stream

Table 14 Results of the analysis of grab samples of the stormwater pond during the 2015-2016 monitoring period

Date	Flow rate (estimated)	BOD_5	Conductivity at 20˚C	Turbidity	Hydro-carbons	pH	Suspended solids
	L/s	g/m³	mS/m	NTU	g/m³		g/m³
16-Jul-15	0.1	0.7	42.9	0.20	<0.5	7.4	<2
20-Aug-15	<0.1	0.9	45.8	0.96	<0.5	7.3	<2
17-Sep-15	<0.1	0.7	48.8	1.4	<0.5	7.6	<2
18-Feb-16	2	4.5	4.8	8.2	<0.5	7.0	9
Consent limit		-	-	-	**15**	**6.5 – 8.5**	**100**
2008-2015							
No of samples		18	19	19	15	18	15
Range		<0.5 – 28	4.6 – 45.2	0.05 – 31	<0.5	6.6 – 7.6	<2 - 35
Median		1.2	39.1	0.6	<0.5	7.4	<2

Conductivity values at this site have been found to vary widely, tending to be higher in winter when groundwater infiltration occurs. (Two sources of groundwater infiltration to the stormwater lines were found by video camera and the lines re-grouted in July 2009, but some infiltration continued). Limits prescribed by conditions on consent **0924-3** were complied with.

The results from additional sampling to characterise the stormwater are given in Table 15.

Table 15 Results of the analysis of additional grab samples of the stormwater from the stormpond outfall discharge

Date	Conduct-ivity at 20˚C	pH	Ammonia	Nitrate	DRP	Copper	Lead	Zinc	Susp. Solids	Faecal coliforms
	mS/m		g/m³N	g/m³N	g/m³P	g/m³	g/m³	g/m³	g/m³	cfu/100ml
25-Jun-15	36.7	6.9	0.143	6.2	0.016	<0.01	<0.05	0.008	<2	2
4-Dec-15	33.2	6.9	0.010	<0.01	0.010	<0.01	<0.05	0.039	150	2500
Range	33.2 – 36.7	6.9	0.010 – 0.143	<0.01 – 6.2	0.010 – 0.016	<0.01	<0.05	0.008 – 0.039	<2 - 150	2 – 2500

Nutrient, trace metal and faecal indicator bacteria levels were within the ranges typical of discharges of this type, and would not be expected to impact adversely on the receiving water under storm flow conditions.

2.1.3.1.3 Receiving water (Kaupokonui Stream) quality

Sampling of the Kaupokonui Stream adjacent to the Company's factory and Northern Farm wastes irrigation area was performed by the Council on the monthly inspection visits. Three sites were located in the Kaupokonui Stream (Figure 7 and Table 16) as follows:

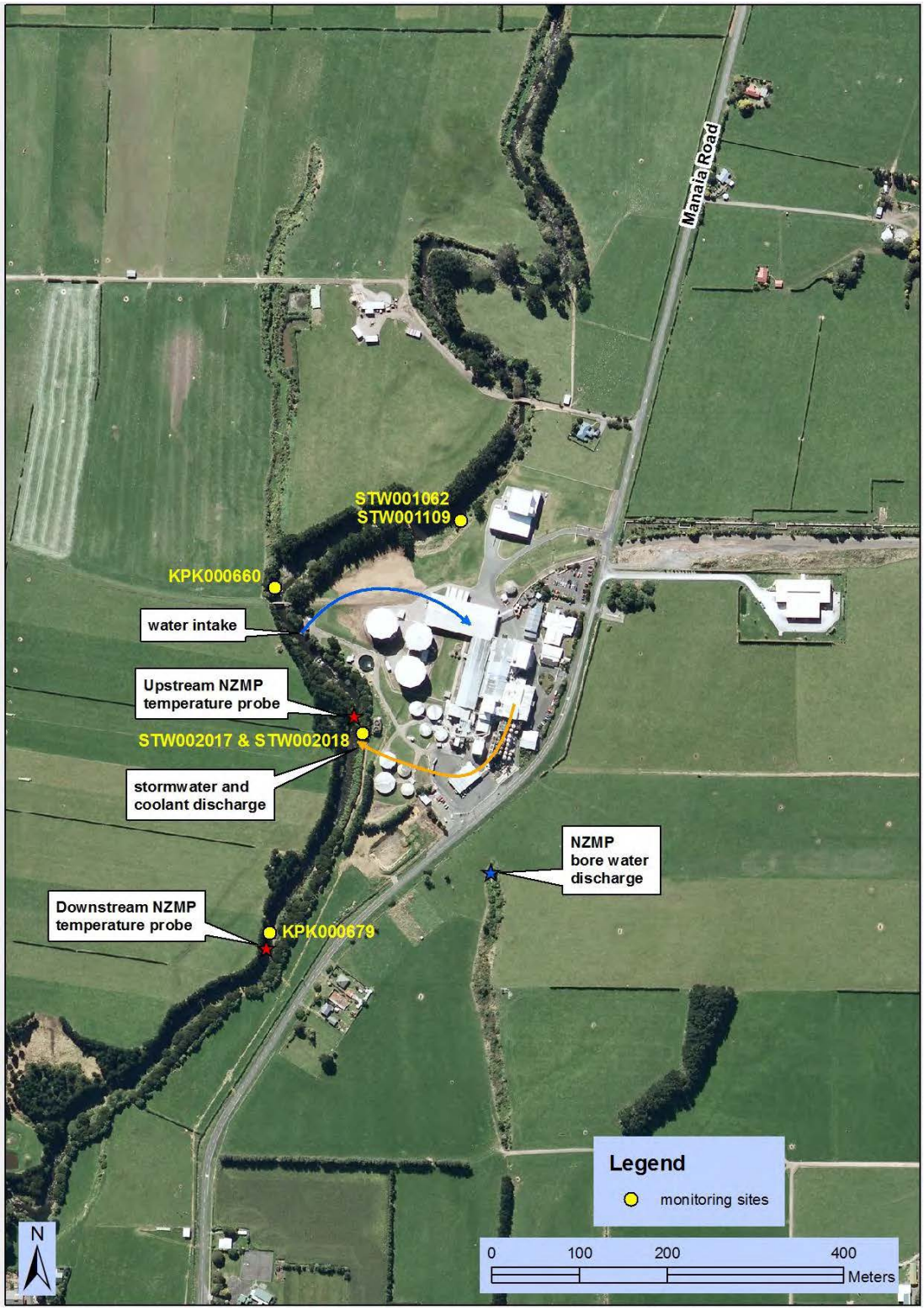

Figure 7 Section of Kaupokonui Stream for physicochemical monitoring in relation to Fonterra Kapuni's waste discharges to water

Table 16 Location of water quality sampling sites

Site	Location	Map reference, NZTM		Site code
		Easting	Northing	
Kaupokonui Stream	1km upstream of rail bridge	1697963	5630770	KPK000655
Kaupokonui Stream	Immediately upstream of rail bridge	1697613	5629791	KPK000660
Kaupokonui Stream	150m downstream of spray cool discharge zone	1697607	5629399	KPK000679

Sampling was performed under varying flow conditions ranging from 0.81 m^3/s to about 30 m^3/s, as measured at Upper Glenn Road hydrometric station, 9.8 km downstream, where the median flow is 2.0 m^3/s, and mean annual low flow (MALF) is 0.75 m^3/s. A record of flows (hydrograph) over the reporting period is presented in Figure 12. Samples were taken in mid to late morning. The results of this monitoring are contained in Appendix II and summarised in Table 17. No samples were taken during the 24 March 2016 inspection, while the Kaupokonui Stream was in flood.

Table 17 Summary of Kaupokonui Stream water quality data (ranges) from monthly monitoring for the period July 2015 to June 2016 (N=11 samples)

Site		KPK000655		KPK000660		KPK000679	
Parameter	Unit	Range	Median	Range	Median	Range	Median
Temperature	˚C	7.7 – 17.1	11.3	8.0 – 17.3	11.5	8.3 – 17.4	12.7
Conductivity @ 20˚C	mS/m	3.8 – 10.1	9.0	4.1 – 11.0	9.4	4.4 – 11.1	9.5
Turbidity	NTU	0.56 – 94	1.1	0.58 - 64	1.2	0.58 – 56	1.1
pH	pH	6.8 – 7.8	7.6	6.8 – 7.9	7.6	7.0 - 8.2	7.8
Total BOD_5	g/m^3	<0.5 – 2.3	<0.5	<0.5 – 2.1	0.7	<0.5 – 2.1	0.6
Filtered BOD_5	g/m^3	<0.5 – 1.1	<0.5	<0.5 – 1.6	<0.5	<0.5 – 1.0	<0.5
Ammonia-N	g/m^3 N	<0.003–0.038	0.017	0.003 – 0.036	0.015	0.003 – 0.037	0.012
Nitrate+Nitrite	g/m^3 N	0.18 – 0.82	0.43	0.20 – 0.96	0.50	0.22 – 0.97	0.50
DRP	g/m^3 P	0.006 - 0.027	0.012	0.007 – 0.027	0.016	0.007 – 0.027	0.017

Past Council sampling results from these sites are presented in summary form in Table 18.

Table 18 Summary of Kaupokonui Stream water quality data from the Council surveys during the period August 1994 to June 2015

Site		KPK000655			KPK000660			KPK000679		
Parameter	Unit	No.	Range	Median	No.	Range	Median	No.	Range	Median
Temperature	˚C	199	4.9 – 19.1	12.2	202	5.1 – 19.4	12.5	202	5.2 – 21.7	13.7
Conductivity	mS/m	201	3.3 – 11.1	9.1	204	3.3 – 11.8	9.6	203	3.2 – 11.9	9.7
Turbidity	NTU	200	0.39 – 120	0.97	203	0.4 – 130	0.9	202	0.4 – 160	0.88
pH	pH	198	6.9 – 8.5	7.7	200	7.0 – 8.6	7.7	199	7.0 – 8.5	7.8
Total BOD_5	g/m^3	198	<0.5 – >8.3	0.6	201	<0.5 – 7.5	<0.5	201	<0.5 - >8	0.7
Filtered BOD_5	g/m^3	198	<0.5 – 1.8	<0.5	200	<0.5 – 1.7	<0.5	200	<0.5 - >8	0.5
Ammonia-N	g/m^3 N	200	<0.003 – 0.87	0.022	199	<0.003– 0.147	0.018	200	<0.003 –0.25	0.018
Nitrate+Nitrite	g/m^3 N	70	0.13 – 1.26	0.38	70	0.12 – 1.36	0.44	70	0.11 – 1.40	0.48

The receiving water quality sampling results (and Appendix II) indicated that minimal impacts of the two cooling waters' discharges were measured in the Kaupokonui Stream, at time of sampling, with no sewage fungus noted over the monitoring period.

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.

No conspicuous changes in clarity, as indicated by turbidity measurements and field comments, were attributed to discharges of cooling or storm water. Natural variation in clarity was observed, in relation to rainfall.

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

The summary of Kaupokonui Stream water quality data for the upstream (control) site recorded over the 21-year period prior to the 2015-2016 monitoring period (Table 18) and during this period (Table 17), shows that, apart from a single lapse in May 2007, there has been very good water quality for the parameters measured under normal flow conditions.

2.1.3.1.4 Groundwater quality

Sampling of shallow groundwater bores was undertaken approximately two-monthly 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 in seasonal variation in groundwater quality, and was reduced to two-monthly in 2009-2010. Eight bores were sampled on the three wastewater spray irrigation farm properties, as described in Table 19 and depicted in Figure 8. One bore ('control') on each property is sited upslope of the irrigation area and another one or two bores ('impact') within or down-slope of each irrigation area.

Table 19 Groundwater monitoring sites

Property	Bore	Designation	Site code	Depth m	Map reference, NZTM	
					Easting	Northing
'Northern' (No 1) Farm	North	Control	GND0636	6.5	1697543	2630420
	South	Impact	GND0637	6.5	1697238	5629857
'Southern' (No 2) Farm	North	Control (new)	GND2049	5.6	1698575	2628905
	West	Impact	GND0638	5.9	1698332	2628562
	South-west	Impact (new)	GND2050	7.0	1698397	5627747
No 3 Farm	North	Control (new)	GND2051	6.5	1697634	5627538
	South-west	Impact (new)	GND2052	7.0	1697216	5626790
	South-east	Impact	GND0700	4.5	1697445	5626790

Relocation and replacement of the original 'impact' bores on the Southern and No. 2 farms was performed in April 1998 (see TRC 98-73), in consultation with the consent holder and following investigations into groundwater contours and flow directions at each of these farms' monitoring sites.

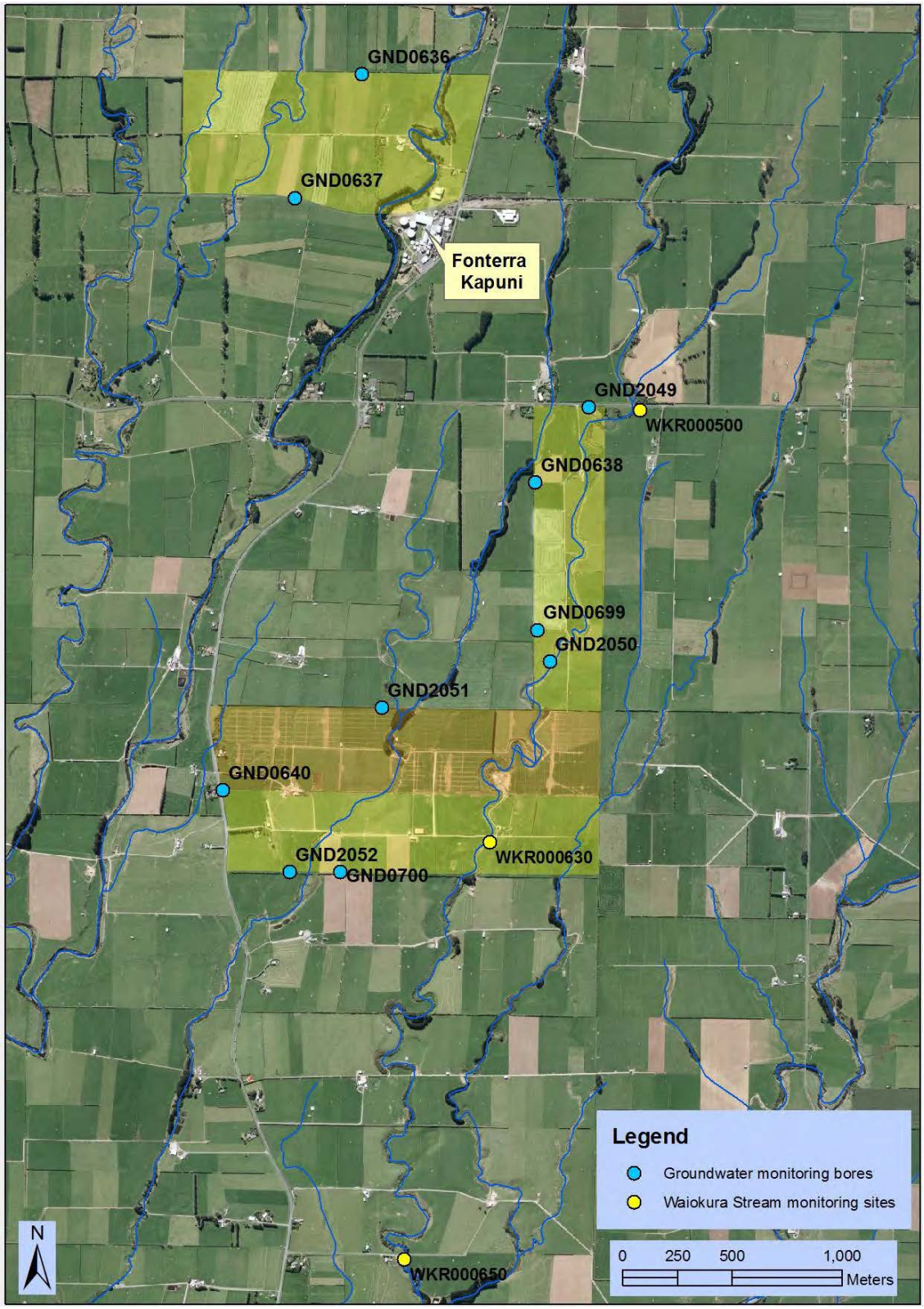

Figure 8 Groundwater monitoring bores and Waiokura Stream sampling site locations on the three Company farms

A summary of groundwater quality data previously collected by the Council from these farm bores is presented in Table 20 for comparison with data collected during the recent monitoring period.

Table 20 Summary of previous Council groundwater quality sampling performed during the period October 1991 to June 2015

Parameter		Level		pH		Conductivity @ 20˚C		Sodium		Nitrate-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)
Northern	Control GND0636	77	1.55-4.83 (2.90)	117	6.2-7.1 (6.5)	116	26.4 -57.7 (30.0)	77	12.0-56 (25)	117	3.7-29 (8.2)	66	<5-27 (<5)
	Impact GND0637	76	2.77-6.15 (4.14)	113	6.1-7.8 (6.5)	111	34.0-82.4 (58.3)	74	40-179 (79)	112	1.5-33 (11.4)	62	<5-42 (7)
Southern (No 2)	Control (New) GND2049	48	1.73-3.80 (2.57)	49	6.2-7.2 (6.4)	49	21.2-48.3 (38.1)	23	26-36 (30)	49	2.4-20 (14.4)	23	<5-7 (<5)
	Impact ('central') GND0638	76	1.08-3.68 (2.58)	111	4.7-6.9 (6.5)	110	54.4-149 (73.9)	72	67-136 (92)	110	<0.01-49 (8.3)	66	<5-1600 (8)
	Impact ('original') GND0639	45	1.90-4.22 (2.88)	64	6.5-7.5 (6.9)	64	43.7-82.6 (64.1)	44	73-157 (120)	64	3.8-29 (11.1)	39	<5-57 (12)
	Impact ('new') GND2050	49	1.60-3.20 (2.59)	49	6.5-7.0 (6.8)	49	13.7-71.1 (54.4)	23	49-102 (80)	49	0.01-13.0 (4.8)	23	<5-21 (<5)
No 3	Control original GND0640	18	0.85-3.24 (1.99)	51	6.4-7.0 (6.8	51	21.0-41.8 (25.9)	45	28-49 (29)	51	<0.01-3.4 (0.13)	42	4-30 (6)
	Control new GND2051	49	1.86-4.46 (3.08)	49	6.4-7.2 (6.5)	49	25.4-56.9 (32.8)	23	24-37 (30)	49	0.03-22 (7.0)	23	<5-31 (<5)
	Impact GND0641	34	1.01–2.94 (1.57)	52	6.3-6.8 (6.5)	53	25.2-63.6 (55.9)	35	30-57 (42)	53	0.87-15.6 (10.7)	32	<5-34 (8)
	Impact ('original') GND0700	73	0.40-4.60 (2.17)	85	5.6-7.2 (6.7)	85	30.3-154 (61.4)	50	39-188 (81)	86	0.02-47 (7.8)	50	<5-33 (6)
	Impact ('new') GND2052	49	1.30-4.38 (2.51)	49	6.4-7.3 (6.6)	49	18.9-42.6 (31.2)	23	35-55 (42)	49	0.01-12.9 (2.0)	23	<5-29 (<5)

* COD = filtered prior to 2006

The groundwater quality monitored at each farm is discussed below. Wastewater irrigation occurred on each farm throughout the monitoring period (see Section 2.1.1.3).

2.1.3.1.4.1 'Northern' Farm groundwater

The results of groundwater monitoring on this farm during the 2015-2016 period are summarised in Table 21. The full set of results is given in Appendix IV.

Table 21 Results of groundwater quality sampling on 'Northern' Farm, 2015-2016

Parameter	Unit	Control (GND0636)			Impact (GND0637)		
		N	Range	Median	N	Range	Median
Water level	m	6	1.74 – 3.74	3.26	6	3.13 – 5.77	4.75
Temperature	°C	6	12.2 – 14.7	13.5	6	13.5 – 15.1	14.0
Conductivity, 20°C	mS/m	6	29.1 – 41.6	29.5	6	34.9 – 60.4	44.6
pH	pH	6	6.5 – 6.8	6.5	6	6.6 – 7.0	6.6
Nitrate+nitrite	g/m³N	6	6.6– 11.2	7.2	6	4.8 – 19.9	5.0
Ammonia	g/m³N	3	<0.003	<0.003	3	<0.003 – 0.008	0.005
Sodium	g/m³	3	22 – 24	24	3	44 – 71	63
Chloride	g/m³	3	37 – 42	41	3	35 – 78	49
COD	g/m³	3	<5 - 7	<5	3	<5 - 50	5

The water quality of the control bore GND0636 groundwater continued to be relatively stable in terms of nitrate. The median nitrate-N concentration of 7.2 g/m³ was lower than the historical median of 8.2 g/m³. The peak concentration of 11.2 g/m³ was recorded in winter, following the large rainfall event of 20 June 2015, when groundwater level was high (this is consistent with the observation that heavy rainfall tends to flush more nitrate into groundwater). Water quality at the impact bore GND0637 showed a marked elevation in sodium (and chloride) and conductivity levels when compared with the control bore, consistent with the effect of leaching of wastewater from spray irrigation disposal to shallow groundwater. Sodium concentration appears to be reducing, overall (refer to Table 20), though it increased in 2015-2016. COD at the impact bore fluctuated, increasing when groundwater level fell, with a spike to the highest level recorded in April 2016.

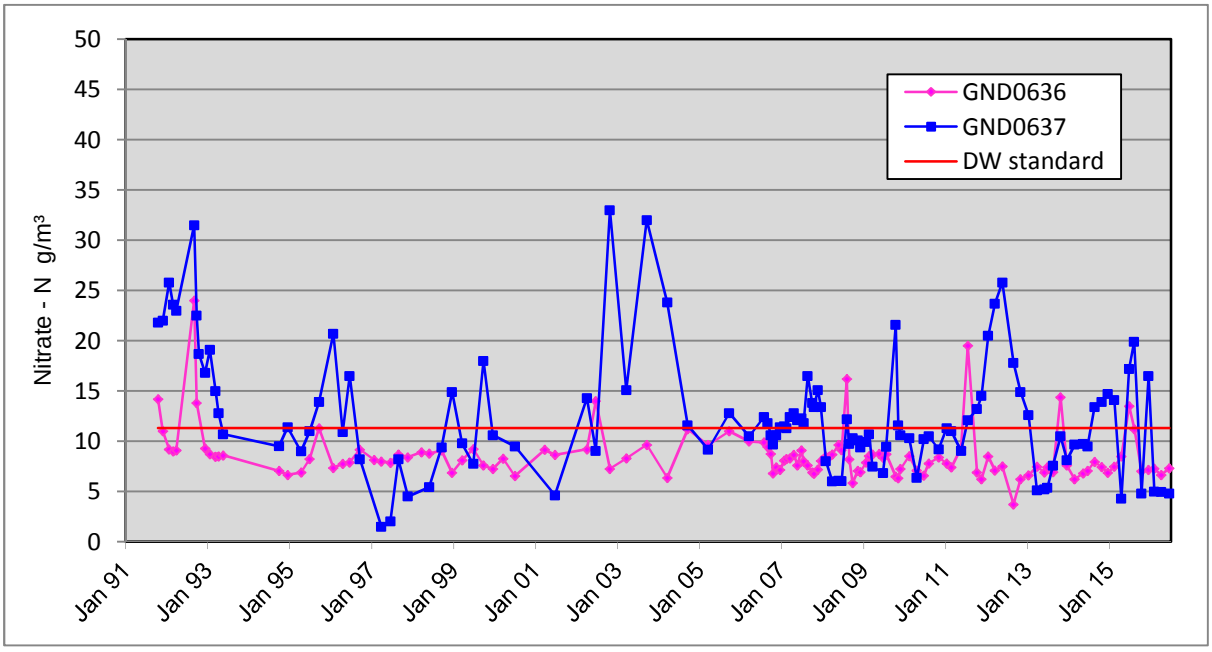

Figure 9 Trends in groundwater Nitrate-N concentration at Farm 1

Figure 9 compares trends in groundwater nitrate-N levels at the impact bore with the control bore, 640 m up-gradient. Levels of nitrate-N in the impact bore fluctuated markedly in Spring 2015 , lifting to peaks of 20 and 17 g/m³ from a base of 5 g/m³, related to rises in water level.

2.1.3.1.4.2 'Southern' Farm groundwater

The results of groundwater monitoring on this farm during the 2015-2016 period are summarised in Table 22. The full set of results is given in Appendix III.

Table 22 Results of groundwater quality sampling on 'Southern' ('No 2') farm, 2015-2016

Parameter	Unit	Control (GND2049)			Impact (GND0638)			Impact (GND2050)		
		N	Range	Median	N	Range	Median	N	Range	Median
Water level	m	6	1.85 – 3.62	2.90	6	1.47 – 3.49	2.68	6	1.89 – 3.05	2.82
Temperature	°C	6	13.6 – 15.0	14.0	6	13.9 – 15.9	14.8	6	13.2 – 14.3	14.1
Conductivity, 20°C	mS/m	6	37.2 – 41.8	40.6	6	67.0 – 77.9	72.2	6	53.8 – 63.7	54.6
pH	pH	6	6.4 – 6.6	6.4	6	6.6 – 6.8	6.6	6	6.8 – 6.9	6.8
Nitrate+nitrite	g/m³N	6	16.6 – 23	22	6	6.3 – 10.8	9.0	3	<0.01 – 9.8	0.04
Ammonia	g/m³N	3	<0.003 – 0.020	0.009	3	<0.003-0.012	0.003	3	0.29 – 0.55	0.45
Sodium	g/m³	3	30 – 33	32	3	71 – 79	77	3	56 – 57	57
Chloride	g/m³	3	37 – 42	39	3	59 – 60	59	3	51 – 57	54
COD	g/m³	3	<5	<5	3	<5 - 14	8	3	<5 - 14	<5

The control bore for Farm 2, GND2049, was drilled in March 2008, on the northern boundary beside Skeet Road. (Refer to Figure 8). This replaced the original 'control' bore, GND0638, which is situated on the western boundary with about 350 m of irrigated paddocks up-gradient, and was affected by ponding of effluent in Spring 2006. For this reason, wastewater is now irrigated only in summer in the paddock (new number 13B) immediately up-gradient.

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 10 compares trends in groundwater nitrate-N levels at the new impact bore, the previous two impact bores, GND0639 and GND0699, and the original control bore, GND0638, with the new control bore GND2049.

The control bore, GND2049, showed the influence of an unknown source, the nitrate-N concentration ranging from 17 to 23 g/m³ during the monitoring period, with the median value increasing from 13 to 22 g/m³ since 2013-2015. Conductivity, pH, sodium and chloride levels were within the normal range that is found in adjacent dairy farming areas. COD and ammonia were low, indicating little leaching of organics. Whether the nitrate comes from farming activities up-gradient across Manaia Road, or from "mounding" of factory effluent applied down (the ground surface) gradient, or by some other mechanism, is being investigated by the Company.

At the bore inside the irrigation area, GND0638, nitrate-N concentration has reduced from the peak (49 g/m³) recorded during 2008-2009 and for the last four years to June 2016 has been level at about 6 to 11 g/m³. Conductivity, sodium and chloride values were elevated, as might be expected underneath such a wastewater irrigation area, though COD and ammonia levels were low.

At the newer impact bore beside the Waiokura Stream, GND2050, nitrate-N concentration appears to fluctuate with groundwater level, being in the range 3 to 13 g/m³ during winter and spring over the total record, and falling to <1 g/m³ in summer and autumn. Denitrification is a likely explanation, as ammonia concentration varies inversely with nitrate, reaching >0.5 g/m³N, while low oxygen level, that is conducive to denitrification, has been recorded. (An additional sample, taken on 12 May 2016 had oxygen 0.05 g/m³, ammonia 0.51 g/m³N, and oxidised nitrogen <0.01 g/m³N). Mineral levels were significantly higher than at the control bore.

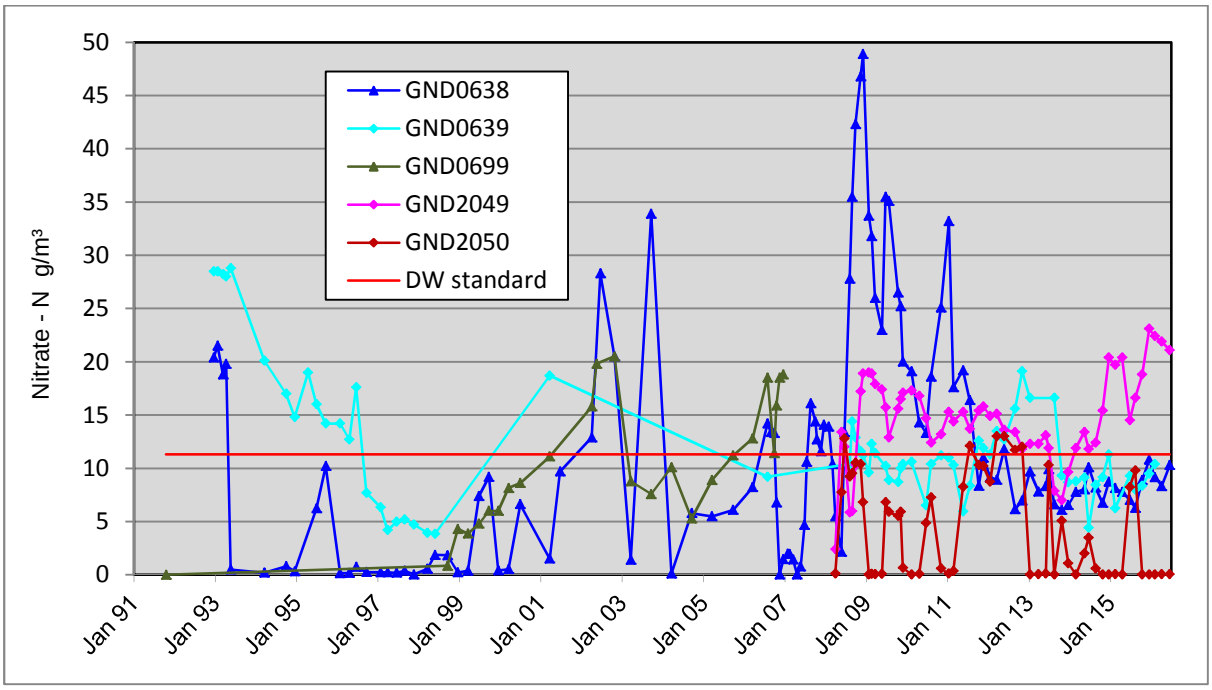

Figure 10 Trends in groundwater Nitrate-N concentration at Farm 2

2.1.3.1.4.3 'No 3' Farm groundwater

The results of groundwater monitoring on this farm during the 2015-2016 period are summarised in Table 23. The full set of results is given in Appendix III.

Table 23 Results of groundwater quality sampling on 'No 3' Farm, 2015-2016

Parameter	Unit	Control (GND2051)			Impact (GND2052)			Impact (GND0700)		
		N	Range	Median	N	Range	Median	N	Range	Median
Water level	m	6	2.20 – 4.36	3.51	6	1.56 – 3.17	2.82	6	0.77 – 3.16	2.62
Temperature	˚C	6	13.8 – 14.4	14.2	6	13.6 – 14.7	14.5	6	13.3 – 14.8	14.2
Conductivity, 20˚C	mS/m	6	28.0 – 56.4	30.0	6	28.5 – 40.3	37.6	6	42.7 – 111	58.4
pH	pH	6	6.5 – 6.6	6.6	6	6.5 – 6.7	6.6	6	6.7 – 6.8	6.8
Nitrate+nitrite	g/m^{3}N	6	0.84 – 19.2	3.6	6	0.02 – 3.3	1.1	6	2.6 – 22	6.4
Ammonia	g/m^{3}N	3	0.006 – 0.009	0.009	3	<0.003 – 0.041	0.014	3	<0.003 – 0.024	0.010
Sodium	g/m^3	3	26 – 33	27	3	38 – 50	48	3	57 – 94	58
Chloride	g/m^3	3	38 – 74	46	3	44 – 47	46	3	53 – 89	69
COD	g/m^3	3	<5 - 9	<5	3	<5	<5	3	<5 - 7	<5

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 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 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 during the 2015-2016 period due to the bailer becoming stuck inside the bore in May 2013. The bore was not able to be unblocked and is no longer used.

The impact of wastewater irrigation upon the old impact bore (GND0700, Table 23) was reflected in elevated sodium, chloride, and conductivity levels.

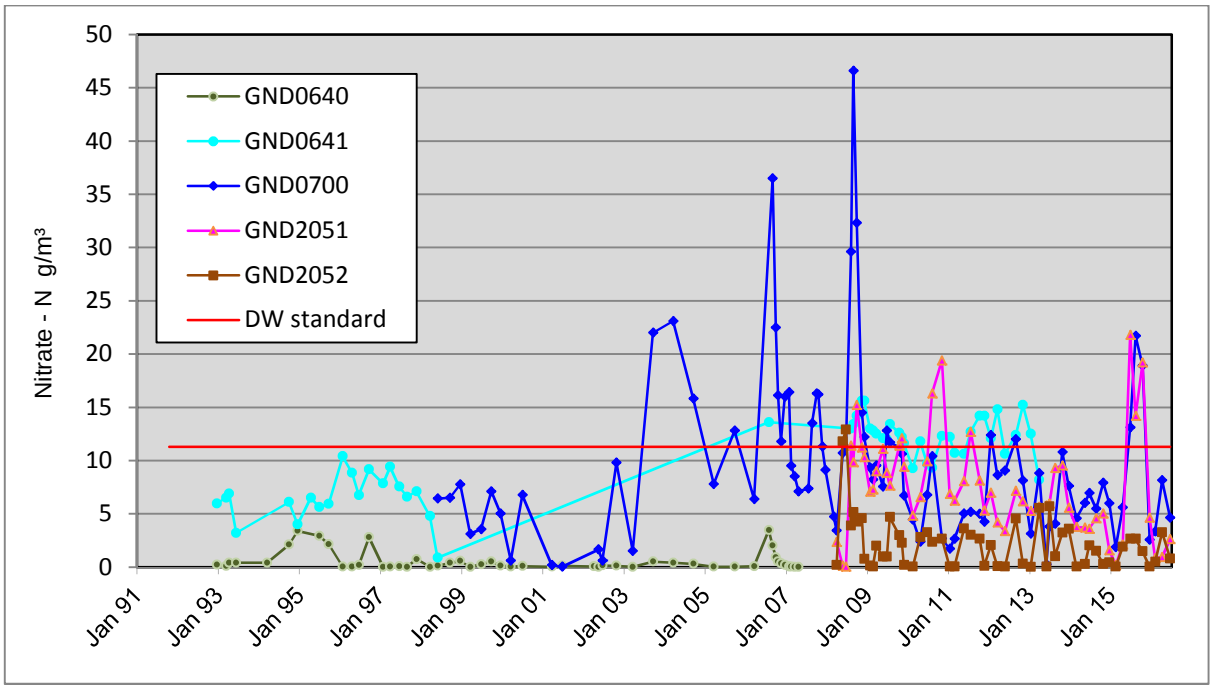

Figure 11 Trends in groundwater Nitrate-N concentration at Farm 3

Figure 11 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), with the old and new control bores, GND0640 (until 2007) and GND2051. At the new control bore, nitrate-N values were moderate, with a median value of 3.6 g/m³; a spike to 22 g/m³ occurred after the large rainfall event on 20 June 2015. The older impact bore GND0700 yielded a similar level of nitrate-N, with a median value of 6.4 g/m³; an increase also followed the rainfall event of June 2015 for a period of about four months. The new impact bore GND2052 had a low median nitrate-N value of 1.1 g/m³. Results overall show good management of nitrogen application rates.

2.1.3.1.4.4 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/m³ (as nitrate-N) has been exceeded frequently during previous monitoring periods. There are no 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. A summary of the groundwater nitrate monitoring results is given in Table 24.

Table 24 Summary of groundwater nitrate concentrations at monitoring bores, 2015-2016

Property	Bore location	Designation	Nitrate & Nitrite-N, g/m³		No. samples	Site code
			Median	Range		
'Northern' (No 1) Farm	North South	Control Impact	7.2 5.0	6.6 – 11.2 4.8 – 19.9	6 6	GND0636 GND0637
'Southern' (No 2) Farm	North West South-west	Control (new) Impact Impact (new)	21.5 9.0 0.04	16.6 – 23.1 6.3 – 10.8 <0.01 – 9.8	6 6 6	GND2049 GND0638 GND2050
'No 3' Farm	North South-west South-east	Control (new) Impact (new) Impact	3.6 1.1 6.4	0.84 – 19.2 0.02 – 3.3 2.6 – 21.7	6 6 6	GND2051 GND2052 GND0700
New Zealand Drinking Water Standard			**11.3**			

In recognition of the potential for adverse effects on soil and groundwater quality, and in order to enable better combination of wastewater disposal and farming operations, the Company in 2006 purchased an additional 60 ha of land between Farm 2 and Farm 3, bringing the total farmed area to 244 ha. Consent **0923**-3 was varied to provide for a planned 41% increase in spray irrigation area, from 120 to 169 ha (5 ha on original Farm 3). Work started in January 2007 on the extension, which comprised a 4.1 km pipeline from the factory to a storage and control facility on Farm 3, and the installation of fixed in-ground irrigators. The new system was commissioned in time for the 2007-2008 processing season.

The effect of the additional irrigation area on groundwater nitrate level has been predicted, using the AgResearch Overseer model in combination with the water balance for the site. The annual average nitrogen loading used in the model was 523 kgN/ha/y (average over the previous 6 years, based on the November/December 2005 wastewater composition study) for the existing area. Assuming average rainfall of 1,200 mm, evapo-transpiration of 450 mm, and wastewater application of 383 mm, the drainage was estimated at 1,133 mm. The concentration of nitrate-N in the leaching water was predicted to be about 25 g/m^3 – this value is similar to the levels that were found in some of the impact monitoring bores in previous monitoring periods. The introduction of the new farm was predicted to reduce the nitrogen load to about 371 kgN/ha/y. The concentration of percolate (leaching water) was predicted to reduce to 17 g/m^3, a factor of 39%.

In 2015-2016, a total metered volume of 557,866 m^3 of factory effluent was generated, which had a (time-based) average total nitrogen concentration of 97.1 g/m^3 (47 samples, range 12 - 191 g/m^3), giving a total nitrogen mass of 54,169 kg. When applied to 164 ha, at an average depth of 340 mm, this amounted to an overall annual nitrogen application rate of 330 kg/ha. The calculated annual nitrogen application rates for Farm 1 (51 ha), Farm 2 (26 ha) and Farm 3 (87 ha) are 280, 332 and 359 kg/ha, respectively. The average rate for (the combined southern) Kapuni Farms was 353 kg/ha.

For dairy shed effluent, on (the southern) Kapuni Farms, a total metered volume of 17,835 m^3 was irrigated over 9 months, which had an average total nitrogen concentration of 181 g/m^3 (36 samples, range 51 – 268 g/m^3), giving a total mass of 3,228 kg. When applied to 113 ha, at an average depth of 16 mm, this amounted to an overall annual nitrogen application rate of 29 kg/ha. On (the northern) Kapuni Farm 1, a total metered volume of 2,651 m^3 was irrigated over 2 months, which had an average total nitrogen concentration of 50.1 g/m^3 (4 samples, range 31 – 60 g/m^3), giving a total mass of 132 kg. When applied to 51 ha, at an average depth of 5 mm, this amounted to a nitrogen application rate of 3 kg/ha.

The total mass of nitrogen from DSE irrigated in 2015-2016, at 3,360 kg, was approximately the same as the reduction in factory wastewater nitrogen mass from 2014-2015, at 2,933 kg. DSE total nitrogen amounted to 5.8 % of nitrogen mass irrigated.

The combined nitrogen loading rate for 2015-2016 from irrigation of factory wastewater and DSE was 283 kg/ha on Kapuni Farm 1 and 382 kg/ha on Kapuni Farms. In comparison, the respective loadings in 2014-2015 from factory wastewater alone were 270 and 383 kg/ha. The nitrogen loading rates for both years were considerably less than the average value of 523 kg/ha/y estimated for the period before the irrigation area was extended.

Four additional groundwater monitoring bores were drilled in March 2008 to provide for the new irrigation area; to replace the two bores damaged during the 2006-2007 monitoring period; and to install a proper control for Farm 2. Overall, it appears that nitrate levels under the irrigation areas have decreased and are stabilising in response to the increase in irrigated area. There was a spike in nitrate level at most monitoring bores, both impact and control, at the end of the previous review period, most likely as the result of a heavy rainfall event. The results for the

two relatively new control bores, at the upslope boundaries of Farm 2 and Farm 3, indicate a significant influence on groundwater nitrate-N levels probably as a result of activities on adjacent farms.

2.1.3.2 Waiokura Stream surface water quality

In combination with groundwater monitoring, 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 8, Table 25). This was carried out approximately monthly at the following sites in conjunction with the groundwater sampling.

Table 25 Water quality monitoring sites in the Waiokura Stream

Site	Description	Map reference, NZTM		Site code
		Easting	Northing	
1	Waiokura Stream at Skeet Road	1698807	5628892	WKR000500
2	Waiokura Stream 1.5 l, u/s of Hicks Road (No. 3 Farm)	1698126	5626926	WKR000630
3	Waiokura Stream at Hicks Road	1697735	5625026	WKR000650

These sites were chosen to monitor any possible effects on surface water from the spray irrigation of wastes on the Company's Southern Farms. The results of analytical work performed by the Council's laboratory in the 2015-2016 monitoring period are presented in Table 26, and a summary of the monitoring previously performed is presented in Table 27.

Table 26 Results of Waiokura Stream quality sampling for the 2015-2016 monitoring period

Site		Site 1(WKR000500)			Site 2 (WKR000630)			Site 3 (WKR000650)		
Parameter	Unit	N	Range	Median	N	Range	Median	N	Range	Median
Temperature	˚C	12	9.1 – 17.6	12.6	12	9.1 – 18.0	12.6	12	9.3 – 18.6	13.1
Conductivity	mS/m	12	20.5 – 24.4	21.0	12	21.4 – 23.5	22.4	12	21.0 – 25.8	23.6
Nitrate + nitrite	g/m^3 N	12	1.5 – 3.5	2.3	12	1.4 – 3.8	2.4	12	1.5 – 3.9	2.6
Sodium	g/m^3	12	18.2 – 25.4	20.4	12	19.3 – 23.6	22.6	12	21.5 – 25.6	22.9

Table 27 Summary of Waiokura Stream water quality data from the Council surveys during the period March 2001 to June 2015

Site		Site 1(WKR000500)			Site 2 (WKR000630)			Site 3 (WKR000650)		
Parameter	Unit	N	Range	Median	N	Range	Median	N	Range	Median
Temperature	˚C	101	7.1 – 18.0	12.2	101	8.4 – 20.2	12.7	100	8.1 – 19.6	12.6
Conductivity	mS/m	99	16.6 – 30.4	21.1	100	17.0 – 25.3	22.3	99	15.0 – 27.4	23.2
Nitrate + nitrite	g/m^3 N	87	1.3 – 4.0	2.7	86	1.0 – 4.0	2,9	86	1.0 – 4.2	2.9
Sodium	g/m^3	98	14.8 – 24.1	19.5	98	9.4 – 24.9	21.4	97	13.9 – 26.5	22.5

The results for the 2015-2016 monitoring period again indicate a slight increase in sodium in the samples downstream of the control site (site 1) on all survey occasions (Table 26), but not significant enough to be considered an environmental effect.

Nitrate-N concentration showed a large seasonal fluctuation, varying from about 1.4 g/m^3 in autumn to 3.9 g/m^3 in winter. Median nitrate concentration for 2015-2016 was lower at all three sites than the long-term median value. The ranges of all parameters were similar to those recorded in previous monitoring periods (Table 27), Continued monitoring over future periods will provide further assessment of any possible environmental effects to surface water from the spray irrigation of wastewater on the Southern Farms.

2.1.3.3 Fish passage temperature compliance in mixing zone

The Taranaki Regional 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 12. 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, transverse monitoring was no longer considered necessary, as disruption to fish passage was not expected to occur because 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.

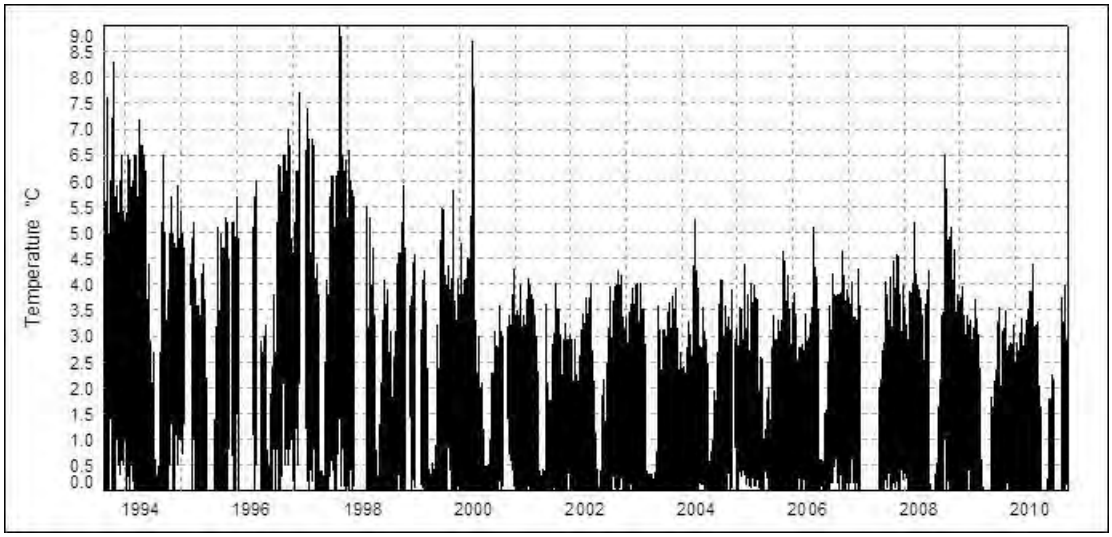

Figure 12 Kaupokonui Stream water temperature differential (LB-RB) records at the periphery of the Fonterra Kapuni spray cooling water discharge zone, 1993-2010

Instead, 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, conducted in January 2014, is discussed below in section 2.1.3.5.

Kaupokonui Stream flow records for the monitoring period for the Glenn Road recording station are presented in Figure 13.

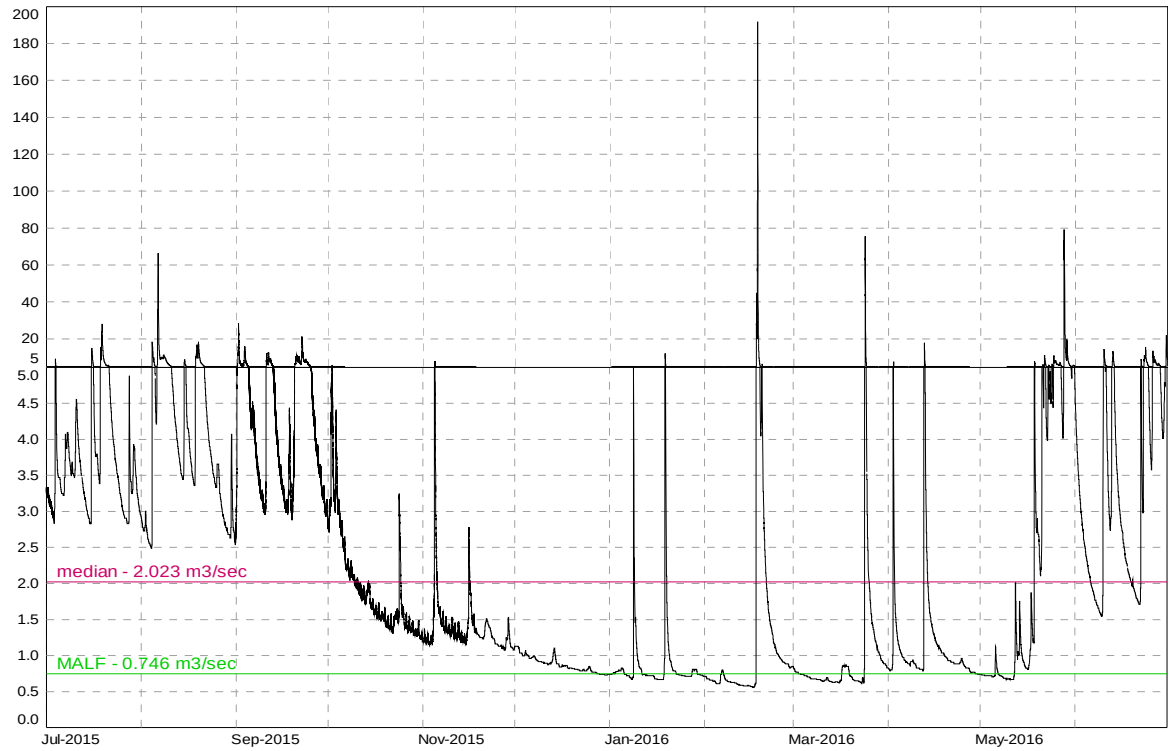

Figure 13 Kaupokonui Stream at Glenn Road flow record (m^3/s) for period 1 July 2015 to 30 June 2016

2.1.3.4 Lower stream water temperatures

Two additional water temperature data loggers were installed in the lower reaches of the Kaupokonui Stream for the duration of the 2015-2016 period to provide ambient stream temperature data over the 14 km reach downstream of the factory to the coast. These loggers were 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.

Water temperature records for these two sites are illustrated in Figure 14 and Figure 15.

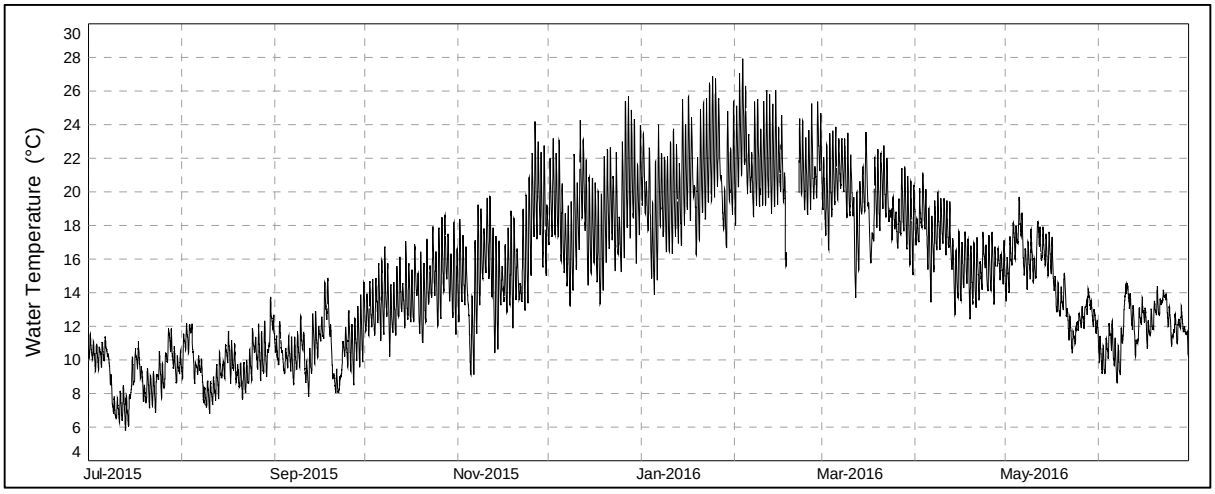

Figure 14 Water temperature (°C) records for the Kaupokonui Stream at Glenn Rd during the period 1 July 2015 to 30 June 2016

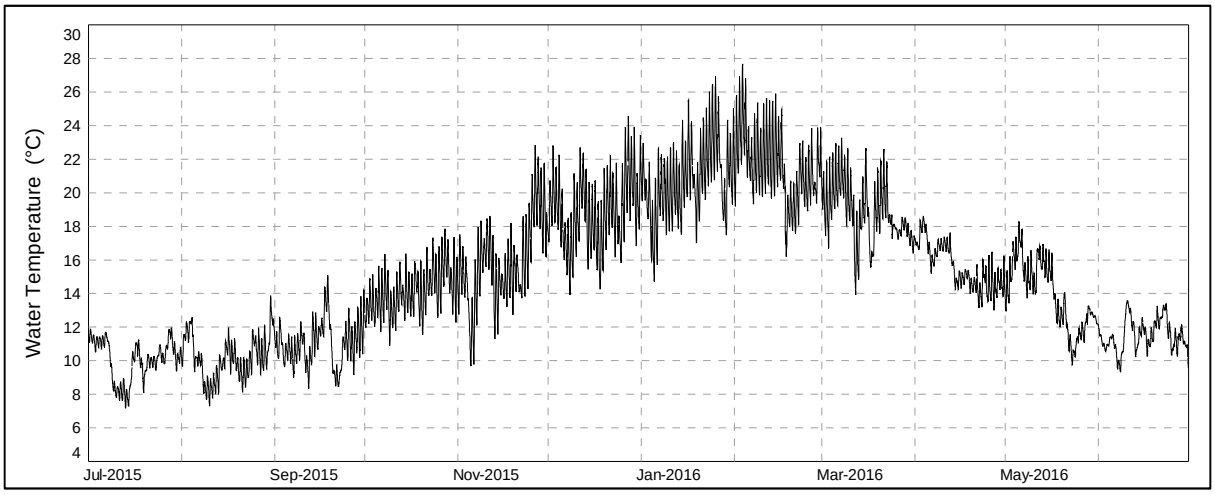

Figure 15 Water temperature (°C) records for the Kaupokonui Stream at beach during the period 1 July 2015 to 30 June 2016

A monthly summary of these data is included in Table 28.

Table 28 Monthly Kaupokonui Stream water temperature data for two sites from July 2015 to June 2016

Site	Upper Glenn Road			Near Coast		
	Min	Max	Mean	Min	Max	Mean
July 2015	5.8	11.9	9.1	7.2	12.0	10.0
August 2015	6.8	13.8	9.8	7.3	13.9	10.2
September 2015	7.8	14.9	10.7	8.3	15.1	11.0
October 2015	10.2	18.6	14.0	10.9	17.9	14.2
November 2015	9.1	24.2	15.8	9.7	22.8	15.9
December 2015	13.1	25.6	18.7	13.9	24.6	18.8
January 2016	13.9	26.9	20.4	14.7	26.9	20.7
February 2016	16.0	27.9	21.9	16.2	27.7	21.5
March 2016	13.7	23.9	19.5	13.9	23.3	18.8
April 2016	12.4	21.1	16.4	13.0	18.6	15.6
May 2016	10.4	19.7	14.7	9.7	18.3	13.9
June 2016	8.6	14.6	11.9	9.3	13.6	11.5

In 2015-2016, stream temperatures reached an instantaneous maximum of 27.9˚C on 3 February 2016 at 1630 NZST at Glenn Road. An analysis of the stream water temperature data for each site indicated that 20˚C, above which trout start to become stressed, was exceeded for approximately 17% of the year at both Glenn Road and near the mouth, while the median water temperatures were 14.9˚C at Glenn Road and 14.8˚C near the mouth.

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

In-stream 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. This will be a matter for further investigation prior to consent renewal (2019).

2.1.3.5 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 new fish pass. However, new 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.

In October 2000 the Council recorded torrentfish in the lower section of the Kaupokonui Stream. Torrentfish migrate up and down waterways several times

throughout the year and have been recorded in Taranaki streams up to an altitude of 440 metres. However, they are poor climbers and are not currently able to negotiate the hydrological control weir in the Kaupokonui Stream at Glenn Road, at an altitude of 50 metres. With the construction of a new fish pass at this weir to enable the passage of torrentfish and other native species over the weir, torrentfish are expected to migrate upstream to the Company's site, at an altitude of 160 metres.

In September 2000, Fish and Game Taranaki wrote to the Council recommending that a 'constructed stream' type fish pass be built over the Company's Kapuni weir, similar to the one recently built on Cold Creek for South Taranaki District Council. Such a pass would allow for the passage of both trout and native fish. A deep channel in the centre of the pass would allow for the passage of trout. Rough, shallow zones on the edge of the pass would allow for the passage of native fish. It was suggested that a local engineering firm develop a design, and that a recognised fish pass expert evaluate the design. The Council concurred with this proposal.

In December 2000, the Council's Freshwater Biologist met onsite with Company and Fish and Game Taranaki staff, and Mr Charles Mitchell, a fish pass consultant. The weir was visited and options for the fish pass to provide passage for native fish (targeting torrentfish), and trout were discussed.

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.

Electric fishing survey, 30 January 2014

A four site fish survey was undertaken in the Kaupokonui Stream on 30 January 2014, 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 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 some kilometres downstream of the factory is an orphaned structure, the Glenn Road weir, which currently does not have adequate fish passage provision.

Four fish species were recorded during the survey, being longfin and shortfin eel, redfin bully and rainbow trout. Redfin bully were recorded in very low abundance, reflecting the impact of the Glenn Road weir.

Although only two species were recorded upstream of the Kapuni Lactose weir, longfin and shortfin eels, there is no indication that this weir is posing a significant barrier to fish passage. There were good numbers of juvenile eels recorded upstream of the weir, and no evidence of fish accrual immediately downstream of the weir.

The presence of rainbow trout downstream of the cooling water discharge is an indication that this discharge had not adversely affected the fish communities, as rainbow trout are considered to be one of the more 'sensitive' species with regards to water quality, including temperature. The higher abundance of eels between 250mm and 450mm is considered to be a reflection of the greater proportion of boulders in the substrate, which provide good cover for these fish.

Overall, it was considered that the activities of the Kapuni lactose factory have not adversely affected the fish communities of the Kaupokonui Stream. It is hoped that as the riparian planting of the catchment matures, and passage remediation works at the Glenn Road weir are undertaken, that the diversity and abundance of fish in this stretch of stream will improve.

The full fish survey report is included in Appendix IV. The next survey is scheduled for summer 2016-2017.

2.1.3.6 Biomonitoring

The Council's standard 'kick-sampling' technique was used to collect streambed macroinvertebrates from five sites in the Kaupokonui Stream on 16 October 2015 and 2 February 2016. Two sites in the Waiokura Stream were sampled in February 2016. Samples were sorted and identified to provide the number of taxa (richness), MCI and $SQMCI_s$ scores for each site. The reports are included as Appendix V. The report summaries are provided below.

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.

16 October 2015

In the Kaupokonui Stream, taxa richnesses were similar to or higher than historical median richnesses (with the exception of site 5), while MCI scores indicated 'good' to 'fair' community health at all sites. MCI scores declined in a downstream direction, but only to the degree expected, likely related to the progressive deterioration typical of Taranaki's ringplain streams and rivers. The MCI scores at all five sites were higher than their historical median scores, and the three sites downstream of the cooling water discharges showed some improvement in community health from that

recorded by the previous summer survey, which is a fairly typical result for a spring survey. The survey continued to show that the Kaupokonui Stream generally has macroinvertebrate communities of 'good' health throughout most of the reach surveyed. The poorest community, found at site 7, was indicative of some influence from the Dunns Creek tributary within the reach between sites 6 and 7.

It may be concluded that the factory's cooling water discharges had not resulted in significant adverse effects on the macroinvertebrate communities, with the communities appearing healthier than that recorded in the previous summer survey, a relatively typical result. The current survey did not record the presence of sewage fungus or blood worm midges, indicating that the poor quality cooling water discharge that had been occurring prior to the spring 2014 survey had ceased. In addition, there was no deterioration in the macroinvertebrate communities between sites upstream and downstream of spray irrigation of wastes onto land (but upstream of the cooling water discharge) from the Fonterra Kapuni factory recorded by the current survey.

MCI values continued to indicate in general that macroinvertebrate communities were mainly in 'good' health, being similar or above median MCI scores from surveys conducted since 1998. Similarities in community composition, including the characteristic taxa, were generally consistent for all sites, although there were some exceptions at site 5, and some additions at sites 6 and 7, further downstream. The deterioration in MCI score recorded between sites 6 and 7 (in the lower reaches), was not a statistically significant result, but was a result commonly recorded in this stream, often due to progressive deterioration in communities in a downstream direction, typical of Taranaki ringplain rivers and streams.

The trend of improvement in communities noted in recent years adjacent to the factory has generally continued to be recorded by this survey, following a break in the trend recorded by the February 2008 survey, which also recorded the additional presence of 'undesirable heterotrophic growths' on the streambed. The spring 2010 survey also recorded such growths at two sites, although only subtle impacts on the macroinvertebrate communities were found. Such growths were again recorded in the spring 2014 survey, but not in the summer 2015 survey or the current survey.

2 February 2016

In the Kaupokonui Stream, taxa richnesses were all slightly higher than historical median richnesses, while MCI scores indicated 'good' to 'fair' community health at all sites. MCI scores generally declined in a downstream direction, but largely to the degree expected, likely related to the progressive deterioration typical of Taranaki's ringplain streams and rivers. The MCI score at the upper site 3b was the same as the historical median score, while the MCI scores at site 4 and 5 were lower than their historical medians. Site 6 was the only site to record an MCI score higher than its historical median. The significant decreases in MCI and $SQMCI_s$ scores recorded between sites 3b and 4 were a possible indication that the community had been recently affected by land irrigation upstream of this site, however may also be attributed to the impacts of dairy shed wastes assimilation in the receiving waters of the inflowing tributary a short distance upstream of site 4. The current survey showed that the Kaupokonui Stream generally has macroinvertebrate communities of 'fair' health throughout most of the reach surveyed. The poorest community, found at site 7, was indicative of possible influence from the Dunns Creek tributary

within the reach between sites 6 and 7 however was also a reflection of a natural progressive downstream deterioration that was exacerbated by low flows.

It may be concluded that the factory's cooling water discharges had not resulted in significant adverse effects on the macroinvertebrate communities, although the communities appeared in slightly worse condition than that recorded in the previous spring survey, a relatively typical result. The current survey did not record the presence of sewage fungus or blood worm midges, indicating that the poor quality cooling water discharge that had been occurring prior to the spring 2014 survey had ceased.

MCI values indicated in general that macroinvertebrate communities were mainly in 'fair' health, being below median MCI scores from surveys conducted since 1998, perhaps a reflection of the extended period of low flow that preceded this survey, and the related algal proliferation. Similarities in community composition, including the characteristic taxa, were generally consistent for all sites, although there were some additions at sites 6 and 7, further downstream. The deterioration in MCI score recorded between sites 6 and 7 (in the lower reaches), was a statistically significant result, and was greater than is commonly recorded in this stream. As with the previous surveys, it is considered that this is due to progressive deterioration in communities in a downstream direction, typical of Taranaki ringplain rivers and streams, but in this case was exacerbated by the preceding low flows.

The trend of improvement in communities noted in recent years adjacent to the factory has generally continued to be recorded by this survey, following a break in the trend recorded by the February 2008 survey, which recorded the additional presence of 'undesirable heterotrophic growths' on the streambed. The spring 2010 survey also recorded such growths at two sites, although only subtle impacts on the macroinvertebrate communities were found. Such growths were again recorded in the spring 2014 survey, but not in the current survey.

The Waiokura Stream communities indicated that conditions during this survey were fairly typical when compared with the relatively limited number of previous surveys at these two sites to date. The MCI value recorded at the downstream site was slightly less than that recorded upstream, although this can be attributed largely to the distance between the sites and the marked habitat differences between sites, especially the predominance of macrophytes at site D, rather than to any effects from the application of wastes to land from the Fonterra factory. This conclusion is supported by the $SQMCI_S$ scores, which were not significantly different to one another. There were some subtle changes in macroinvertebrate community compositions between the sites which were associated with differences in habitat, principally an increase in macrophytes and periphyton at the downstream site. These community differences were insignificant and not indicative of recent impacts of wastewater irrigation within the Waiokura Stream catchment.

2.2 Air

2.2.1 Inspections

Officers of the Council carried out inspections in relation to air emissions, of the Kapuni lactose plant, during the 2015-2016 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.

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. On-site odours were noted during inspections, particularly in the vicinity of the effluent tank, and occasional slight odours were noted at the southern plant entrance under northerly wind conditions.

The plant appeared to be well managed and well maintained, with a high standard of housekeeping observed at the time of each inspection. Any on-site spills were responded to and cleaned up promptly.

2.2.2 Emission monitoring

A wet scrubber system was commissioned by the Company in October 1998. The wet scrubber system links the exhaust streams from the pre-drier stack and the refined fluid bed drier.

Table 29 is included for comparison of results prior to the installation of the wet scrubber system.

Table 29 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 11 November 2015 by CRL Energy, using USEPA Method 17 over a 64 minute period. Average production rate was 5 t/h. These results are presented in Table 30 below, along with previous CRL and Council results since 1998.

Table 30 Summary of isokinetic stack analysis for 1998-2016

Date	Emission (mg/dsm³)*	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/h
11 January 2012	67	Mass emission rate 3.0 kg/h
9 January 2013	27	Mass emission rate 1.3 kg/h
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

Key * mg/dsm³ = 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 result obtained in November 2015 was below consent limits.

2.2.3 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 1.6m. 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.

Gauges were deployed at five sampling sites around the lactose plant for a period of approximately three weeks over summer/autumn in 2015-2016. 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 31 and Figure 16 below.

Table 31 Description of the Fonterra 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

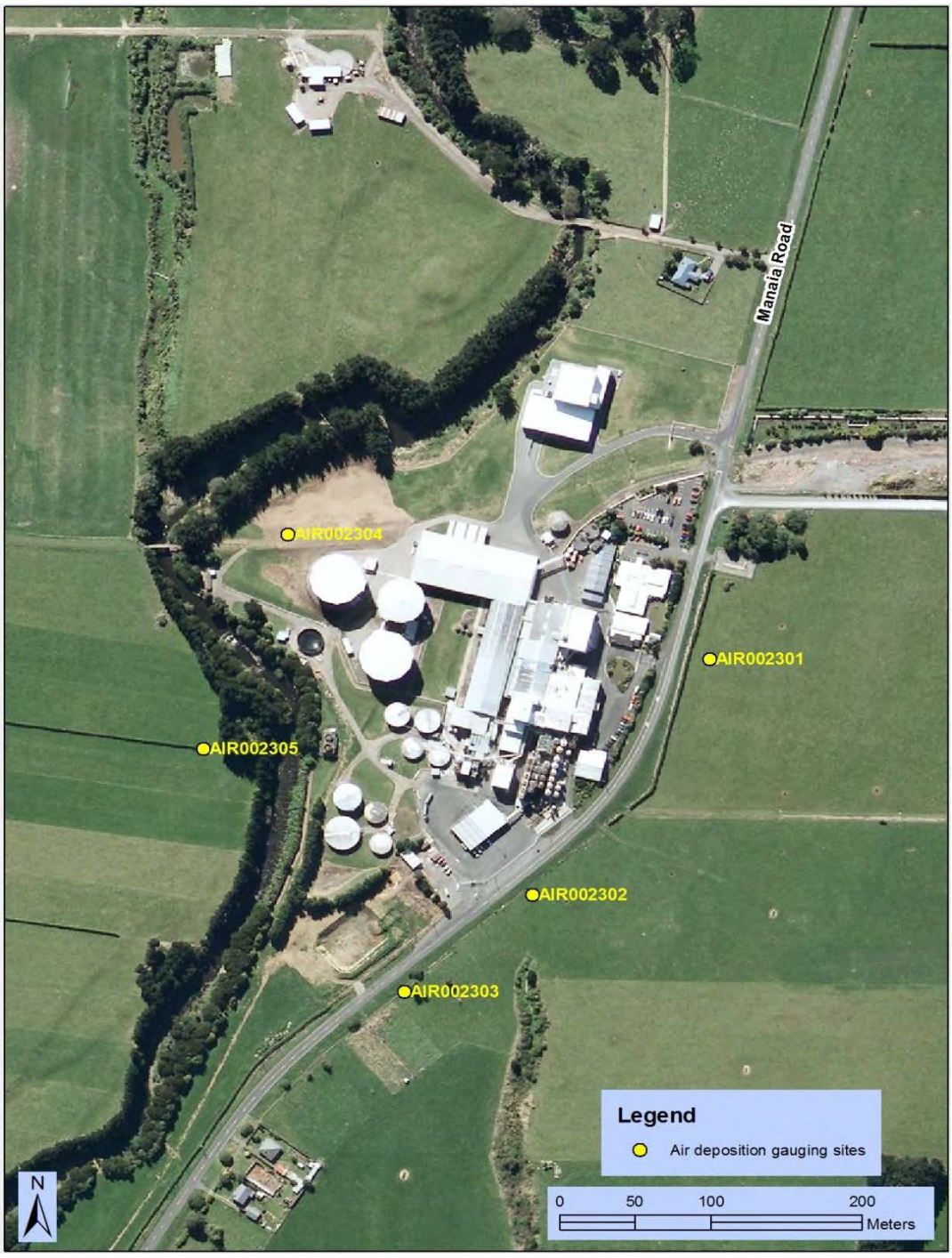

Figure 16 Location of air deposition gauging sites

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 0.13 g/ 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 2015-2016 deployment period are compared with previous results since 1997 in Table 32.

Prior to the commissioning of the wet scrubber in October 1998, deposition rates of up to 1300 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 32 Deposition gauge results from 1997-2016 monitoring periods

Period	Number of days	TDP mg/m^2/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	-	-	-	-	-
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

Westerly winds predominated during the gauge deployment, with northerly and northwesterly components.

The deposition rates obtained during the periods under review were generally similar to the most recent monitoring periods (Table 32). There was no visible evidence of lactose powder deposition.

2.3 Investigations, interventions and incidents

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 consent holder. During the monitoring period 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.

The Council operates and maintains a register of all complaints or reported and discovered excursions from acceptable limits and practices, including non-compliance with consents, which may damage the environment. The incident register includes events where the company concerned has itself notified the Council. The register contains details of any investigation and corrective action taken.

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 company is indeed the source of the incident (or that the allegation cannot be proven).

In the 2015-2016 period, the Council was required to undertake additional investigations and interventions, or record incidents, in association with the Company's conditions in resource consents or provisions in Regional Plans on one occasion, in relation to a self-notified odour complaint.

On 17 August 2015, Fonterra notified Council of a complaint made to the Company by a neighbour on Saturday 15 August about sewage odour from the lactose plant's septic tank soakage field, situated across Manaia Road from the plant. Immediate inspection by Fonterra had found some ponding, but no run-off, and odour present. A vacuum truck was employed to maintain a low level in the septic tank, and the service agent called to investigate the cause and a remedy. The neighbour was kept informed. A written report on these actions was forwarded to Council. No odour was detected during the Council's monthly inspection on 20 August. Subsequently, a Council Officer met with Fonterra and its service agent about the construction of an improved sewage treatment system and a disposal field less likely to block.

The septic tank system was replaced in December 2015, at a new location on the other (western) side of Manaia Road next to the storm pond, and a new soakage field was installed next to the old field across the road in February 2016. No consent for the discharge was required, as the activity was permitted under Rule 29 of the Regional Fresh Water Plan. (An application to surrender Consent 5629-1, which provided for the discharge before the Plan was promulgated, was accepted upon construction of the new system).

3. Discussion

3.1 Discussion of plant performance

Generally the on-site 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.

Contingency planning is in place in the form of the Environmental Management System manual (this included the Spray Irrigation Plan). The plan is updated annually, with the most recent edition received in August 2015.

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, and volume and composition of effluent sprayed to pasture on the two farms. Daily volumes and temperature maxima were reported monthly. Compliance with consent conditions was demonstrated, with minor exceedances for stream temperature and dairy effluent volume that were within the error bounds of the monitoring instruments.

Telemetry to Council of cooling water discharge volume data was instituted during the review period, following an agreement by Council in July 2014 not to review the discharge consents in order to get the information for water allocation purposes. The telemetry connection was delayed by more than three months, until January 2016, while landscaping was completed around new cooling towers. Telemetry of abstraction data was established at the same time. (Telemetry of water temperature upstream and downstream in the Kaupokonui had been in place since March 2014). Ongoing problems with transmission of the data were being addressed at the end of the review period, in terms of missing record and of accuracy. In the interim, the daily values that were supplied by the Company in its monthly report were used to determine consent compliance on volumes and temperatures.

The main cooling system was replaced in August 2015, with towers designed to achieve a temperature of less than 25°C for water entering Kaupokonui Stream after going through the towers and existing spray system. This addressed the issue of increasing water temperature upstream of the plant.

One unauthorised incident was recorded, a self notification of an odour complaint received from a neighbour about the sewage soakaway system. Remedial action was taken through replacement of both the septic tank and the soakage field.

Recorded annual abstraction volume from Kaupokonui Stream decreased in 2015-2016, by a factor of about 10% over 2014-2015. The measured strength of wastewater irrigated onto land decreased in terms of lactose concentration and nitrogen concentration, while volume remained constant. As the volume abstracted decreased while the volume discharged to land changed little, it is assumed that the volume returned to Kaupokonui Stream as cooling water decreased correspondingly.

Disposal of DSE to land via the factory effluent spray irrigation system was established in 2015-2016, replacing the oxidation pond treatment systems which had discharged to a Kaupokonui tributary and Motumate Stream. This is in line with

Council's policy of promoting discharges of DSE to land. The total mass of nitrogen from DSE irrigated in 2015-2016 was approximately equivalent to the decrease in nitrogen irrigated in factory wastewater, though irrigation from Farm 1 occurred only for part of the season.

Two major projects were completed during the 2007-2008 reporting period which have had long-term beneficial effects on environmental performance: extension of the wastewater irrigation system, and construction of a stormwater detention system.

The 41% extension of irrigation area, from 120 to 169 ha, with no increase in effluent volume has significantly reduced loading rates on soil and groundwater, and the use of automated in-ground irrigators has greatly improved the management of the combined waste disposal and farming operation.

The new stormwater system to contain and control stormwater from the southern catchment of the factory site has provided additional security for the area where road tankers operate and process materials are stored. In 2015-2016, the Company began two further projects in relation to stormwater control, to divert all stormwater from the factory site through a continuously monitored system which will enable detection of contaminants for storage in the detention pond and/or diversion to wastewater irrigation.

Riparian planting was maintained on the factory site and a donation was received by the Taranaki Tree Trust as per consent conditions.

3.2 Environmental effects of exercise of consents

Ecological monitoring did not note any problems in regard to the abstraction of water from the Kaupokonui Stream for cooling water and general purposes.

The discharge of cooling water did not have a visible effect on receiving waters during the monitoring period, and there was good compliance with discharge permit conditions. Biological monitoring of the Kaupokonui Stream during spring 2015 and summer 2016 did not show any significant adverse effect of the cooling and storm water discharges to the stream on streambed communities.

A fish survey carried out in summer 2014 found no indication that the weir was posing a significant barrier to fish passage, or that cooling water had adversely affected the fish communities. The next survey is due in summer 2017.

Temperature data supplied by the Company showed that, with one minor exception, the ambient temperature of the receiving water during the monitoring period was not increased by more than the amounts prescribed on consents **0921** and **0924**, that is, by less than 2 ˚C for 90% of the time with an upper limit of 3 ˚C.

Irrigation onto the dairy farms was, in general, well managed. A 20 m buffer was maintained to the bank of water courses. Effects on the groundwater in the vicinity of the farms were varied, but most showed an adverse impact on both mineral and organic component levels. This has been addressed through extension of the irrigation disposal system and by more intensive wastewater and groundwater

monitoring. The monitoring results show that, since 2011-2012, total volume irrigated has remained stable. There was a reduction in total nitrogen loading in 2012-2013, which increased back to the previous levels in 2014-2015, possibly as the result of a change in cleaning procedures, which was reversed for 2015-2016.

No effect on stream communities of Kaupokonui Stream or Waiokura Stream was noted in relation to land irrigation.

Stormwater discharged from the northern outfall complied with the conditions of consent **4604**.

Results from monitoring of the stormwater discharged from the IGL plant showed that the discharge was complying with conditions of consent **6423.**

Results from monitoring of the stormwater discharged from the southern stormwater outlet showed that the discharge was complying with the conditions of consent **0924-3.**

Particulate deposition from air emissions were similar to the previous monitoring periods, with all sites within the guideline target value set by the Council. Visual inspections found no evidence of depositions, and odour surveys continued to note low level of odour off site, with some odour observed around the effluent tank and in the vicinity of this depending on the direction of the wind.

3.3 Evaluation of performance

A tabular summary of the Company's compliance record for the year under review is set out in Table 33 to Table 51.

Table 33 Summary of performance for Consent 0302-3

Purpose: ***To take and use up to 19,500 cubic metres/day (225 litres/second) 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	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**

Table 34 Summary of performance for Consent 0919-3

Purpose: ***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***		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
1. Physicochemical and ecological monitoring of wastes	Collection of samples	Yes
2. Effects on receiving water	Site inspections, collection of samples, biological surveys	Yes
3. BOD level	Collection of samples	Yes
4. Limits on temperature increase of receiving water	Council data logger information, temperature information supplied by Fonterra	Yes
5. Limit on temperature of receiving water	Temperature data supplied by the Company	Yes
6. Monitoring of temperature of receiving water	Temperature information supplied by the Company	Yes, with minor loss of record
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	Temperature information, site inspections, fish survey in 2014	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, donation received	Yes
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		**Good**

Table 35 Summary of performance for Consent 0920-3

Purpose: ***To take up to 700 cubic metres/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 – no abstraction during monitoring period	Yes
2. Access to bore 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**

Table 36 Summary of performance for Consent 0921-3

Purpose: ***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***		
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 and biological surveys	Yes
2. Consent holder to monitor daily volume, temperature of discharge	Information supplied by the Company	Yes
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		**High**
Overall assessment of administrative performance in respect of this consent		**High**

Table 37 Summary of performance for Consent 0922-3

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. Maintenance of effluent spray irrigation plan		Yes
2. Consent exercised in accordance with procedures set out in effluent spray irrigation plan	Site and farm inspections	Yes
3. Limit on maximum volumes	Records received	Yes
4. Review of spray irrigation plan	Document received, July 2015	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

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***		
8. 20 metre 'buffer zone' to watercourse	Farm inspections	Yes
9. Records provided to Council of effluent produced, volume irrigated, area and hours pumped	Records received	Yes
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**

Table 38 Summary of performance for Consent 0923-3

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	Yes
2. Maintenance of effluent spray irrigation plan		Yes
3. Limit on maximum volumes	Records received	Yes
4. Consent exercised in accordance with procedures set out in plan	Site and farm inspections	Yes
5. Review of spray irrigation plan	Document received, July 2015	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		N/A
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
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		**High**
Overall assessment of administrative performance in respect of this consent		**High**

Table 39 Summary of performance for Consent 0924-3

Purpose: ***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***		
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	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	Yes
6. Consent holder to constantly monitor the temperature of the receiving waters	Consent holder maintains temperature probes in stream, data forwarded to Council	Yes
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	Temperature monitoring and site inspections	Yes
10. No anti-corrosion agents, biocides, anti-flocculants or other chemicals added to cooling water	Site inspections, sample collection	Yes
11. Maintenance of contingency plan	Plan approved April 2013	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		**Good**

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

Table 40 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

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?**
3. Limits of particulate from wet scrubber	Stack testing in November 2015	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**

Table 41 Summary of performance for Consent 4235-2

Purpose: ***To discharge up to 240 cubic metres/day of stormwater from the factory site via the existing stormwater system into the Kaupokonui Stream only during factory shutdown periods***		
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	Yes
2. Levels of contaminants not to be exceeded in discharge	No sampling was undertaken during period under review	N/A
3. Contingency plan	Approved August 2015	Yes
4. Factory shut down when no whey is being processed		N/A
5. Review of consent	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**

Table 42 Summary of performance for Consent 4604-2

Purpose: ***To discharge up to 280 litres/second 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 mixing zone	Site inspections, samples, biomonitoring	Yes
2. Levels of oil & grease, pH and suspended solids in discharge	Sample collection	Yes
3. Contingency planning	Approved August 2015	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**

Table 43 Summary of performance for Consent 4623-2

Purpose: ***To erect, place and maintain various spray, stormwater, irrigation and intake structures in the bed of the Kaupokonui Stream***		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
1. Notification of maintenance works	Receipt of notification of works in July 2013	Yes
2. Construction in accordance with application		N/A
3. Best practicable option to minimise environmental effects	Consent holder monitored maintenance activity	Yes
4. Structures not to restrict fish passage	Site inspections	Yes
5. Works to be undertaken between November and April	Works did not result in downstream discolouration, therefore fell outside date restrictions	Yes
6. Structure to be removed and area reinstated when no longer required		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**

Table 44 Summary of performance for Consent 5368-1

Purpose: ***To erect, place, use and maintain a bridge over Little Dunn's Creek a tributary of Dunns Creek in the Kaupokonui catchment for access purposes***		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
1. Notification of works	No maintenance carried out during period under review	N/A
2. Construction in accordance with application	No maintenance carried out during period under review	N/A
3. Practicable measures to prevent contamination of watercourse	No maintenance carried out during period under review	N/A

Purpose: ***To erect, place, use and maintain a bridge over Little Dunn's Creek a tributary of Dunns Creek in the Kaupokonui catchment for access purposes***		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
4. Removal and reinstatement when no longer required		N/A
5. No discharge of contaminated stormwater	No maintenance carried out during period under review	N/A
6. 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		**N/A**
Overall assessment of administrative performance in respect of this consent		**N/A**

Table 45 Summary of performance for Consent 6422-1

Purpose: ***To erect, place and maintain a stormwater outlet structure in the bed of the Kaupokonui Stream***		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
1. Notification prior to maintenance	No maintenance undertaken	N/A
2. Exercise of consent in accordance with application	Site inspections	Yes
3. Best practicable option to minimise environmental effects		N/A
4. Disturbance to be minimised		N/A
5. Structure to be removed and area reinstated if no longer required		N/A
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**

Table 46 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	Approved August 2015	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 levels of pH, suspended solids and hydrocarbons in the discharge	Sample collection	Yes

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?**
5. Effects which must not arise below the 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**

Table 47 Summary of performance for Consent 6885-1

Purpose: *To erect, place and maintain an outlet structure in the Kaupokonui Stream for stormwater discharge purposes*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
1. Best practicable option		N/A
2. Exercise of consent in accordance with application		N/A
3. Notification prior to installation		N/A
4. Minimise disturbance of stream bed		N/A
5. Reinstatement when structure no longer needed		N/A
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		**N/A**
Overall assessment of administrative performance in respect of this consent		**N/A**

Table 48 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 f conveying irrigation wastewater*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
1. Best practicable option on adverse effects		N/A
2. Exercise in accordance with application	Inspection by Council	Yes
3. Notification prior to installation		N/A
4. Best practicable option to minimise contaminant		N/A

Purpose: ***To erect, place, maintain and use pipeline crossings over the Motumate and Waiokura Streams, for the purposes f conveying irrigation wastewater***		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
5. Minimise disturbance of riverbed		N/A
6. Works resulting in downstream discolouration to be undertaken between November and April		N/A
7. Reinstatement of structure when no longer required		N/A
8. Lapse of consent		N/A
9. Review of consent conditions	Next review date available 1 June 2017	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**

Table 49 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 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

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?**
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
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	Yes
19. Procedure on discovery of archaeological remains		N/A
20. Removal of structure when no longer required		N/A
21. Lapse of consent if not exercised		N/A
22. Optional review provision for environmental effects	Next review date available 1 June 2017	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**

Table 50 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	Checking of records and information provided to Council	Yes
3. Notification upon volume exceedance	Checking of records and information provided to Council	Yes
4. Best practicable option on adverse effects	General observation and checking of records	Yes
5. Diversion of stormwater	Assessment by Council Officers	Yes
6. Maintenance of buffer distances	Monitoring by Council Officers	Yes
7. Limit on Nitrogen application rate	Checking of records and sampling if necessary	Yes

Purpose: *To discharge solid farm dairy effluent onto and into land*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
8. Keeping of records	Information provided to Council	Yes
9. Actions following unauthorised discharge	Notification received by Council	Yes
10. Optional review provision for environmental effects	Next review date available 1 June 2023	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**

Table 51 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 and information provided to Council	Yes
3. Notification upon volume exceedance	Checking of records and information provided to Council	N/A
4. Best practicable option on adverse effects	General observation and checking of records	Yes
5. Diversion of stormwater	Assessment by Council Officers	Yes
6. Maintenance of buffer distances	Monitoring by Council Officers	Yes
7. Limit on Nitrogen application rate	Checking of records and sampling if necessary	Yes
8. Keeping of records	Information provided to Council	Yes
9. Actions following unauthorised discharge	Notification received by Council	N/A
10. Optional review provision for environmental effects	Next review date available 1 June 2023	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**

During the two years under review, the Company demonstrated a high level of environmental and a good level of administrative performance with the resource

consents as defined in Section 1.1.4. There were ongoing issues with telemetry of monitoring data that were being addressed at the end of the monitoring period. Also, the methodology for inter-laboratory comparisons needs revision.

3.4 Recommendations from the 2013-2015 Biennial Report

In the 2013-2015 Biennial Report, it was recommended:

1. THAT monitoring of air emissions from the Fonterra Kapuni site in the 2015-2016 year continue at the same level as in 2014-2015.

2. THAT monitoring of discharges from the Fonterra Kapuni site in the 2015-2016 year continue to be exercised as in 2014-2015.

These recommendations were followed.

3.5 Alterations to monitoring programmes for 2016-2017

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

- the extent of information made available by previous authorities,
- its relevance under the RMA,
- the obligations to monitor emissions/discharges and effects under the RMA, and
- to report 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 emitting to the atmosphere/discharging to the environment.

In the case of Fonterra Limited, the programme for 2015-2016 was essentially the same as that for 2014-2015. Some additional sampling of discharges to Kaupokonui Stream, for nutrients, trace metals and faecal indicator bacteria, was carried out at the request of the Company, in preparation for an assessment of environmental effects when applications are made for consent replacement. It is now proposed that for 2016-2017, the programme revert to that for 2014-2015.

3.6 Exercise of optional review of consent

Two of the consents provide for an optional review in June 2017.

Resource consents **6948-1** (pipeline structure) and **9546-**1 (culvert) provide for an optional review of the consent in June 2017. Condition 9 on consent **6948-1** and condition 22 on consent **9546-1** allow the Council to review the consents, for the purpose of ensuring that the conditions are adequate to deal with any adverse effects of the respective activities on the environments.

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 a review to be pursued or grounds to exercise the review options.

4. Recommendations

1. THAT monitoring of air emissions from the Fonterra Kapuni site in the 2016-2017 year continue at the same level as in 2015-2016.

2. THAT monitoring of abstractions and discharges at the Fonterra Kapuni site in the 2016-2017 year continue to be exercised as in 2015-2016.

3. THAT the option for a review of resource consent **6948-1** (pipeline structure) in June 2017, as set out in condition 9 on consent **6948-1** not be exercised, on the ground that the current conditions are adequate to deal with any potential adverse effects.

4. THAT the option for a review of resource consent **9546-1** (culvert) in June 2017, as set out in condition 22 on consent **9546-1** not be exercised, on the ground that the current conditions are adequate to deal with any potential adverse effects.

Glossary of common terms and abbreviations

The following abbreviations and terms are 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.
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 20˚C and expressed in mS/m.
DSE	Dairy shed effluent.
Fresh	Elevated flow in a stream, such as after heavy rainfall.
g/m^3	Grammes per cubic metre, and equivalent to milligrammes per litre (mg/L). In water, this is also equivalent to parts per million (ppm), but the same does not apply to gaseous mixtures.
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.
IR	Unauthorised Incident Register – contains a list of events recorded by the Council on the basis that they may have the potential or actual environmental consequences that may represent a breach of a consent or provision in a Regional Plan.
l/s	Litres per second
m^3	Cubic metres, a measure of volume.
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
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.
NH_4	Ammonium, normally expressed in terms of the mass of nitrogen(N).
NH_3	Unionised ammonia, 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 subsequent amendments.
SIMP	Spray effluent management plan.
SS	Suspended solids.
Temp	Temperature, measured in ˚C (degrees Celsius).
Turb	Turbidity, expressed in NTU.
UI	Unauthorised Incident.

For further information on analytical methods, contact the Council's laboratory.

Bibliography and references

Aston, T and Zillwood, B., 2009, *Particulate Emission Report Wet Scrubber.* CPL 09-31701.

Fowles, CR, 1993, *A water temperature survey of the Kaupokonui River to provide an assessment of a mixing zone and documentation of the effects of two cooling water discharges from the Lactose Company of New Zealand Ltd, 3 March 1993.* Taranaki Regional Council Internal Memorandum.

Fowles, CR, 1994, *A water temperature survey of the Kaupokonui River to provide an assessment of the mixing zone and documentation of the effects of the two re-positioned cooling water discharges from the Lactose Company of New Zealand Ltd, 29 March 1994.* Taranaki Regional Council Internal Memorandum.

Fowles, CR, 1995, *'Water temperature survey of the Kaupokonui River, 23 January 1995'*. Taranaki Regional Council Internal Memorandum.

Kingett, Mitchell & Associates, 1993, *Environmental effects on the Kaupokonui River, of the proposed modifications to the Kapuni Factory.* Report prepared for the Lactose Company of NZ Ltd.

Ministry of Health, 1995, *Drinking-water standards for New Zealand 1995.* Ministry of Health, 87pp.

Taranaki Catchment Board, 1989, *Lactose Company of New Zealand – Water Rights Compliance Monitoring Programme Annual Report 1988/89.* Technical Report 89-18, Taranaki Catchment Board, Stratford.

Taranaki Regional Council, 1990, *Kaupokonui River Catchment Water Management Plan,* Taranaki Regional Council, Stratford.

Taranaki Regional Council, 1990, *Lactose Company of New Zealand – Water Rights Compliance Monitoring Programme Annual Report 1989/90.* Technical Report 90-41, Taranaki Regional Council, Stratford.

Taranaki Regional Council, 1991, *Lactose Company of New Zealand Report 1990/91.* Technical Report 91-42, Taranaki Regional Council, Stratford.

Taranaki Regional Council, 1992, *Lactose Company of New Zealand: Compliance Monitoring Programme Annual Report 1991/92.* Technical Report 92-18, Taranaki Regional Council, Stratford.

Taranaki Regional Council, 1993, *Lactose Company of New Zealand: Monitoring Programme Annual Report 1992/93.* Technical Report 93-26, Taranaki Regional Council, Stratford.

Taranaki Regional Council, 1994, *Lactose Company of New Zealand: Air and Water Monitoring Programme Annual Report 1993/94.* Technical Report 94-26, Taranaki Regional Council, Stratford.

Taranaki Regional Council, 1995, *Lactose Company of New Zealand: Air and Water Monitoring Programme Annual Report 1994/95.* Technical Report 95-57, Taranaki Regional Council, Stratford.

Taranaki Regional Council, 1996, *Lactose Company of New Zealand: Air and Water Monitoring Programme Annual Report 1995/96.* Technical Report 96-23, Taranaki Regional Council, Stratford.

Taranaki Regional Council, 1997, *Lactose Company of New Zealand: Air and Water Monitoring Programme Annual Report 1996/97.* Technical Report 97-57, Taranaki Regional Council, Stratford.

Taranaki Regional Council, 1998, *Lactose Company of New Zealand: Air and Water Monitoring Programme Annual Report 1997/98.* Technical Report 98-57, Taranaki Regional Council, Stratford.

Taranaki Regional Council, 1999:,*Lactose Company of New Zealand: Air and Water Monitoring Programme Annual Report 1998-1999.* Technical Report 99-52, Taranaki Regional Council, Stratford.

Taranaki Regional Council, 2000:,*Lactose Company of New Zealand: Air and Water Monitoring Programme Annual Report 1999-2000.* Technical Report 2000-46, Taranaki Regional Council, Stratford.

Taranaki Regional Council, 2001, *Lactose Company of New Zealand: Air and Water Monitoring Programme Annual Report 2000-2001.* Technical Report 2001-41, Taranaki Regional Council, Stratford.

Taranaki Regional Council, 2003, *Fonterra Kapuni Air and Water Monitoring Programme Annual Report 2001-2002.* Technical Report 2002-79, Taranaki Regional Council, Stratford.

Taranaki Regional Council, 2003, *Fonterra Kapuni Air and Water Monitoring Programme Annual Report 2002-2003.* Technical Report 2003-38, Taranaki Regional Council, Stratford.

Taranaki Regional Council, 2004, *Fonterra Kapuni Air and Water Monitoring Programme Annual Report 2003-2004.* Technical Report 2004-64, Taranaki Regional Council, Stratford.

Taranaki Regional Council, 2005, *Fonterra Kapuni Air and Water Monitoring Programme Annual Report 2004-2005.* Technical Report 2005-107, Taranaki Regional Council, Stratford.

Taranaki Regional Council, 2006, *Fonterra Kapuni Air and Water Monitoring Programme Annual Report 2005-2006.* Technical Report 2006-24, Taranaki Regional Council, Stratford.

Taranaki Regional Council, 2007, *Fonterra Kapuni Air and Water Monitoring Programme Annual Report 2006-2007.* Technical Report 2007-107, Taranaki Regional Council, Stratford.

Taranaki Regional Council, 2008, *Fonterra Kapuni Air and Water Monitoring Programme Annual Report 2007-2008.* Technical Report 2008-106, Taranaki Regional Council, Stratford.

Taranaki Regional Council, 2009, *Fonterra Kapuni Air and Water Monitoring Programme Annual Report 2008-2009.* Technical Report 2009-41, Taranaki Regional Council, Stratford.

Taranaki Regional Council, 2010, *Fonterra Kapuni Stream Air and Water Monitoring Programme Annual Report 2009-2010.* Technical Report 2010-86, Taranaki Regional Council, Stratford.

Taranaki Regional Council, 2012, *Fonterra Kapuni Stream Air and Water Monitoring Programme Biennial Report 2010-2012.* Technical Report 2012-81, Taranaki Regional Council, Stratford

Taranaki Regional Council, 2013, *Fonterra Kapuni Stream Air and Water Monitoring Programme Annual Report 2012-2013.* Technical Report 2013-106, Taranaki Regional Council, Stratford.

Taranaki Regional Council, 2015, *Fonterra Kapuni Stream Air and Water Monitoring Programme Annual Report 2013-2015.* Technical Report 2015-111, Taranaki Regional Council, Stratford.

Appendix I

Resource consents held by Fonterra Limited

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

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

_____

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

_____

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

_____

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

_____

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

_____

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

_____

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

_____

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 240 cubic metres/day of stormwater from the factory site via the existing stormwater system into the Kaupokonui Stream only during factory shutdown periods
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 allowing for a mixing zone of 150 metres extending downstream of the periphery of the spray discharge zone, 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 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 g/m^3

3. That the consent holder shall prepare and 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.

4. That the purpose of this consent the factory shall be deemed to be shut down when no whey is being processed.

5. That the Taranaki Regional Council may review any or all of the conditions of this consent by giving notice of review during 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

_____

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

_____

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:	4 February 1999
Commencement Date:	4 February 1999

Conditions of Consent

Consent Granted:	To erect, place, use and maintain various spray, stormwater, irrigation and intake structures in the bed of the Kaupokonui Stream
Expiry Date:	1 June 2017
Site Location:	Manaia Road Kapuni Kaponga
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 notify the Taranaki Regional Council at least 48 hours prior to undertaking any maintenance works that would involve disturbance of, or deposition to the river bed or discharges to water.

2. That the structure[s] authorised by this consent shall be constructed generally in accordance with the documentation submitted in support of the application and shall be maintained to ensure the conditions of this consent are met.

3. That the consent holder shall adopt the best practicable option [as defined in the Resource Management Act] to avoid or minimise the discharge of silt or other contaminants into water or onto the river bed and to avoid or minimise the disturbance of the river bed and any adverse effects on water quality.

4. That structures which are the subject of this consent shall not obstruct the passage of eels, mature fish, juveniles and adult trout.

5. That 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 by the written approval of the Chief Executive, Taranaki Regional Council.

6. That 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.

7. 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 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

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:	21 July 1998
Commencement Date:	21 July 1998

Conditions of Consent

Consent Granted:	To erect, place, use and maintain a bridge over Little Dunns Creek a tributary of Dunns Creek in the Kaupokonui catchment for access purposes
Expiry Date:	1 June 2017
Site Location:	Little Dunns Creek, Manaia Road, Kapuni
Legal Description:	Road Reserve Blk XV Kaupokonui SD
Grid Reference (NZTM)	1696440E-5630060N
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 notify the Taranaki Regional Council at least 48 hours prior to commencement, and upon completion of the initial construction, and again prior to, and upon completion of, any subsequent maintenance works which might involve disturbance of the streambed or discharges to the watercourse.

2. That the structure licenced by this consent shall be constructed and maintained in accordance with the documentation submitted in support of application 401.

3. That during the construction, and any subsequent maintenance of the bridge and its approaches, the consent holder shall observe every practicable measure to prevent the discharge or placement of silt and/or organics and/or cement products and/or any other contaminants into the watercourse.

4. That the structure covered by this consent shall be removed and the area reinstated, if and when it is no longer required.

5. That the consent holder shall ensure that there is not discharge of contaminated stormwater to the watercourse from the bridge or its approaches.

6. 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 adequately deal with the environmental effects arising from the exercise of this consent, which were not foreseen at the time the application was considered and which it was not appropriate to deal with at that time.

Transferred at Stratford on 13 April 2015

For and on behalf of
Taranaki Regional Council

_____

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:	13 July 2004
Commencement Date:	13 July 2004

Conditions of Consent

Consent Granted:	To erect, place and maintain a stormwater outlet structure in the bed of 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. The consent holder shall notify the Chief Executive, Taranaki Regional Council in writing at least 48 hours prior to the commencement and upon completion of the initial installation and again at least 48 hours prior to and upon completion of any subsequent maintenance works which would involve disturbance of or deposition to the river bed or discharges to water.

2. The structure authorised by this consent shall be constructed generally in accordance with the documentation submitted in support of application 3197 and shall be maintained to ensure the conditions of this consent are met. In the case of any contradiction between the documentation submitted in support of application 3197 and the conditions of this consent, the conditions of this consent shall prevail.

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. 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.

5. 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.

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

_____

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

_____

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:	12 May 2006
Commencement Date:	12 May 2006

Conditions of Consent

Consent Granted:	To erect, place and maintain an outlet structure in the Kaupokonui Stream for stormwater discharge purposes
Expiry Date:	1 June 2017
Site Location:	Manaia Road, Kapuni
Legal Description:	Lot 6 Pt Lot 5 DP 4509 Pt Lot 2 DP 6157 Secs 51 & 55 Blk XV Kaupokonui SD
Grid Reference (NZTM)	1697690E-5629540N
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 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.

2. The exercise of this consent shall be undertaken generally in accordance with the documentation submitted in support of application 4214. In the case of any contradiction between the documentation submitted in support of application 4214 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 48 hours prior to the commencement and upon completion of the initial installation and again at least 48 hours prior to and upon completion of any subsequent maintenance works which would involve disturbance of or deposition to the riverbed or discharges to water.

4. 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.

5. 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.

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 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

_____

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

_____

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

_____

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:	5 February 2016
Commencement Date:	5 February 2016

Conditions of Consent

Consent Granted:	To discharge solid farm dairy effluent onto and into land
Expiry Date:	1 June 2041
Review Date(s):	June 2023, June 2029, June 2035 and in accordance with special condition 11
Site Location:	1291 Skeet Road; 560 A & B, 586 and 594 Manaia Road, Kapuni (Kapuni Farms)
Legal Description:	Lot 2 DP 5897 Lot 2 DP 6039 Blk III Waimate SD, Lot 6 DP 2903 Lot 3 DP 3601 Blk XV Kaupokonui SD (Discharge source & site)
Grid Reference (NZTM)	1698545E–5626837N; 1698551E–5627075N 1698184E–5627034N; 1697499E–5626999N 1698510E–5627964N; 1698564E–5628854N
Catchment:	Waiokura Motumate

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 authorises the discharge of pond sludge from farm dairy effluent onto land. For the purposes of this consent:

   a) Farm dairy includes every area of the dairy cow milking process and includes covered and uncovered areas where cows reside for longer than five minutes for the purpose of milking (including a stand-off pad or yard) but does not include raceways; and

   b) 'Effluent' includes slurry and solid forms. It also includes sand trap cleanings.

2. A maximum of 500 m^3/year of dried solid effluent shall be discharged to 9.23 ha of land.

3. The consent holder shall advise the Taranaki Regional Council by sending an email to consents@trc.govt.nz if the volume of dairy farm exceeds the amount authorised in condition 2. The email shall include the consent number or dairy supply number.

4. 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 the environment.

5. A stormwater diversion system and a sand trap system shall be installed, maintained and operated at the farm dairy. The diversion system shall prevent, as far as practicable, uncontaminated stormwater entering the effluent disposal system.

   Note. Farm dairy includes any stand-off pad or yard (see condition 1(a)).

6. No contaminants shall be discharged within:

   (a) 25 metres of any surface water body; or
   (b) 25 metres of any fenced urupa (burial ground) without the written approval of the relevant Iwi; or
   (c) 50 metres of any bore, well or spring used for water supply purposes; or
   (d) 150 metres of any dwelling that is not owned by the consent holder, or any marae, unless the written approval of the owner and occupier has been obtained to allow the discharge at a closer distance.

7. Over any 12 month period the Total Nitrogen applied to any hectare of land as a result of the discharge shall be no more than 200 kg.

   Advice Note: Any Nitrogen applied within effluent should be taken into account in the nutrient budget for that land.

8. The consent holder shall keep accurate records of effluent discharged including, but not necessarily limited to the:

   (a) effluent type (e.g. liquid, slurry, solid);
   (b) source of any solid effluent (e.g. anaerobic pond sludge, sand trap);
   (c) paddock and area (ha) that effluent was applied to; and
   (d) date the paddock received effluent.

   This information shall be provided to the Taranaki Regional Council upon request.

9. Where, for any cause (accidental or otherwise), effluent enters surface water or a subsurface drainage system, the consent holder shall:

   (a) immediately notify the Taranaki Regional Council on Ph. 0800 736 222 (notification must include either the consent number or farm dairy number); and
   (b) stop the discharge and immediately take steps to control and stop the escape of effluent to surface water; and
   (c) immediately take steps to ensure that a recurrence of the escape of effluent to surface water is prevented; and
   (d) report in writing to the Chief Executive, Taranaki Regional Council, describing the manner and cause of the escape and the steps taken to control it and to prevent it reoccurring. The report shall be provided to the Chief Executive within seven days of the occurrence.

10. 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 2023 and/or June 2029 and/or June 2035, 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.

11. 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 within a period of 12-months immediately following a Regional Plan, that includes rules relating to discharges of farm dairy effluent, becoming operative. Any such review would be for the purposes of ensuring that the consent conditions have appropriate regard to that plan.

Signed at Stratford on 5 February 2016

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 444 Hawera 4640
Decision Date:	5 February 2016
Commencement Date:	5 February 2016

Conditions of Consent

Consent Granted:	To discharge pond sludge from farm dairy effluent onto and into land
Expiry Date:	1 June 2041
Review Date(s):	June 2023, June 2029, June 2035 and in accordance with special condition 11
Site Location:	893, 901, 911 Manaia Road, Kapuni (Kapuni 1)
Legal Description:	Lot 1 DP 4509 Sec 1 SO 11967 Blk XV Kaupokonui SD, Lot 6 Pt Lot 5 DP 4509 Pt Lot 2 DP 6157 Secs 51 & 55 Blk XV Kaupokonui SD (Discharge source & site)
Grid Reference (NZTM)	1697477E–5629140N 1696786E–5630300N 1697978E–5630246N
Catchment:	Kaupokonui
Tributary:	Dunns Creek

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 authorises the discharge of solid farm dairy effluent onto land. For the purposes of this consent:

   a) Farm dairy includes every area of the dairy cow milking process and includes covered and uncovered areas where cows reside for longer than five minutes for the purpose of milking (including a stand-off pad or yard) but does not include raceways; and

   b) 'Effluent' includes slurry and solid forms. It also includes sand trap cleanings.

2. A maximum of 1000 m^3/year of the solid farm dairy effluent shall be discharged to 14.1 ha of land.

3. The consent holder shall advise the Taranaki Regional Council by sending an email to consents@trc.govt.nz if the volume of dairy farm exceeds the amount authorised in condition 2. The email shall include the consent number or dairy supply number.

4. 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 the environment.

5. A stormwater diversion system and a sand trap system shall be installed, maintained and operated at the farm dairy. The diversion system shall prevent, as far as practicable, uncontaminated stormwater entering the effluent disposal system.

   Note. Farm dairy includes any stand-off pad or yard (see condition 1(a)).

6. No contaminants shall be discharged within:

   (a) 25 metres of any surface water body; or
   (b) 25 metres of any fenced urupa (burial ground) without the written approval of the relevant Iwi; or
   (c) 50 metres of any bore, well or spring used for water supply purposes; or
   (d) 150 metres of any dwelling that is not owned by the consent holder, or any marae, unless the written approval of the owner and occupier has been obtained to allow the discharge at a closer distance.

7. Over any 12 month period the Total Nitrogen applied to any hectare of land as a result of the discharge shall be no more than 200 kg.

   Advice Note: Any Nitrogen applied within effluent should be taken into account in the nutrient budget for that land.

8. The consent holder shall keep accurate records of effluent discharged including, but not necessarily limited to the:

   (a) effluent type (e.g. liquid, slurry, solid);
   (b) source of any solid effluent (e.g. anaerobic pond sludge, sand trap);
   (c) paddock and area (ha) that effluent was applied to; and
   (d) date the paddock received effluent.

   This information shall be provided to the Taranaki Regional Council upon request.

9. Where, for any cause (accidental or otherwise), effluent enters surface water or a subsurface drainage system, the consent holder shall:

   (a) immediately notify the Taranaki Regional Council on Ph. 0800 736 222 (notification must include either the consent number or farm dairy number); and
   (b) stop the discharge and immediately take steps to control and stop the escape of effluent to surface water; and
   (c) immediately take steps to ensure that a recurrence of the escape of effluent to surface water is prevented; and
   (d) report in writing to the Chief Executive, Taranaki Regional Council, describing the manner and cause of the escape and the steps taken to control it and to prevent it reoccurring. The report shall be provided to the Chief Executive within seven days of the occurrence.

10. 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 2023 and/or June 2029 and/or June 2035, 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.

11. 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 within a period of 12-months immediately following a Regional Plan, that includes rules relating to discharges of farm dairy effluent, becoming operative. Any such review would be for the purposes of ensuring that the consent conditions have appropriate regard to that plan.

Signed at Stratford on 05 February 2016

For and on behalf of
Taranaki Regional Council

_____

A D McLay
Director - Resource Management

Appendix II

Monthly analytical monitoring results for the Kaupokonui Stream (sites KPK000655, KPK000660, KPK000679)

Sample date: 16 July 2015 (flow at Glenn Road – 4.85 m^3/s)

Parameter	Unit	Site			Conditions
		1	2	3	
Time	NZST	0910	1025	1110	High flow recession, one day after rain on mountain. Tannin colour. Some brown turbidity.
Temperature	°C	7.9	8.2	8.4	
Conductivity	mS/m	5.9	6.2	6.4	
Turbidity	NTU	1.8	2.0	2.0	
pH	pH	7.4	7.4	7.5	
Total BOD	g/m^3	<0.5	<0.5	<0.5	
Filtered BOD	g/m^3	<0.5	<0.5	<0.5	
Ammonia-N	g/m^3N	0.014	0.016	0.015	
Nitrate-N	g/m^3N	0.43	0.50	0.50	
DRP	g/m^3P	0.006	0.007	0.007	

Sample date: 20 August 2015 (flow at Glenn Road – 7.32 m^3/s)

Parameter	Unit	Site			Conditions
		1	2	3	
Time	NZST	0915	1020	1115	Light showers. High flow, one day after peak. Slightly brown turbidity
Temperature	°C	7.7	8.0	8.3	
Conductivity	mS/m	6.5	6.7	6.9	
Turbidity	NTU	1.1	1.2	1.4	
pH	pH	6.8	6.8	7.0	
Total BOD	g/m^3	<0.5	<0.5	<0.5	
Filtered BOD	g/m^3	<0.5	<0.5	<0.5	
Ammonia-N	g/m^3N	0.020	0.0015	0.012	
Nitrate-N	g/m^3N	0.47	0.53	0.54	
DRP	g/m^3P	0.014	0.010	0.012	

Sample date: 17 September 2015 (flow at Glenn Road – 2.96 m^3/s)

Parameter	Unit	Site			Conditions
		1	2	3	
Time	NZST	0950	1040	1135	Shower earlier in day. Moderate-high swift flow, 5 days into recession. Grey-green turbidity. Green/brown film upstream, thick light brown mat downstream.
Temperature	°C	10.3	10.9	12.3	
Conductivity	mS/m	9.5	10.2	10.3	
Turbidity	NTU	0.96	1.4	1.1	
pH	pH	7.8	7.7	7.8	
Total BOD	g/m^3	<0.5	1.2	0.6	
Filtered BOD	g/m^3	<0.5	0.6	<0.5	
Ammonia-N	g/m^3N	0.014	0.013	0.007	
Nitrate-N	g/m^3N	0.82	0.91	0.89	
DRP	g/m^3P	0.010	0.027	0.022	

Sample date: 16 October 2015 (flow at Glenn Road – 1.77 m^3/s)

Parameter	Unit	Site			Conditions
		1	2	3	
Time	NZST	0820	0925	1030	Overcast. Moderate flow, 13 days into recession. Clear. Thick light brown algal filamentous algae ~75mm length upstream and downstream.
Temperature	°C	10.9	11.3	12.7	
Conductivity	mS/m	10.1	11.0	11.1	
Turbidity	NTU	1.1	0.93	0.93	
pH	pH	7.8	7.9	8.1	
Total BOD	g/m^3	<0.5	0.5	0.5	
Filtered BOD	g/m^3	<0.5	<0.5	<0.5	
Ammonia-N	g/m^3N	0.014	0.008	0.006	
Nitrate-N	g/m^3N	0.79	0.96	0.97	
DRP	g/m^3P	0.012	0.017	0.017	

Sample date: 20 November 2015 (flow at Glenn Road – 1.33 m^3/s)

Parameter	Unit	Site			Conditions
		1	2	3	
Time	NZST	0815	0910	1005	Overcast. Moderate-low flow, 16 days into recession. Clear upstream, slight miilky turbidity downstream. Thick light brown filamentous algae, 50-60% coverage.
Temperature	°C	12.1	12.5	13.8	
Conductivity	mS/m	9.5	10.5	10.5	
Turbidity	NTU	0.56	0.76	0.70	
pH	pH	7.8	7.9	8.2	
Total BOD	g/m^3	<0.5	<0.5	0.5	
Filtered BOD	g/m^3	<0.5	<0.5	<0.5	
Ammonia-N	g/m^3N	0.020	0.012	0.017	
Nitrate-N	g/m^3N	0.45	0.65	0.62	
DRP	g/m^3P	0.012	0.020	0.021	

Sample date: 17 December 2015 (flow at Glenn Road – 0.85 m^3/s)

Parameter	Unit	Site			Conditions
		1	2	3	
Time	NZST	0825	0935	1035	Local showers. Low flow, 33 days into recession. Clear. Silt-laden algal film.
Temperature	°C	13.2	14.1	15.3	
Conductivity	mS/m	9.8	10.8	10.9	
Turbidity	NTU	0.98	1.2	1.1	
pH	pH	7.8	7.8	8.0	
Total BOD	g/m^3	0.5	1.0	1.0	
Filtered BOD	g/m^3	<0.5	0.7	0.7	
Ammonia-N	$g/m^3/N$	0.020	0.020	0.010	
Nitrate-N	g/m^3N	0.33	0.52	0.52	
DRP	g/m^3P	0.011	0.026	0.027	

Sample date: 28 January 2016 (flow at Glenn Road – 0.81 m^3/s)

Parameter	Unit	Site			Conditions
		1	2	3	
Time	NZST	0805	0935	1015	Misty/spitting. Low flow, 9 days into recession. Clear. Thick green/brown algal mat. Foam flecks downstream.
Temperature	°C	17.1	17.3	17.4	
Conductivity	mS/m	9.7	10.2	10.3	
Turbidity	NTU	1.2	1.2	1.0	
pH	pH	7.8	7.8	7.9	
Total BOD	g/m^3	0.6	0.7	0.7	
Filtered BOD	g/m^3	<0.5	<0.5	<0.5	
Ammonia-N	$g/m^3/N$	0.017	0.012	0.007	
Nitrate-N	g/m^3N	0.37	0.46	0.44	
DRP	g/m^3P	0.014	0.014	0.016	

Sample date: 18 February 2016 (flow at Glenn Road – ~30 m^3/s)

Parameter	Unit	Site			Conditions
		1	2	3	
Time	NZST	0815	0930	1010	Fine. Flood, shortly after peak. Highly turbid brown. Temperature probes lifted for safety.
Temperature	°C	15.5	15.9	16.0	
Conductivity	mS/m	3.8	4.1	4.4	
Turbidity	NTU	94	64	56	
pH	pH	7.0	7.0	7.1	
Total BOD	g/m^3	2.3	2.0	2.0	
Filtered BOD	g/m^3	1.1	1.1	1.0	
Ammonia-N	$g/m^3/N$	0.038	0.036	0.037	
Nitrate-N	g/m^3N	0.18	0.20	0.22	
DRP	g/m^3P	0.027	0.026	0.026	

Sample date: 22 April 2016 (flow at Glenn Road – 0.90 m^3/s)

Parameter	Unit	Site			Conditions
		1	2	3	
Time	NZST	0920	1050	1130	Fine, no rain for 9 days. Low flow, Clear. Brown/green algal film.
Temperature	°C	11.8	12.3	14.4	
Conductivity	mS/m	9.0	9.4	9.5	
Turbidity	NTU	0.60	0.58	0.58	
pH	pH	7.4	7.6	7.8	
Total BOD	g/m^3	<0.5	<0.5	<0.5	
Filtered BOD	g/m^3	<0.5	<0.5	<0.5	
Ammonia-N	$g/m^3/N$	<0.003	0.003	0.0031	
Nitrate-N	g/m^3N	0.29	0.33	0.34	
DRP	g/m^3P	0.013	0.009	0.011	

Sample date: 19 May 2016 (flow at Glenn Road – 2.75 m^3/s)

Parameter	Unit	Site			Conditions
		1	2	3	
Time	NZST	0910	1040	1135	Light showers. Moderate-high flow. Tannin colour. Slight brown turbidity. Brown algal film downstream.
Temperature	°C	10.5	10.6	11.6	
Conductivity	mS/m	7.1	7.2	7.4	
Turbidity	NTU	2.4	2.4	2.2	
pH	pH	7.6	7.6	7.6	
Total BOD	g/m^3	0.7	0.7	0.7	
Filtered BOD	g/m^3	<0.5	0.7	<0.5	
Ammonia-N	$g/m^3/N$	0.032	0.023	0.019	
Nitrate-N	g/m^3N	0.24	0.27	0.28	
DRP	g/m^3P	0.018	0.016	0.017	

Sample date: 22 June 2016 (flow at Glenn Road – 8.34 m^3/s)

Parameter	Unit	Site			Conditions
		1	2	3	
Time	NZST	09:10	10:20	11:10	Recent showers. High flow, near peak. Highly turbid brown.
Temperature	°C	11.3	11.5	11.6	
Conductivity	mS/m	8.1	7.8	7.4	
Turbidity	NTU	16	18	18	
pH	pH	7.6	7.6	7.6	
Total BOD	g/m^3	2.0	2.1	2.1	
Filtered BOD	g/m^3	<0.5	1.6	0.9	
Ammonia-N	$g/m^3/N$	0.015	0.024	0.031	
Nitrate-N	g/m^3N	0.43	0.37	0.32	
DRP	g/m^3P	0.011	0.012	0.012	

Appendix III

Groundwater monitoring data

SITE	DATE	TIME	LEVEL	TEMP	CONDY	pH	NNN	CL	NA	NH4	COD
		NZST	m	°C	mS/m@20C		g/m³ N	g/m³	g/m³	g/m³ N	g/m³
Farm 1											
GND0636	11-Aug-15	12:35	1.74	12.2	41.6	6.8	11.2				
	12-Oct-15	13:00	2.24	13.0	29.7	6.8	7.0	42	22	<0.003	<5
	14-Dec-15	13:00	3.06	13.4	29.1	6.5	7.2	41	24	<0.003	7
	03-Feb-16	11:30	3.46	14.7	29.3	6.5	7.3				
	05-Apr-16	13:40	3.74	13.6	29.8	6.5	6.6	37	24	<0.003	<5
	16-Jun-16	12:45	3.52	13.9	29.2	6.5	7.3				
GND0637	11-Aug-15	12:05	3.13	13.5	59.7	6.7	19.9				
	12-Oct-15	12:35	3.31	13.7	54.2	7.0	4.8	78	71	0.008	5
	14-Dec-15	12:45	4.37	14.1	60.4	6.6	16.5	49	63	<0.003	<5
	03-Feb-16	11:00	5.13	14.8	35.0	6.7	5.0				
	05-Apr-16	13:15	5.77	15.1	34.9	6.6	5.0	35	44	0.005	50
	16-Jun-16	13:15	5.62	13.8	35.1	6.6	4.8				
Farm 2											
GND2049	11-Aug-15	09:10	1.85	13.9	37.2	6.6	16.6				
	12-Oct-15	10:35	2.17	13.6	37.9	6.5	18.8	37	30	0.009	<5
	14-Dec-15	11:00	2.76	13.8	41.1	6.4	23.1	42	32	0.020	<5
	03-Feb-16	08:30	3.39	14.3	40.4	6.4	22.4				
	05-Apr-16	10:00	3.62	15.0	40.8	6.4	21.9	39	33	<0.003	<5
	16-Jun-16	10:00	3.05	14.2	41.8	6.4	21.1				
GND0638	11-Aug-15	09:25	1.47	13.9	67.0	6.7	6.3				
	12-Oct-15	10:00	2.30	14.4	74.8	6.8	8.9	60	71	<0.003	8
	14-Dec-15	11:10	2.84	14.6	77.9	6.8	10.8	59	77	0.003	14
	03-Feb-16	08:50	3.08	15.1	72.6	6.6	9.2				
	05-Apr-16	10:25	3.49	15.9	70.8	6.6	8.3	59	79	0.012	<5
	16-Jun-16	09:45	2.51	15.3	71.8	6.6	10.3				
GND2050	11-Aug-15	10:00	1.89	13.2	63.7	6.8	9.8				
	12-Oct-15	10:40	2.80	14.1	53.8	6.8	0.01	57	57	0.29	<5
	14-Dec-15	11:30	2.79	14.1	54.6	6.8	0.03	54	56	0.45	<5
	03-Feb-16	09:15	2.96	14.3	54.5	6.9	0.02				
	05-Apr-16	10:50	3.05	14.3	55.3	6.8	0.04	51	57	0.55	14
	16-Jun-16	10:25	2.84	14.0	54.7	6.8	0.06				

SITE	DATE	TIME	LEVEL	TEMP	CONDY	pH	NNN	CL	NA	NH4	COD
		NZST	m	°C	mS/m@20C		g/m³ N	g/m³	g/m³	g/m³ N	g/m³
Farm 3											
GND2051	11-Aug-15	10:40	2.20	13.9	56.4	6.6	14.2				
	12-Oct-15	11:20	2.82	13.8	49.6	6.6	19.2	74	33	0.006	<5
	14-Dec-15	12:00	3.30	14.2	31.4	6.5	4.6	46	26	0.009	9
	03-Feb-16	09:45	3.72	14.3	28.7	6.6	0.84				
	05-Apr-16	11:45	4.20	14.4	28.0	6.5	0.94	38	27	0.009	<5
	16-Jun-16	11:10	4.36	14.4	28.6	6.5	2.6				
GND0639	11-Aug-15	09:45	2.11	12.9	49.4	6.9	8.0				
	12-Oct-15	10:30	2.80	13.5	66.9	7.0	8.3	80	107	<0.003	6
	14-Dec-15	11:20	3.20	13.6	67.7	7.0	9.5	84	115	0.014	<5
	03-Feb-16	09:00	3.76	14.8	64.4	7.0	10.4				
	05-Apr-16	10:20									
	16-Jun-16	10:20	4.19								
GND2052	11-Aug-15	11:00	1.56	13.6	40	6.7	2.7				
	12-Oct-15	12:05	2.28	14.1	37.3	6.7	1.47	44	48	0.004	<5
	14-Dec-15	12:10	2.96	14.5	28.5	6.6	0.02	46	38	0.041	<5
	03-Feb-16	10:15	3.10	14.7	29.7	6.7	0.48				
	05-Apr-16	12:05	3.17	14.7	40.3	6.5	3.3	47	50	<0.003	<5
	16-Jun-16	11:35	2.68	14.5	38.0	6.5	0.79				
GND0700	11-Aug-15	11:15	0.77	13.4	111	6.8	21.7				
	12-Oct-15	12:15	1.51	13.3	60.4	6.8	18.9	53	58	<0.003	<5
	14-Dec-15	12:20	2.62	14.4	42.7	6.8	2.6	69	57	0.024	<5
	03-Feb-16	10:30	2.84	14.8	48.1	6.7	3.3				
	05-Apr-16	12:20	3.16	14.6	63.7	6.8	8.1	89	94	0.010	7
	16-Jun-16	12:00	2.61	14.1	56.4	6.7	4.6				

Appendix IV

Report on fish survey of Kaupokonui Stream

30 January 2014

Memorandum

To James Kitto, Job Manager
From Bart Jansma, Scientific Officer
Report No. BJ247
Doc No. 1458187
Date 19 January 2015

Fish survey in the Kaupokonui Stream in relation to the Fonterra Kapuni lactose factory and weir, January 2014

Introduction

The Fonterra Kapuni lactose factory, located on Manaia Road, Kapuni, sits alongside the Kaupokonui Stream. There are numerous consents held in relation to this factory, a number of which have the potential to impact on the fish communities of the Kaupokonui Stream. For example, the discharge of cooling water could potentially increase the water temperature of the stream, beyond the tolerance limits of those fish species inhabiting it, and the weir associated with the water intake (Figure 1), could pose a barrier to the passage of migrant fish.

There has been no regular fish monitoring undertaken in the Kaupokonui Stream to date, although some sites have been monitored on an ad hoc basis. The current survey is the first undertaken in relation to the Kapuni Lactose factory since April 1999, and is to be repeated on a three yearly basis.

Before any results are interpreted, it is necessary to provide some context. Located downstream of the Kapuni Lactose factory, there is a weir, known as the Glenn Road weir. This weir is an orphaned structure, but is considered to have historical significance. It also presents a significant barrier to the passage of most fish, with only the best climbers being able to negotiate it. It is considered highly unlikely that swimming species, such as common smelt, inanga and torrentfish, could negotiate this weir, and as such they are not expected to be in the Kaupokonui River near the lactose factory.

Figure 1 Kaupokonui Stream, Kapuni Lactose weir and fish pass

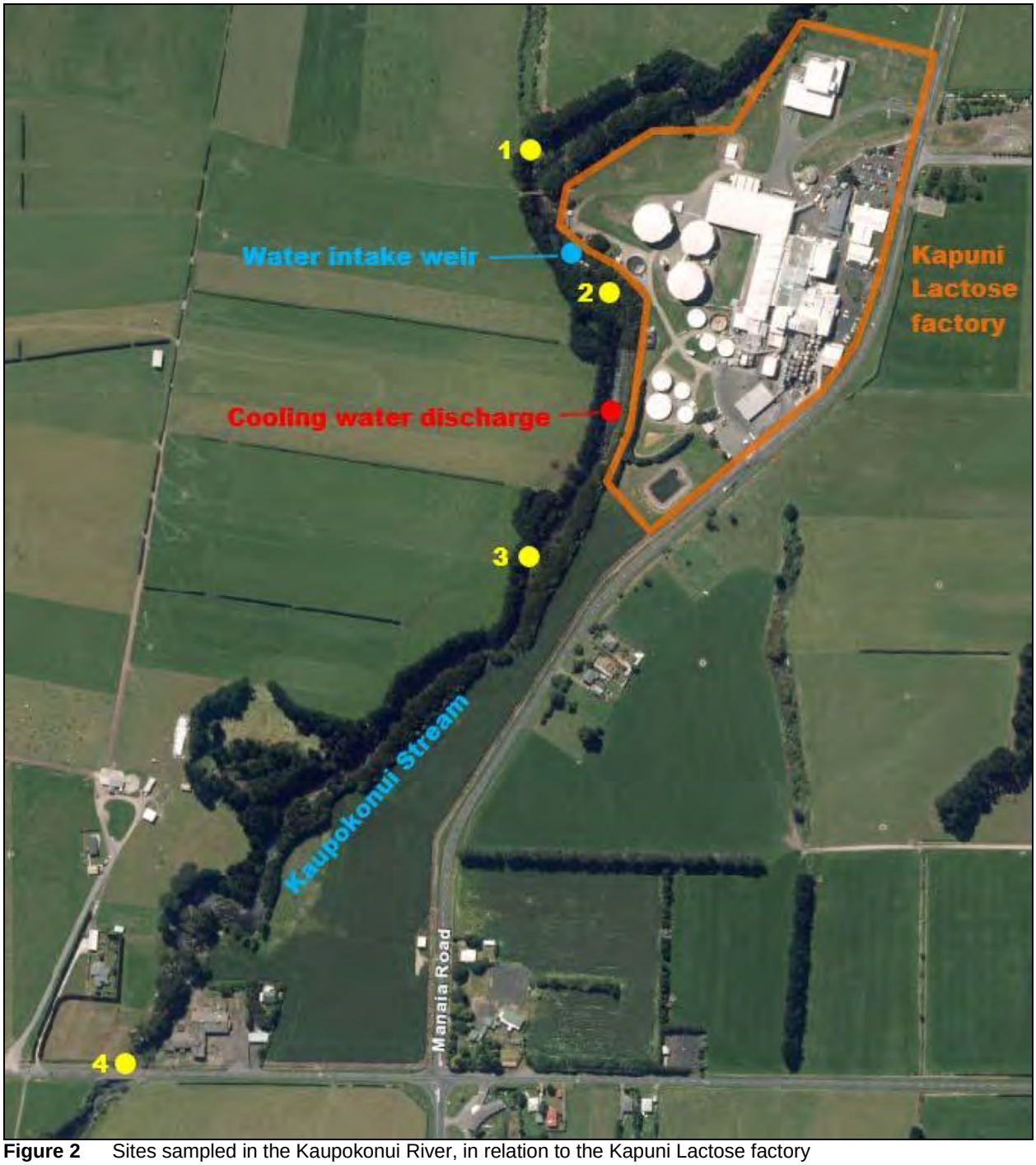

Figure 2 Sites sampled in the Kaupokonui River, in relation to the Kapuni Lactose factory

Methods

The current survey was performed at four sites in the Kaupokonui Stream on 30 January 2014. Details of the sites surveyed in the current survey are presented in Table 1, and their locations are shown in Figure 2.

Table 1 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	KPK000660	Upstream of intake weir	1697613-5629791	15.98	170
2	KPK000666	Between intake weir and cooling water discharge	1697744-5629658	15.5	160
3	KPK000677	Downstream of cooling water discharge	1697644-5629458	15.3	160
4	KPK000685	Skeet Rd	1697221-5628986	14.51	150

The sites were surveyed using the electric fishing method, which employed a Kainga EFM machine. Those fish captured were identified and counted, where possible. Inevitably some fish eluded capture, although some were identified before reaching cover. The length of each fish was estimated, following which they were released. The results of this survey are presented in Table 2 together with the results of previous surveys.

In addition, the area surveyed was estimated, and some observations made regarding the habitat present at the sites surveyed.

Results

The sites surveyed all included similar habitat, with the substrate comprising predominantly boulders and cobbles, with lesser proportions of gravels and sand. With the exception of site 4, all sites enjoyed partial shading, while only site 1 had any undercut bank. Overhanging vegetation was observed at site 2, 3 and 4. Water clarity was good during this survey, with uncoloured and clear flow at all sites.

The results for each site are summarised in Table 2.

Table 2 Fish species and abundance recorded during the current survey.

	Site:	Site 1	Site 2	Site 3	Site 4
	Area fished (m^2):	36	72	80	84
Longfin eel (*Anguilla dieffenbachii*)	Number	13	9	9	6
	Length range (mm)	100-200	100-150	100-400	150-400
Shortfin eel (*Anguilla australis*)	Number	7	1	-	9
	Length range (mm)	100-200	130	-	100-400
Unidentified eel	Number	-	2	2	2
	Length range (mm)	-	200-600	100-100	200-350
Redfin bully	Number	-	-	1	1
	Length range (mm)	-	-	40	40
Unidentified bully	Number	-	-	-	1
	Length range (mm)	-	-	-	80
Rainbow trout	Number	-	-	1	
	Length range (mm)	-	-	120	
Unidentified trout	Number	-	-	-	1
	Length range (mm)	-	-	-	100
Crayfish	Number	3	10	1	2
Total number of species		2	2	3	4
Total number of fish		20	12	13	20

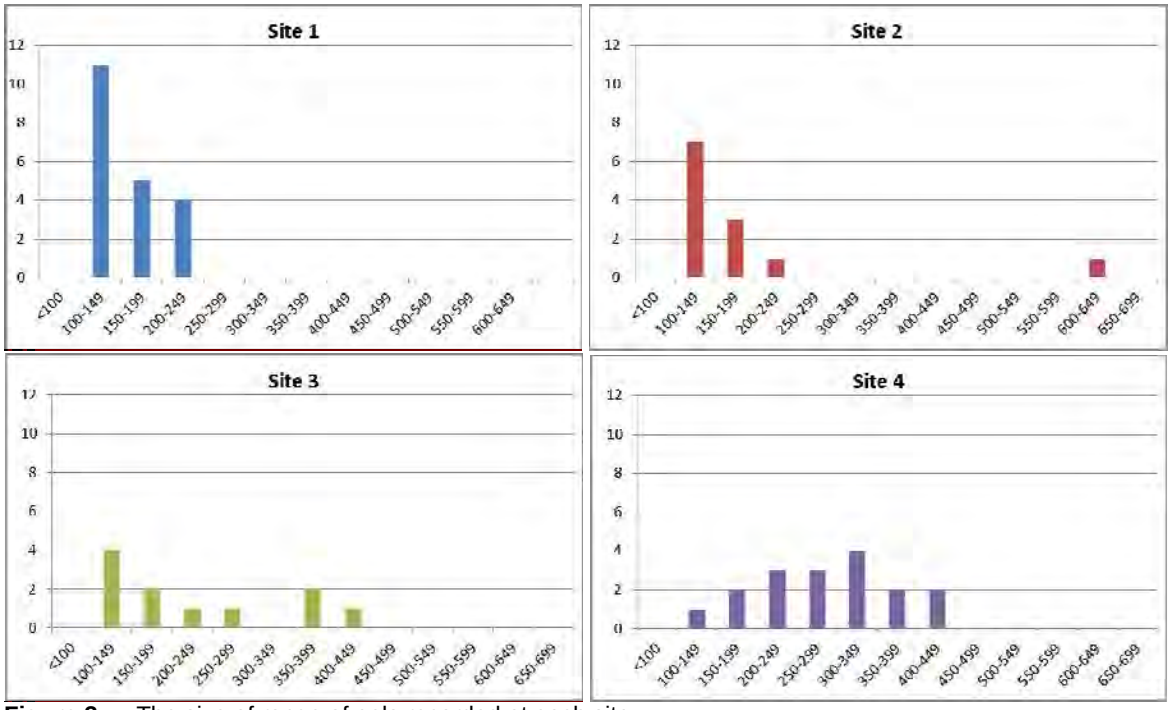

Figure 3 The size of range of eels recorded at each site

Length distribution data for all eels recorded are presented in Figure 3, while the number of fish recorded per square metre is presented in Figure 4.

Only two species were recorded at sites 1 and 2, while site 3 recorded three species, and four species were recorded at site 4. Longfin eel and shortfin eel were recorded both upstream and downstream of the weir, while redfin bully were only recorded downstream of the weir, and in very low abundance. A juvenile rainbow trout was recorded at site 3, and freshwater crayfish were recorded at all sites, being most abundant at site 2. This low species abundance, and also low redfin bully abundance is an indication that the Glenn Road weir is still having a significant deleterious effect on upstream fish migration. Although only two species were recorded upstream of the Kapuni Lactose weir, there is no indication that this weir is posing a significant barrier to fish passage. There were good numbers of juvenile eels recorded upstream of the weir (Figure 3), and no evidence of fish accrual immediately downstream of the weir (Figure 4). This would have been evident by higher fish abundance per square metre at site 2 than any other site, especially site 1.

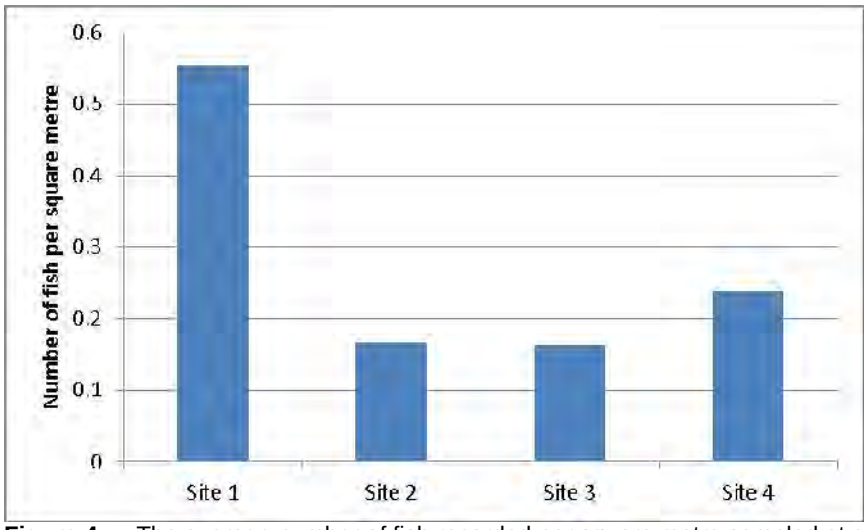

Figure 4 The average number of fish recorded per square metre sampled at each site

There is also no evidence that the discharge of cooling water to the Kaupokonui Stream has had a significant impact on the fish communities. Rainbow trout are considered to be one of the more 'sensitive' species, with regards to water quality, and the presence of a rainbow trout at site 3 is an indication of good preceding water quality (including water temperature). However, there were some differences in small eel distribution, with sites 3 and 4 having higher numbers of eels longer than 250mm. Only one eel longer than 250mm was recorded upstream of the cooling water discharge, compared with a total of fifteen eels at sites 3 and 4. This could be an indication that the cooling water discharge has caused an increase in food supply downstream, for example through nutrients contamination of the discharge. However, it is also likely to be related to the increased boulder habitat observed at sites 3 and 4, which provides ideal habitat for these small eels. This observation, coupled with the findings of the macroinvertebrate survey undertaken in February 2014 (Fowles & Jansma, 2015), indicates that there is little evidence of a cooling water impact. Although it is possible that a subtle impact has occurred, it is not possible to differentiate this from the changes caused by habitat variation.

Summary and Conclusions

A four site fish survey was undertaken in the Kaupokonui Stream on 30 January 2014, 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 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 some kilometres downstream of the factory is an orphaned structure, the Glenn Road weir, which currently does not have adequate fish passage provision.

Four fish species were recorded during this survey, being longfin and shortfin eel, redfin bully and rainbow trout. Redfin bully were recorded in very low abundance, reflecting the impact of the Glenn Road weir.

Although only two species were recorded upstream of the Kapuni Lactose weir, longfin and shortfin eels, there is no indication that this weir is posing a significant barrier to fish passage. There were good numbers of juvenile eels recorded upstream of the weir, and no evidence of fish accrual immediately downstream of the weir.

The presence of rainbow trout downstream of the cooling water discharge is an indication that this discharge had not adversely affected the fish communities, as rainbow trout are considered to be one of the more 'sensitive' species with regards to water quality, including temperature. The higher abundance of eels between 250mm and 450mm is considered to be a reflection of the greater proportion of boulders in the substrate, which provide good cover for these fish.

Overall, it is considered that the activities of the Kapuni Lactose factory have not adversely affected the fish communities of the Kaupokonui Stream. It is hoped that as the riparian planting of the catchment matures, and passage remediation works at the Glenn Road weir are undertaken, that the diversity and abundance of fish in this stretch of stream will improve.

References

Jansma, B and Fowles, C: Biomonitoring of the Kaupokonui River and Waiokura Stream in relation to the Fonterra Kapuni farm and factory, February 2014. Report No. CF628.

Taranaki Regional Council, 1999: Lactose Company of New Zealand: Air and Water Monitoring Programme Annual Report 1998-1999. Technical Report 99-52, Taranaki Regional Council, Stratford.

Appendix V

Biomonitoring reports

To Job Manager, James Kitto
From Scientific Officer, B Jansma
Report No BJ256
Doc No 1539920
Date 15 July 2015

Biomonitoring of the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, October 2014

Introduction

This biological survey was the first of two scheduled in relation to the Fonterra Kapuni (formerly Lactose) factory in the 2014-2015 monitoring year. The results from surveys performed since the 2001-2002 monitoring year are discussed in reports listed in the references section of this report.

This survey relates to the following consents held by Fonterra Kapuni Ltd:

0919 to discharge cooling water to the Kaupokonui River;
0922 to spray irrigate wastewater and stormwater to land in the Kaupokonui catchment;
0923 to spray irrigate wastewater and stormwater to land in the Waiokura and Motumate catchments;
0924 to discharge stormwater and cooling water to the Kaupokonui River;
4235 to discharge stormwater to the Kaupokonui River during factory shutdown periods;
4604 to discharge stormwater to the Kaupokonui River from the factory extension;
6423 to discharge stormwater from an inhalation grade lactose plant site into the Kaupokonui River

Methods

The standard '400 ml kick-sampling' technique was used to collect streambed macroinvertebrates from five sites in the Kaupokonui River in relation to discharges to the river and on to land in the catchment (Table 1, Figure 1) on 14 October 2014. The 'kick-sampling' technique is very similar to Protocol C1 (hard-bottomed, semi-quantitative) of the New Zealand Macroinvertebrate Working Group (NZMWG) protocols for macroinvertebrate samples in wadeable streams (Stark et al, 2001).

Table 1 Biomonitoring sites in the Kaupokonui River and Waiokura Stream

Stream	Site No.	Site Code	Location
Kaupokonui River	3b	KPK000655	1 km u/s of railway bridge
	4	KPK000660	Railway, above factory
	5	KPK000679	160m below cooling water discharge zone
	6	KPK000685	Skeet Road
	7	KPK000880	Glenn Road
Waiokura Stream	U	WKR000500	Skeet Road
	D	WKR000650	At Hicks (Thomas) Road

Samples were preserved with Kahle's Fluid for later sorting and identification under a stereomicroscope according to Taranaki Regional Council methodology using protocol P1 of NZMWG protocols for sampling macroinvertebrates in wadeable streams (Stark et al. 2001).

Macroinvertebrate taxa found in each sample were recorded as:

R (rare)	= less than 5 individuals;
C (common)	= 5-19 individuals;
A (abundant)	= estimated 20-99 individuals;
VA (very abundant)	= estimated 100-499 individuals;
XA (extremely abundant)	= estimated 500 individuals or more.

Stark (1985) developed a scoring system for macroinvertebrate taxa according to their sensitivity to organic pollution in stony New Zealand streams. Highly 'sensitive' taxa were assigned the highest scores of 9 or 10, while the most 'tolerant' forms scored 1. Sensitivity scores for certain taxa have been modified in accordance with Taranaki experience. Averaging the scores assigned to the taxa found at a site, and multiplying the average by a scaling factor of 20, produces a Macroinvertebrate Community Index (MCI) value.

The MCI was designed as a measure of the overall sensitivity of macroinvertebrate communities to the effects of organic pollution. MCI results can also reflect the effects of warm temperatures, slow current speeds and low dissolved oxygen levels, because the taxa capable of tolerating these conditions generally have low sensitivity scores. Usually more 'sensitive' communities (with higher MCI values) inhabit less polluted waterways.

A semi-quantitative MCI value ($SQMCI_s$) has also been calculated for the taxa present at each site by multiplying each taxon score by a loading factor (related to its abundance), totalling these products, and dividing by the sum of the loading factors (Stark, 1998 and 1999). The loading factors were 1 for rare (R), 5 for common (C), 20 for abundant (A), 100 for very abundant (VA) and 500 for extremely abundant (XA). Unlike the MCI, the $SQMCI_s$ is not multiplied by a scaling factor of 20, so that its corresponding range of values is 20x lower.

When necessary, sub-samples of periphyton (algae and other microflora) taken from the macroinvertebrate samples were scanned under 40-400x magnification to determine the presence or absence of any mats, plumes or dense growths of bacteria, fungi or protozoa ("undesirable biological growths") at a microscopic level. The presence of masses of these organisms can be an indicator of organic enrichment within a stream.

Figure 1 Biomonitoring sites in the Kaupokonui River sampled in relation to Fonterra Kapuni factory discharges

Results and discussion

This survey was undertaken following a short period of receding flows in the Kaupokonui River, and followed 8 and 15 days after flow events in excess of three and seven times median flow respectively. The Kaupokonui River had a moderate, clear, uncoloured, and swift flow at all sampling sites. River flow at the Glenn Road recorder site was 2.1 m^3/sec, just above the median flow (2.04 m^3/sec) for the Kaupokonui River.

At the time of this morning survey, water temperatures in the Kaupokonui River ranged from 12.8°C to 13.9°C. Periphyton mats and algal filaments were patchy all sites, with the exception of site 3b, which did not support any filaments. It was noted during this survey that site 7 was relatively clean, as this site usually supports widespread mats and long filaments. This is probably related to the high flows that preceded this survey, with flows exceeding seven times median twice, and three times median seven times in the preceding month. Cobbles, gravel and boulders were the predominant substrate at all sites in the river.

Of concern was the observation of undesirable heterotrophic growths (sewage fungus) on the bed of the stream at site 5, the first site downstream of the cooling water discharge. This sewage fungus was present as a thin film over much of the stream bed, but in smaller areas was quite thick. Observations at site 6 indicated that it was also present there, although to a lesser degree. The presence of sewage fungus at these sites was confirmed through microscopic examination of the sample, and identified as growths of filamentous bacteria.

Macroinvertebrate communities

Kaupokonui River

Historically the mid to lower reaches of the Kaupokonui River have shown the effects of nutrient enrichment from the surrounding farmland, and in past years (mainly prior to 2000) there have been a number of surveys showing detectable impacts of discharges from the lactose factory on the riverbed fauna. On many past sampling occasions, the sites immediately upstream and downstream of the Fonterra Kapuni factory supported moderate numbers of taxa, with relatively low proportions of 'sensitive' taxa (such as mayflies and stoneflies), resulting in median MCI values in the low 80s (Table 2). Since 1998 however, macroinvertebrate communities have improved throughout the reach and have shown higher numbers of taxa and MCI scores on most occasions. Median values for both the total data set and the results since 1998 are included in Table 2. Faunal results from the current survey are presented in full in Table 3.

Table 2 Numbers of taxa and MCI values recorded previously in the Kaupokonui River (since 1985), together with current results

Site	Number of previous surveys	Numbers of taxa				MCI values			
		Median (all data)	Range (all data)	*Median (Nov 1998 to date)*	Current survey	Median (all data)	Range (all data)	*Median (Nov 1998 to date)*	Current survey
3b	47	24	13-28	*24*	27	105	68-125	*110*	117
4	61	22	8-32	*25*	22	94	65-128	*104*	109
5	42	23	11-28	*24*	17	98	65-121	*100*	107
6	61	20	4-30	*23*	20	90	40-125	*102*	103
7	52	17	7-31	*19*	21	90	57-110	*92*	95

Generally the summer (February to March) surveys have found lower proportions of 'sensitive' taxa resulting in lower MCI values than the spring (October to November) surveys (see Figures 3, 4, 5, 6 and 7).

In this October 2014 survey, all sampling sites supported between 17 and 27 taxa. These results were all within 3 taxa of the site medians from data since 1998, with the exception of site 7, which recorded a richness seven taxa less than this median. MCI scores at all sites were above their respective median values for surveys since November 1998. The MCI scores at all sites also were well in excess of their respective median values for the entire record with the exception of the score at site 7 which was only five units above its historical median (Table 2, Figure 2). Four sites had very similar numbers of taxa, with site 5 recording the lowest richness of 17 taxa. MCI scores generally decreased steadily in a downstream direction, with the highest scores recorded at the 'control site'. MCI scores ranged from 97 to 117 units, reflecting relatively fair to good physicochemical water quality, indicating that land irrigation of wastewater had not adversely affected the Kaupokonui River macroinvertebrate communities in the months prior to this survey but that there were some impacts of the cooling water discharges in the mid-reaches of the river as indicated by the presence of sewage fungus at sites 5 and 6. Similar to results frequently recorded by most previous surveys, there was an eight unit decrease in scores between sites 6 and 7, indicating further impacts on the macroinvertebrate communities at site 7. In most previous surveys, the inflow from Dunns Creek in this reach was likely to have contributed to this recorded deterioration, although the natural decrease in MCI with distance downstream in the lower mid-reaches of the Taranaki ringplain, over a stream distance of about 9 km (of 5 units (Stark and Fowles, 2009)) should also be taken into account.

The 'fair' to 'good' MCI scores did not reflect the results of the microscopic scan for undesirable biological growths, which recorded such growths at sites 5 and 6. This indicates that although the cooling water discharge was facilitating the growth of sewage fungus, it either had not been occurring for very long, and/or was not causing sufficient deterioration in water quality that caused a reduction in macroinvertebrate community health. The last time such growths were noted in the Kaupokonui River was during the spring 2010 survey, which found dense growths of filamentous bacteria at two sites.

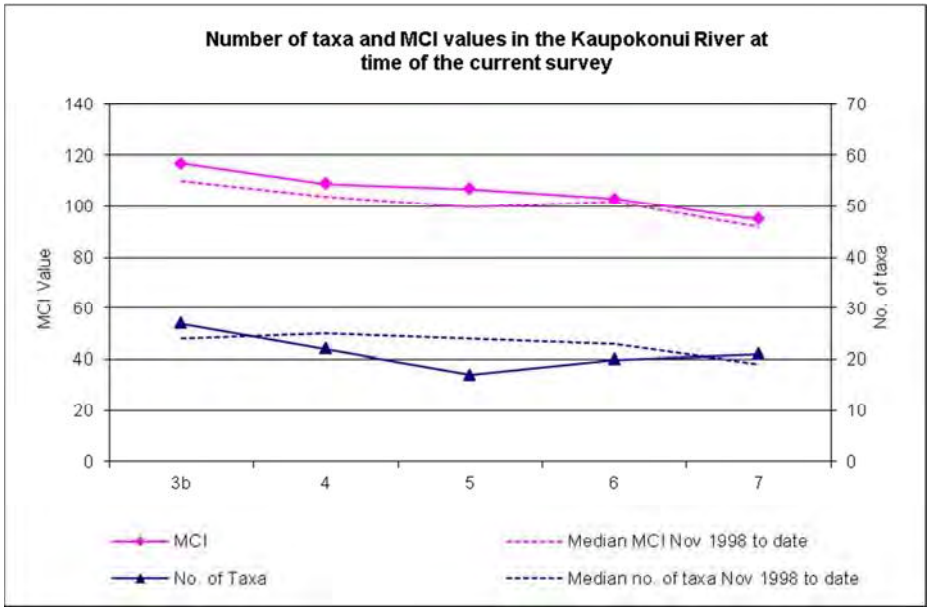

Figure 2 Numbers of taxa and MCI values recorded in the Kaupokonui River in this survey, together with median values from previous surveys (November 1998 to date)

Table 3 Macroinvertebrate fauna of the Kaupokonui River in relation to Fonterra Kapuni samples on 14 October 2014

Taxa List	Site Number	MCI score	3b	4	5	6	7
	Site Code		KPK000655	KPK000660	KPK000679	KPK000685	KPK000880
	Sample Number		FWB14261	FWB14262	FWB14263	FWB14264	FWB14265
PLATYHELMINTHES	*Cura*	3	-	-	-	-	R
NEMATODA	Nematoda	3	-	-	C	R	R
ANNELIDA	Oligochaeta	1	C	A	R	C	A
	Lumbricidae	5	-	-	-	-	R
MOLLUSCA	*Potamopyrgus*	4	C	C	R	-	C
CRUSTACEA	*Paracalliope*	5	-	-	-	-	R
EPHEMEROPTERA	*Acanthophlebia*	9	R	-	-	-	-
	Austroclima	7	C	C	R	R	-
	Coloburiscus	7	VA	VA	A	A	R
	Deleatidium	8	XA	VA	VA	XA	VA
	Nesameletus	9	C	-	R	-	-
	Zephlebia group	7	-	-	-	-	R
PLECOPTERA	*Acroperla*	5	C	R	-	R	C
	Megaleptoperla	9	R	R	-	-	-
	Zelandobius	5	C	R	-	-	R
	Zelandoperla	8	R	-	-	-	-
COLEOPTERA	Elmidae	6	A	VA	C	A	C
	Hydraenidae	8	R	-	-	R	-
MEGALOPTERA	*Archichauliodes*	7	A	A	C	C	C
TRICHOPTERA	*Hydropsyche (Aoteapsyche)*	4	VA	VA	C	A	R
	Costachorema	7	A	A	C	C	C
	Hydrobiosis	5	R	R	R	C	A
	Neurochorema	6	R	-	-	-	-
	Psilochorema	6	-	-	-	R	-
	Beraeoptera	8	A	R	R	R	-
	Olinga	9	R	R	-	-	-
	Pycnocentrodes	5	VA	C	R	A	VA
DIPTERA	*Aphrophila*	5	A	VA	C	A	C
	Maoridiamesa	3	A	VA	A	A	VA
	Orthocladiinae	2	VA	VA	VA	VA	A
	Tanypodinae	5	R	R	-	-	-
	Tanytarsini	3	R	-	-	R	-
	Austrosimulium	3	-	-	-	-	R
	Tabanidae	3	R	R	-	R	-
ACARINA	Acarina	5	-	R	-	-	-
		No of taxa	27	22	17	20	21
		MCI	117	109	107	103	95
		SQMCIs	6.4	5.0	5.1	6.6	4.9
		EPT (taxa)	16	12	9	10	9
		%EPT (taxa)	59	55	53	50	43
'Tolerant' taxa	'Moderately sensitive' taxa				'Highly sensitive' taxa		

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Site 3b (KPK000655)

A moderately high richness of twenty-seven taxa was recorded at site 3b, upstream of the Fonterra Kapuni farm. This was slightly higher than the long term median number of taxa recorded at this site to date (Table 3) and the median richness of more recent records (since 1998). The community was characterised by eleven taxa including two 'highly sensitive' taxa [mayfly (*Deleatidium*) and caddisfly (*Beraeoptera*)]; six 'moderately sensitive' taxa [*Coloburiscus* mayfly, elmid beetles, dobsonfly (*Archichauliodes*), free-living caddisflies (*Costachorema*), stony-cased caddisfly (*Pycnocentrodes*), and cranefly (*Aphrophila*)]; and three 'tolerant' taxa [net-spinning caddisfly (*Aoteapsyche*) and extremely abundant midges (orthoclads and *Maoridiamesa*)]. This dominance represented an increase in the relative proportions of 'highly sensitive' to 'tolerant' taxa dominating the community, in comparison with the characteristic taxa found by the previous summer (2014) survey.

The moderate proportion of 'tolerant' taxa in the community (26% of taxa richness) was reflected in the MCI score (117) which was similar to the previous summer (2014) survey score and six units higher than the previous spring score at this site (Figure 3). The presence of eight 'highly sensitive' taxa indicated good preceding physicochemical water quality at this control site, above all Fonterra activities in the Kaupokonui River catchment.

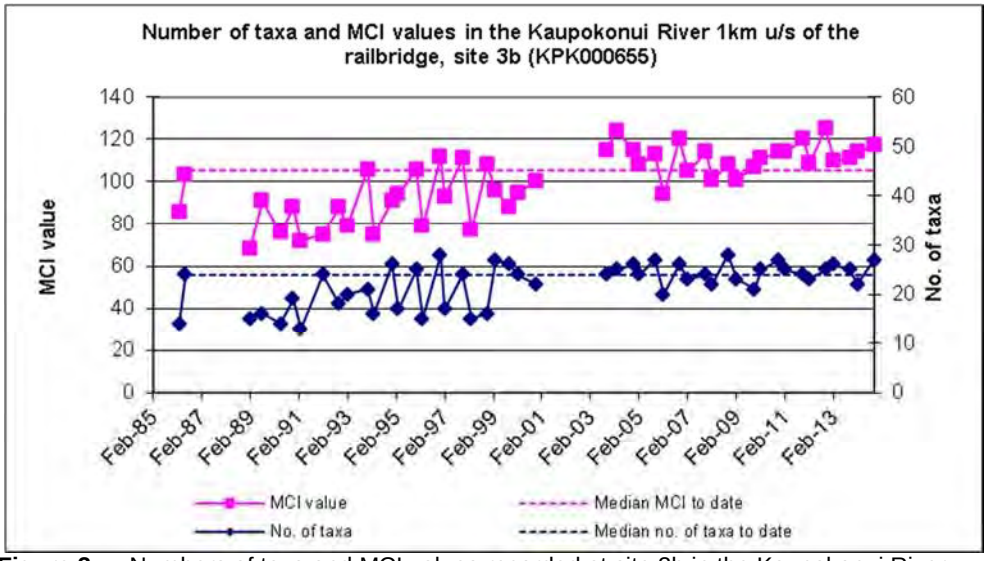

Figure 3 Numbers of taxa and MCI values recorded at site 3b in the Kaupokonui River since 1985

The MCI score of 117 units was well within the range recorded in recent surveys (Figure 3). It was seven units higher than the median score for surveys since 1998 and twelve units higher than the median from all surveys conducted to date (Figure 2, Table 3). The numerical dominance by 'sensitive' taxa, in particular the extremely abundant 'highly sensitive' mayfly *Deleatidium* resulted in the $SQMCI_s$ value of 6.4 units, a significant 2.7 units higher than the $SQMCI_s$ value found at this site by the previous summer (2014) survey.

Site 4 (KPK000660)

A moderate richness of twenty-two macroinvertebrate taxa was recorded in the community at site 4, upstream of the Fonterra Kapuni weir and rail bridge, and downstream of the area of land irrigated by wastes from Fonterra Kapuni. This taxa richness was slightly less than the numbers of taxa recorded in recent monitoring years (Figure 4), and five less than that recorded at site 3b by this current survey (Table 3).

The community was characterised by one 'highly sensitive' taxon [mayfly (*Deleatidium*)]; five 'moderately sensitive' taxa [mayfly (*Coloburiscus*), elmid beetles, dobsonfly (*Archichauliodes*), free-living caddisflies (*Costachorema*), and cranefly (*Aphrophila*)]; and four 'tolerant' taxa [oligochaete worms, net-spinning caddisfly (*Aoteapsyche*), and midges (orthoclads and *Maoridiamesa*)]. Only three taxa showed a significant change in abundances between sites 3b and 4 (Table 3).

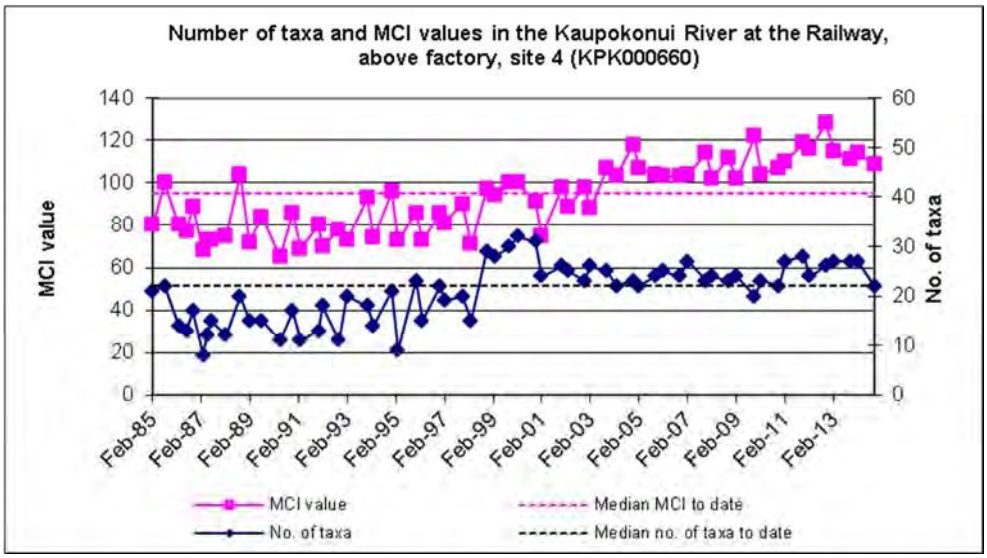

Figure 4 Numbers of taxa and MCI value recorded at site 4 in the Kaupokonui River since February 1985

The MCI score at site 4 was eight units less than the score recorded upstream at site 3b (Stark, 1998), reflecting a slightly less sensitive community composition (Table 3). The MCI score was significantly higher (Stark, 1998) than the historic median recorded to date and five units above the median of values since 1998 (Table 3, Figure 4), continuing a trend of higher than average values over the last twenty-three surveys. This indicated 'good' generic health (TRC, 2013) and that this site had good physicochemical water quality preceding this survey.

The $SQMCI_s$ value for this (5.0 units) was 1.4 units lower than that at site 3b (Table 3), primarily due to decreased abundance of two 'highly sensitive' taxa, in particular *Deleatidium* mayfly. This score indicated that the community was dominated by similar proportions of 'sensitive' and 'tolerant' taxa and this was further confirmation that the community had not been recently adversely affected by land irrigation upstream of this site.

In prior surveys some of the deterioration in biological 'health' between sites 3b and 4 had been attributed to the impacts of dairy shed wastes assimilation in the receiving waters of the inflowing tributary a short distance upstream of site 4. No such deterioration was indicated by the results of this survey.

Site 5 (KPK000679)

A reduced richness of seventeen macroinvertebrate taxa was found at site 5, downstream of the cooling water discharges from Fonterra Kapuni. This was seven taxa less than the median number of taxa recorded at this site since 1998 (Table 3, Figure 2). This richness was also five taxa fewer than recorded at site 4 located upstream of the cooling water discharges.

The community was characterised by one 'highly sensitive' taxon [mayfly (*Deleatidium*)]; one 'moderately sensitive' taxon [mayfly (*Coloburiscus*)]; and two 'tolerant' taxa [midges (*Maoridiamesa* and orthoclads)] (Table 3). This represents a reduction in the number of abundant taxa from that recorded in the previous (summer 2014) survey.

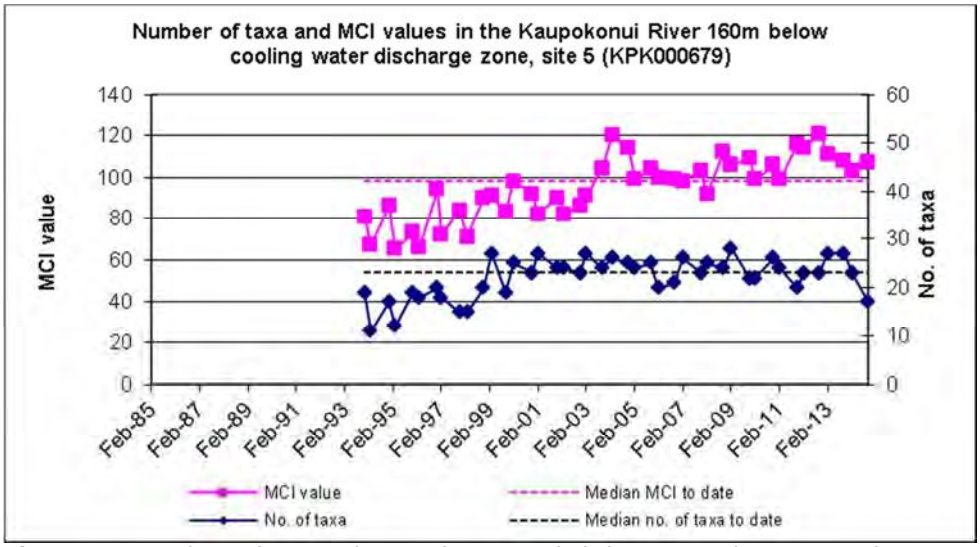

Figure 5 Numbers of taxa and MCI values recorded since December 1993 at site 5 in the Kaupokonui River

The MCI score (107 units) was higher than most of the earlier surveys' scores, especially those prior to 2003 (Figure 5) and nine units above the median of scores from all surveys to date (Figure 2, Table 2). This MCI score was similar to that recorded at site 4 upstream of the cooling water spray discharge, despite the widespread growth of sewage fungus. This indicates that the deterioration in water quality that has resulted in the sewage fungus outbreak was not sufficiently bad enough to cause a deterioration in macroinvertebrate health. This was further reinforced by the absence of taxa indicative of severe organic enrichment (e.g. blood worm midge (*Chironomus*)).

The $SQMCI_S$ value (5.1 units) was similar to that recorded at site 4, but 1.3 units lower than that recorded at site 3b. As with sites 3b and 4, the community at this site was dominated by *Deleatidium* mayfly, which was very abundant. This explained the similarity in $SQMCI_S$ values between these sites, and overall was not indicative of significant impacts from the cooling water discharge.

It should be noted that the historical MCI median at this site was lowered by some poor results in the 1980s and early 1990s caused by wastes entering the river via the cooling water discharges. Most surveys in recent years had found no sign of the 'sewage fungus' growths that were recorded at site 5 in several of the 1980s and early 1990s surveys. However, an extensive 'sewage fungus' outbreak occurred in this reach of the river during the autumn-winter months of 2007. Mats of filamentous bacteria and protozoa ('heterotrophic growths') were found on the substrate by the late summer survey of 2008, coincident with the deterioration in the macroinvertebrate community at this site at that time, and in the spring 2010 survey bacterial growths were again recorded, although there was no significant deterioration in the macroinvertebrate community. At that time, subtle impacts, such as the appearance of the blood worm midge (*Chironomus*), suggested that the degree of impact was potentially approaching a 'tipping point' after which deterioration in the macroinvertebrate community was more likely, provided the poor quality discharge continued. The current

survey again recorded the presence of 'sewage fungus' growth, but not the presence of blood worm midges, indicating that a poor quality cooling water discharge was (or had recently been) occurring, but that it was not resulting in the same degree of deterioration in water quality as the discharges that occurred in the early 1990s.

Site 6 (KPK000685)

An increased richness of twenty taxa was recorded at site 6, at Skeet Road, a further 700 m below the cooling water discharges. This was three taxa fewer than the median number of taxa since 1998 for this site but equal to the historical median. It was however three taxa more than found at the nearest upstream site 5 (Table 2, Figure 2 and Figure 6).

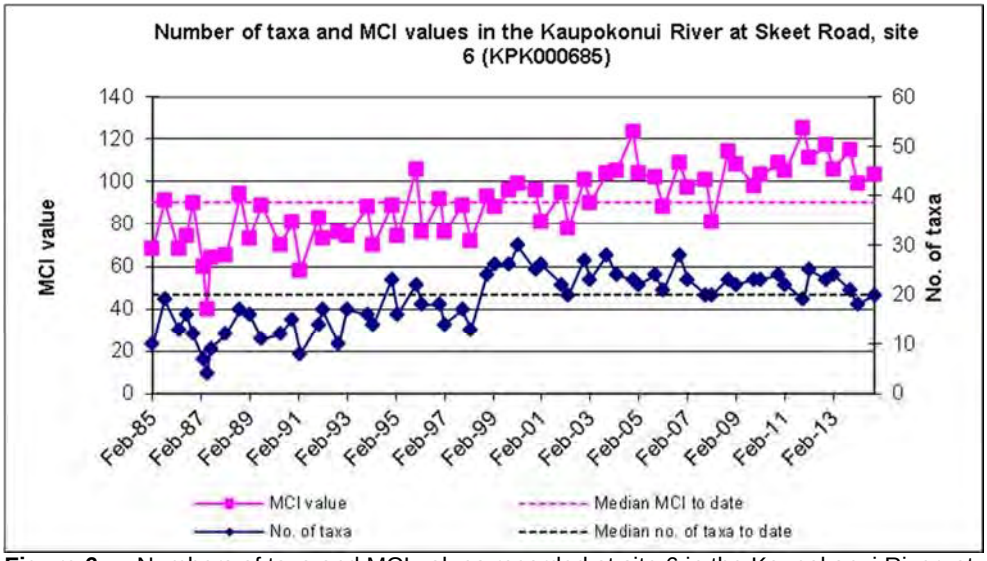

Figure 6 Numbers of taxa and MCI values recorded at site 6 in the Kaupokonui River, at Skeet Road, since February 1985

This community was characterised by more taxa than at site 5, with one 'highly sensitive' taxon (extremely abundant *Deleatidium* mayfly); four 'moderately sensitive' taxa [*Coloburiscus* mayfly, elmid beetles, caddisfly (*Pycnocentrodes*) and cranefly (*Aphrophila*)]; and three 'tolerant' taxa [(net-spinning caddisfly (*Aoteapsyche*) and midges (orthoclads, and *Maoridiamesa*)] (Table 3). This represented an increase in the number of abundant 'sensitive' taxa from that recorded at site 5.

The MCI score of 103 units was thirteen units higher than the historical median for this site but only one unit higher than the median of scores recorded since 1998. Although this result was lower than that recorded by most recent surveys, it was still higher than the majority of previous surveys undertaken to date (Figure 2, Table 2). The MCI score at this site can be variable (Figure 6), and as the current result was much higher than the long-term median score and only six units below the score recorded at site 4 (upstream of the cooling water discharges), there was no indication of marked deterioration in community health at this site at the time of the current survey. This is despite the presence of sewage fungus growths recorded on the substrate.

The $SQMCI_s$ (6.6 units) was 1.5 units higher than that recorded at site 5, suggesting an improvement in the health of the community structure. It was also the highest $SQMCI_s$ score recorded in this survey. Only one taxon changed significantly in abundance at this site (from site 5), but the increased abundance of 'highly sensitive' *Deleatidium* mayfly, which was recorded in extreme abundance, was the primary driver behind the improved $SQMCI_S$ score.

This indicated that the subtle effects recorded by some past surveys were minimal at the time of the current survey and not considered to be significant in terms of impacts on the macroinvertebrate communities recorded at this site. As with site 5 upstream, although sewage fungus was recorded as present at this site, the degree of deterioration in water quality that resulted in this growth was not sufficient to cause deterioration in macroinvertebrate community health.

Site 7 (KPK000880)

A moderate richness of twenty-one taxa was recorded at site 7, at Upper Glenn Road (Table 2), above both the long term median and the median richness of surveys since 1998. One 'highly sensitive' taxon was present in this community, being the very abundant *Deleatidium* mayfly; fewer than that found at the four upstream sites, but typical of the number recorded by most previous surveys. Characteristic taxa included the one aforementioned 'highly sensitive' mayfly; two 'moderately sensitive' taxa [free-living caddisfly (*Hydrobiosis*) and stony-cased caddisfly (*Pycnocentrodes*)]; and three 'tolerant' taxa [oligochaete worms, and midges (orthoclads and *Maoridiamesa*)]. Despite the distance between sites 6 and 7 and a degree of natural deterioration in macroinvertebrate communities normally found in a downstream direction over such a distance, the community compositions were more dissimilar than usual between the two sites with only fourteen (of 27) taxa common to both communities.

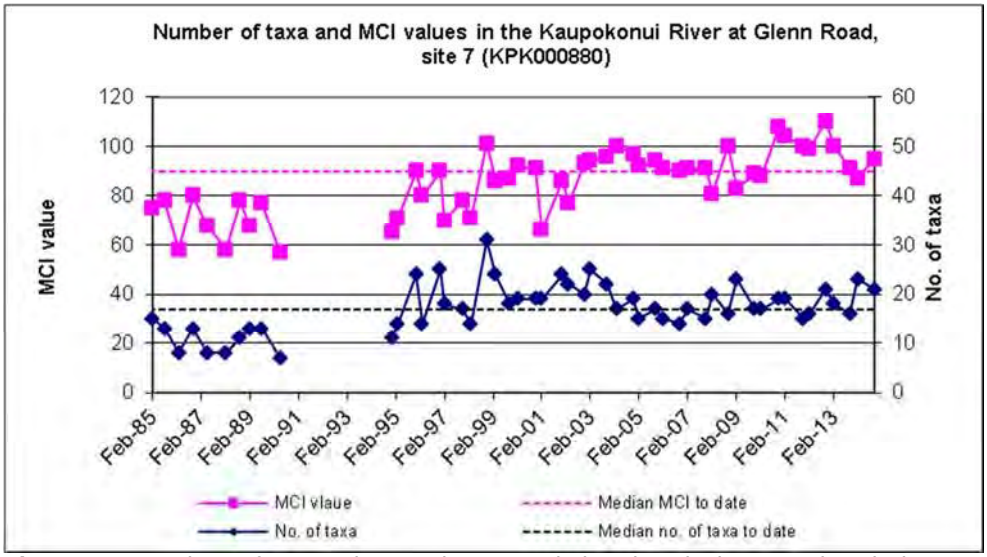

Figure 7 Numbers of taxa and MCI values recorded at site 7 in the Kaupokonui River, since February 1985

The proportion of 'tolerant' taxa (38% of taxa number) reduced from that recorded in the previous summer (2014) survey resulted in an increased MCI score of 95 units. This score was three units higher than the median of scores since 1998, and five units higher than the historic median at this site (Table 2, Figure 7), neither of which was a statistically significant difference (Stark, 1998). This indicated some recovery from that recorded in the previous two surveys, and is a return to the above-median health normally recorded since 2010 (Figure 7). The current MCI score was eight units less than that recorded at site 6, some 9 km upstream. This was a relatively typical trend though this reach, and an improvement on that recorded in the previous two surveys. It also reflects the natural downstream deterioration typical of ringplain streams and rivers, with streams and rivers at this altitude and distance from the National Park boundary typically seeing a reduction in MCI score of approximately 0.6 MCI unit/km (Stark and Fowles, 2009).

The $SQMCI_S$ score (4.9) showed a significant decrease, being 1.7 units lower than the score at the nearest upstream site (Table 3). This change was principally due to an increased abundance of 'very tolerant' oligochaete worms and decreased abundances of two 'sensitive' mayfly taxa (*Coloburiscus* and *Deleatidium*). Generally, there has been a decreasing trend in $SQMCI_S$ scores between sites 6 and 7, (especially in the summer surveys). This was usually due to the distance between the sites and the influence of the Dunns Creek tributary, which joins the river between the two sites. Occasionally, there has been little difference, due to site 6 showing impacts from the cooling water discharge. In the current survey, there was minor evidence of some cooling water discharge influence at site 6, indicating that the deterioration in community health at site 7 may be largely attributed to some typical downstream deterioration and the additional influence of the Dunns Creek tributary.

Summary and Conclusions

The Council's standard 'kick-sampling' technique was used to collect streambed macroinvertebrates from five sites in the Kaupokonui River on 14 October 2014. Samples were sorted and identified to provide the number of taxa (richness), MCI and $SQMCI_s$ scores for each site. The samples were also microscopically scanned to determine the presence or absence of any mats, plumes or dense growths of bacteria, fungi or protozoa ("undesirable biological growths").

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.

In the Kaupokonui River, taxa richnesses were similar to or higher than historical median richnesses (with the exception of site 5), while MCI scores indicated 'good' to 'fair' community health at all sites. MCI scores declined in a downstream direction, but only to the degree expected, likely related to the progressive deterioration typical of Taranaki's ringplain streams and rivers. The MCI scores at all five sites were higher than their historical median scores, and the three sites downstream of the cooling water discharges showed some improvement in community health from that recorded by the previous summer survey, which is a fairly typical result for a spring survey. The survey continued to show that the Kaupokonui River generally has macroinvertebrate communities of 'good' health throughout most of the reach surveyed. The poorest community, found at site 7, was indicative of some influence from the Dunns Creek tributary within the reach between sites 6 and 7.

Of concern was the presence of sewage fungus on the bed of the River at the first site downstream of the cooling water discharge (site 5) and also at Skeet Rd (site 6). This sewage fungus was visible at site 5, where a thin film was observed covering much of the stream bed. At site 6 it was only confirmed through microscopic examination of the sample. The results of the current survey indicated that the deterioration in water quality that had resulted in the sewage fungus outbreak was not sufficiently severe to cause a deterioration in macroinvertebrate health.

It may be concluded that the factory's cooling water discharges had not resulted in significant adverse effects on the macroinvertebrate communities, with the communities appearing healthier than that recorded in the previous summer survey, a relatively typical result. Although the presence of sewage fungus at sites 5 and 6 indicated some deterioration in biological health, it was not to the degree recorded by the 2010 spring survey. At that time subtle impacts, such as the appearance of the blood worm midge (*Chironomus*), suggested that the degree of impact was potentially approaching a 'tipping point' after which deterioration in the macroinvertebrate community was more likely, provided the poor quality discharge continued. The current survey did not record the presence of blood worm midges, indicating that a poor quality cooling water discharge was (or had recently been) occurring, but that it had not resulted in the same degree of deterioration in water quality as that recorded in spring 2010. In addition, there was no deterioration in the macroinvertebrate communities between sites upstream and downstream of spray irrigation of wastes onto land (but upstream of the cooling water discharge) from the Fonterra Kapuni factory recorded by the current survey.

MCI values continued to indicate in general that macroinvertebrate communities were mainly in 'good' health, being above median MCI scores from surveys conducted since 1998. Similarities in community composition, including the characteristic taxa, were generally consistent for all sites, although there were some exceptions at site 5. The deterioration in MCI score recorded between sites 6 and 7 (in the lower reaches), was not a statistically significant result, but was a result commonly recorded in this river, often due to progressive deterioration in communities in a downstream direction, typical of Taranaki ringplain rivers and streams.

The trend of improvement in communities noted in recent years adjacent to the factory has generally continued to be recorded by this survey, following a break in the trend recorded by the February 2008 survey, which also recorded the additional presence of 'undesirable heterotrophic growths' on the streambed. The spring 2010 survey also recorded such growths at two sites, although only subtle impacts on the macroinvertebrate communities were found. Such growths were again recorded by the current survey, but there were only subtle impacts on the macroinvertebrate communities recorded at these sites.

References

Dunning KJ, 2002a: Biomonitoring of the Kaupokonui River, in relation to the Lactose Co NZ Ltd farm and factory, December 2001. TRC report KD90.

Dunning KJ, 2002b: Biomonitoring of the Kaupokonui River, and the Motumate Stream in relation to the Lactose Co NZ Ltd farm and factory, March 2002. TRC report KD128.

Dunning KJ, 2002c: Biomonitoring of the Kaupokonui River in relation to the FONTERRA Kapuni farm and factory, November 2002. TRC report KD138.

Fowles CR, 2003: Biomonitoring of sites in the Waiokura Stream in relation to the irrigation of lactose production wastes from the NZMP Kapuni factory, February 2003.

Fowles CR, & Colgan B, 2004a: Biomonitoring of the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, March 2004. TRC report CF335.

Fowles CR, & Colgan B, 2004b: Biomonitoring of sites in the Waiokura Stream in relation to the land irrigation of lactose production wastes from the Fonterra Kapuni factory, March 2004. TRC report CF328.

Fowles CR, & Jansma B, 2008a: Biomonitoring of sites in the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, November 2007. TRC report CF461.

Fowles CR, & Jansma B, 2008b: Biomonitoring of sites in the Kaupokonui River and the Waiokura Stream in relation to the Fonterra Kapuni farm and factory, February 2009. TRC report CF463.

Fowles CR, & Jansma B, 2014a: Biomonitoring of sites in the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, November 2013. TRC report CF627.

Fowles CR, & Jansma B, 2014b: Biomonitoring of the Kaupokonui River and Waiokura Stream in relation to the Fonterra Kapuni farm and factory, February 2014. TRC report CF628.

Hope KJ, 2005: Biomonitoring of the Kaupokonui River and Waiokura Stream in relation to the Fonterra Kapuni farm and factory, February 2005. TRC report KH037.

Hope KJ, 2006a: Biomonitoring of the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, October 2005. TRC report KH055.

Hope KJ, 2006b: Biomonitoring of the Kaupokonui River and Waiokura Stream in relation to the Fonterra Kapuni farm and factory, February 2006. TRC report KH079.

Jansma B, 2007: Biomonitoring of the Kaupokonui River and Waiokura Stream in relation to the Fonterra Kapuni farm and factory, February 2007. TRC report BJ032.

Jansma B, 2009a: Biomonitoring of sites in the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, October 2008. TRC report BJ057.

Jansma B, 2009b: Biomonitoring of sites in the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, February 2009. TRC report BJ058.

Jansma B, 2010a: Biomonitoring of sites in the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, November 2009. TRC report BJ122.

Jansma B, 2010b: Biomonitoring of the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, February 2010. TRC report BJ123.

Jansma B, 2011a: Biomonitoring of the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, November 2010. TRC report BJ165.

Jansma B, 2011b: Biomonitoring of the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, February 2011. TRC report BJ166.

Jansma B, 2013a: Biomonitoring of the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, November 2011. TRC report BJ181.

Jansma B, 2013b: Biomonitoring of the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, February 2012. TRC report BJ182.

Jansma B, 2014a: Biomonitoring of the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, October 2012. TRC report BJ227.

Jansma B, 2014b: Biomonitoring of the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, February 2013. TRC report BJ228.

Jansma B and Hope KJ, 2007: Biomonitoring of the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, October 2006. TRC report KH090.

Moore SC, 2003: Biomonitoring of the Kaupokonui River, in relation to the NZMP Kapuni farm and factory, February 2003. TRC report SM584.

Moore SC, 2004: Biomonitoring of the Kaupokonui River, in relation to the NZMP Kapuni farm and factory, October 2003. TRC report SM590.

Stark JD, 1985: A macroinvertebrate community index of water quality for stony streams. *Water and Soil* Miscellaneous Publication No. 87.

Stark JD, 1998: SQMCI: a biotic index for freshwater macroinvertebrate coded abundance data. *New Zealand Journal of Marine and Freshwater Research 32(1*): 55-66.

Stark JD, 1999: An evaluation of TRC's SQMCI biomonitoring index. Cawthron Institute, Nelson. Cawthron Report No. 472.

Stark JD, Boothroyd IKG, Harding JS, Maxted JR, Scarsbrook MR, 2001: Protocols for sampling macroinvertebrates in wadeable streams. New Zealand Macroinvertebrate Working Group Report No. 1. Prepared for the Ministry for the Environment. Sustainable Management Fund Project No. 5103. 57p.

Stark, JD and Fowles, CR, 2009: Relationships between MCI, site altitude, and distance from source for Taranaki ring plain streams. Stark Environmental Report No 2009-01 47pp.

TRC, 1999: Some statistics from the Taranaki Regional Council database (FWB) of freshwater macroinvertebrate surveys performed during the period from January 1980 to 31 December 1988, (SEM reference report). TRC Technical Report 99-17.

TRC, 2013: Freshwater Macroinvertebrate Fauna Biological Monitoring Programme Annual State of the Environment Monitoring Report 2012-2013. TRC Technical Report 2013-48.

To Job Manager, James Kitto
From Scientific Officer, B Jansma
Report No BJ266
Doc No 1542459
Date 20 July 2015

Biomonitoring of the Kaupokonui River and Waiokura Stream in relation to the Fonterra Kapuni farm and factory, February 2015

Introduction

This biological survey was the second of two scheduled in relation to the Fonterra Kapuni (formerly Lactose) factory in the 2014-2015 monitoring year. The results from surveys performed since the 2001-2002 monitoring year are discussed in reports listed in the references section of this report.

This survey relates to the following consents held by Fonterra Kapuni Ltd:

0919 to discharge cooling water to the Kaupokonui River;
0922 to spray irrigate wastewater and stormwater to land in the Kaupokonui catchment;
0923 to spray irrigate wastewater and stormwater to land in the Waiokura and Motumate catchments;
0924 to discharge stormwater and cooling water to the Kaupokonui River;
4235 to discharge stormwater to the Kaupokonui River during factory shutdown periods;
4604 to discharge stormwater to the Kaupokonui River from the factory extension;
6423 to discharge stormwater from an inhalation grade lactose plant site into the Kaupokonui River

Methods

The standard '400 ml kick-sampling' technique was used to collect streambed macroinvertebrates from seven sites in the Kaupokonui River and Waiokura Stream in relation to discharges to the river and on to land in the catchment (Table 1, Figure 1) on 19 February 2015. The 'kick-sampling' technique is very similar to Protocol C1 (hard-bottomed, semi-quantitative) of the New Zealand Macroinvertebrate Working Group (NZMWG) protocols for macroinvertebrate samples in wadeable streams (Stark et al, 2001).

Table 1 Biomonitoring sites in the Kaupokonui River and Waiokura Stream

Stream	Site No.	Site Code	Location
Kaupokonui River	3b	KPK000655	1 km u/s of railway bridge
	4	KPK000660	Railway, above factory
	5	KPK000679	160m below cooling water discharge zone
	6	KPK000685	Skeet Road
	7	KPK000880	Glenn Road
Waiokura Stream	U	WKR000500	Skeet Road
	D	WKR000650	At Hicks (Thomas) Road

Samples were preserved with Kahle's Fluid for later sorting and identification under a stereomicroscope according to Taranaki Regional Council methodology using protocol P1 of NZMWG protocols for sampling macroinvertebrates in wadeable streams (Stark et al. 2001).

Macroinvertebrate taxa found in each sample were recorded as:

R (rare)	= less than 5 individuals;
C (common)	= 5-19 individuals;
A (abundant)	= estimated 20-99 individuals;
VA (very abundant)	= estimated 100-499 individuals;
XA (extremely abundant)	= estimated 500 individuals or more.

Stark (1985) developed a scoring system for macroinvertebrate taxa according to their sensitivity to organic pollution in stony New Zealand streams. Highly 'sensitive' taxa were assigned the highest scores of 9 or 10, while the most 'tolerant' forms scored 1. Sensitivity scores for certain taxa have been modified in accordance with Taranaki experience. Averaging the scores assigned to the taxa found at a site, and multiplying the average by a scaling factor of 20, produces a Macroinvertebrate Community Index (MCI) value.

The MCI was designed as a measure of the overall sensitivity of macroinvertebrate communities to the effects of organic pollution. MCI results can also reflect the effects of warm temperatures, slow current speeds and low dissolved oxygen levels, because the taxa capable of tolerating these conditions generally have low sensitivity scores. Usually more 'sensitive' communities (with higher MCI values) inhabit less polluted waterways.

A semi-quantitative MCI value ($SQMCI_s$) has also been calculated for the taxa present at each site by multiplying each taxon score by a loading factor (related to its abundance), totalling these products, and dividing by the sum of the loading factors (Stark, 1998 and 1999). The loading factors were 1 for rare (R), 5 for common (C), 20 for abundant (A), 100 for very abundant (VA) and 500 for extremely abundant (XA). Unlike the MCI, the $SQMCI_s$ is not multiplied by a scaling factor of 20, so that its corresponding range of values is 20x lower.

When necessary, sub-samples of periphyton (algae and other microflora) taken from the macroinvertebrate samples were scanned under 40-400x magnification to determine the presence or absence of any mats, plumes or dense growths of bacteria, fungi or protozoa ("undesirable biological growths") at a microscopic level. The presence of masses of these organisms can be an indicator of organic enrichment within a stream.

Figure 1 Biomonitoring sites in the Kaupokonui River sampled in relation to Fonterra Kapuni factory discharges

Results and discussion

This survey was undertaken following a long period of receding flows in the Kaupokonui River, and followed 60 and 143 days after flow events in excess of three and seven times median flow respectively. The Kaupokonui River had a very low, clear, uncoloured, and swift flow at all sampling sites. River flow at the Glenn Road recorder site was 0.703 m^3/sec, just below the mean annual low flow (0.755 m^3/sec), and well below median flow (2.04 m^3/sec) for the Kaupokonui River.

At the time of this morning survey, water temperatures in the Kaupokonui River ranged from 18.7°C to 17.2°C. Periphyton mats and algal filaments were patchy to widespread at all sites, a direct reflection of the lack of preceding scouring flows. Cobbles, gravel and boulders were the predominant substrate at all sites in the river. The Waiokura Stream sites had a finer substrate with the bed primarily composed of gravels and cobbles, with slightly higher proportions of sand and silt than in the Kaupokonui River and some boulders at site U. Aquatic vegetation grew throughout the stream at site D, with *Myriophyllum* the dominant macrophyte. Algae were noted only as slippery films on the substrate at site U, while site D supported patches of algal mats and filaments. Water temperatures ranged from 14.4˚C to 15.6˚C at the time of this early-morning component of the survey. The Waiokura Stream had also recorded an extended period of stable flows, with this survey performed 144 and 158 days after flow events in excess of three and seven times median flow respectively.

Macroinvertebrate communities

Kaupokonui River

Historically the mid to lower reaches of the Kaupokonui River have shown the effects of nutrient enrichment from the surrounding farmland, and in past years (mainly prior to 2000) there have been a number of surveys showing detectable impacts of discharges from the lactose factory on the riverbed fauna. On many past sampling occasions, the sites immediately upstream and downstream of the Fonterra Kapuni factory supported moderate numbers of taxa, with relatively low proportions of 'sensitive' taxa (such as mayflies and stoneflies), resulting in median MCI values in the low 80s (Table 2). Since 1998 however, macroinvertebrate communities have improved throughout the reach and have shown higher numbers of taxa and MCI scores on most occasions. Median values for both the total data set and the results since 1998 are included in Table 2. Faunal results from the current survey are presented in full in Table 3.

Generally the summer (February to March) surveys have found lower proportions of 'sensitive' taxa resulting in lower MCI values than the spring (October to November) surveys (see Figures 3, 4, 5, 6 and 7).

Table 2 Numbers of taxa and MCI values recorded previously in the Kaupokonui River (since 1985), together with current results

Site	Number of previous surveys	Numbers of taxa				MCI values			
		Median (all data)	Range (all data)	*Median (Nov 1998 to date)*	Current survey	Median (all data)	Range (all data)	*Median (Nov 1998 to date)*	Current survey
3b	48	24	13-28	*25*	22	106	68-125	*111*	107
4	62	22	8-32	*25*	27	95	65-128	*104*	100
5	43	23	11-28	*24*	26	98	65-121	*100*	102
6	62	20	4-30	*23*	27	91	40-125	*102*	104
7	51	17	7-31	*19*	18	89	57-110	*92*	84

In this February 2015 survey, all sampling sites supported between 18 and 27 taxa. These results were all within four taxa of the site medians from data since 1998. MCI scores at all sites were similar to their respective median values for surveys since November 1998, with the exception of site 7, which recorded a score eight units less than this median. The MCI scores at sites 3b, 4, 5 and 6 were slightly higher than their respective median values for the entire record with site 7 being the exception, with a score which was six units below its historical median (Table 2, Figure 2). Four sites had very similar numbers of taxa, with site 7 recording the lowest richness of 18 taxa. MCI scores were relatively stable in a downstream direction, although the highest score was recorded at the 'control site' (site 3b), and the lowest (by twenty units) was recorded at site 7. MCI scores ranged from 84 to 107 units, reflecting relatively 'fair' to 'good' physicochemical water quality, indicating that land irrigation of wastewater had not adversely affected the Kaupokonui River macroinvertebrate communities in the months prior to this survey. There was also no obvious impact of the cooling water discharges in the mid-reaches of the river as indicated by the lack of sewage fungus at the downstream sites. Worse than that frequently recorded by most previous surveys, there was a twenty unit decrease in scores between sites 6 and 7, indicating further impacts on the macroinvertebrate communities at site 7. In most previous surveys, the inflow from Dunns Creek in this reach was likely to have contributed to this recorded deterioration, although the natural decrease in MCI with distance downstream in the lower mid-reaches of the Taranaki ringplain, over a stream distance of about 9 km (of 5 units (Stark and Fowles, 2009)) should also be taken into account. In this case this is considered to still be the case, but amplified by the extremely long period of stable flows that preceded this survey.

The 'fair' to 'good' MCI scores were also reflected by the results of the microscopic scan for undesirable biological growths, which recorded no such growths at any site. This is an improvement from that recorded in the previous survey, which recorded sewage fungus at sites 5 and 6. This indicates that the cooling water discharge had either improved in quality, or was being better assimilated. Considering the low flows noted during this survey, the former is most likely to be the case.

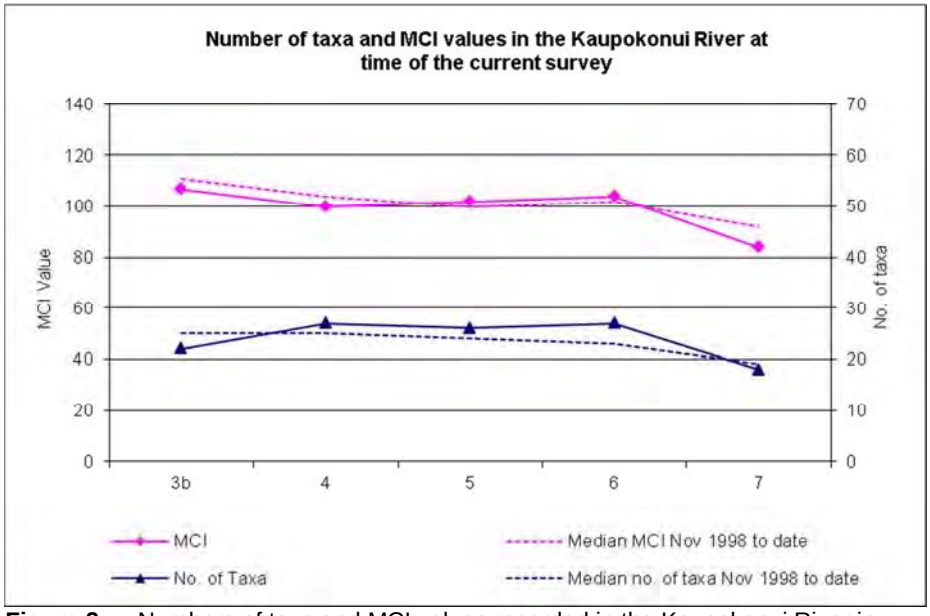

Figure 2 Numbers of taxa and MCI values recorded in the Kaupokonui River in this survey, together with median values from previous surveys (November 1998 to date)

Table 3 Macroinvertebrate fauna of the Kaupokonui River in relation to Fonterra Kapuni samples on 19 February 2015

Taxa List	Site Number	MCI score	3b	4	5	6	7
	Site Code		KPK000655	KPK000660	KPK000679	KPK000685	KPK000880
	Sample Number		FWB15151	FWB15152	FWB15153	FWB15154	FWB15155
PLATYHELMINTHES	*Cura*	3	-	R	-	-	R
NEMERTEA	Nemertea	3	-	-	R	C	C
NEMATODA	Nematoda	3	-	R	-	C	-
ANNELIDA	Oligochaeta	1	C	C	C	R	A
	Lumbricidae	5	-	-	C	R	-
MOLLUSCA	*Ferrissia*	3	-	R	-	-	-
	Potamopyrgus	4	C	A	A	VA	VA
CRUSTACEA	*Paracalliope*	5	-	-	-	R	-
EPHEMEROPTERA	*Austroclima*	7	A	A	C	C	R
	Coloburiscus	7	C	A	A	A	R
	Deleatidium	8	VA	VA	A	VA	C
	Nesameletus	9	R	R	R	-	-
PLECOPTERA	*Stenoperla*	10	-	-	-	R	-
COLEOPTERA	Elmidae	6	VA	VA	A	VA	C
	Hydraenidae	8	-	R	R	R	-
	Staphylinidae	5	-	R	-	-	-
MEGALOPTERA	*Archichauliodes*	7	A	A	C	A	A
TRICHOPTERA	*Hydropsyche (Aoteapsyche)*	4	VA	XA	VA	XA	C
	Costachorema	7	R	A	R	R	-
	Hydrobiosis	5	A	A	A	VA	A
	Neurochorema	6	R	-	R	R	-
	Psilochorema	6	R	-	-	-	-
	Beraeoptera	8	R	R	-	R	-
	Olinga	9	R	R	R	R	-
	Oxyethira	2	R	C	R	A	A
	Pycnocentrodes	5	C	R	C	A	VA
DIPTERA	*Aphrophila*	5	R	R	C	R	-
	Limonia	6	-	-	R	-	-
	Maoridiamesa	3	-	R	C	-	C
	Orthocladiinae	2	XA	VA	A	A	VA
	Tanytarsini	3	C	A	VA	XA	A
	Empididae	3	-	C	-	C	-
	Ephydridae	4	R	-	R	-	-
	Muscidae	3	C	C	C	-	C
	Austrosimulium	3	-	-	R	R	C
	Tanyderidae	4	-	-	-	R	-
ACARINA	Acarina	5	-	R	-	-	-
		No of taxa	22	27	26	27	18
		MCI	107	100	102	104	84
		SQMCIs	3.7	4.6	4.3	4.2	3.7
		EPT (taxa)	12	10	10	11	6
		%EPT (taxa)	55	37	38	41	33

'Tolerant' taxa | 'Moderately sensitive' taxa | 'Highly sensitive' taxa

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Site 3b (KPK000655)

A moderate richness of twenty-two taxa was recorded at site 3b, upstream of the Fonterra Kapuni farm. This was slightly less than the long term median number of taxa recorded at this site to date (Table 3) and the median richness of more recent records (since 1998). The community was characterised by seven taxa including one 'highly sensitive' taxon [mayfly (*Deleatidium*)]; four 'moderately sensitive' taxa [*Austroclima* mayfly, elmid beetles, dobsonfly (*Archichauliodes*) and the free-living caddisflies (*Hydrobiosis*)]; and two 'tolerant' taxa [net-spinning caddisfly (*Hydropsyche-Aoteapsyche*) and extremely abundant orthoclad midges. This dominance represented an decrease in the relative proportions of 'highly sensitive' to 'tolerant' taxa dominating the community, in comparison with the characteristic taxa found by the previous spring (2014) survey.

The moderate proportion of 'tolerant' taxa in the community (36% of taxa richness) was reflected in the MCI score (107) which was lower than most recent surveys, and reflective of the long period of stable flows and relatively prolific periphyton growths observed. This score was ten units less than that recorded in the previous spring survey (Figure 3). The presence of four 'highly sensitive' taxa indicated good preceding physicochemical water quality at this control site, above all Fonterra activities in the Kaupokonui River catchment.

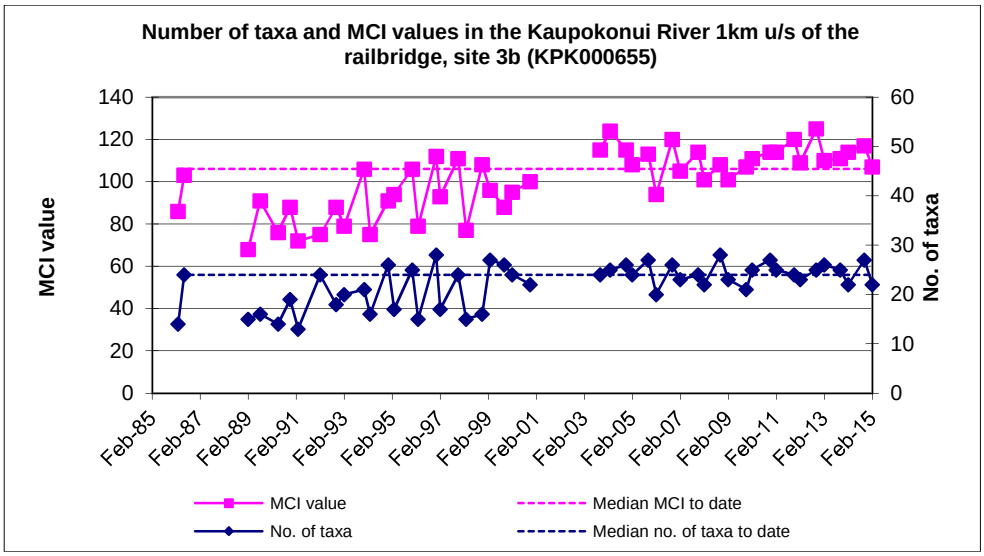

Figure 3 Numbers of taxa and MCI values recorded at site 3b in the Kaupokonui River since 1985

The MCI score of 107 units was well within the range recorded in recent surveys (Figure 3). It was four units lower than the median score for surveys since 1998 and only one unit higher than the median from all surveys conducted to date (Figure 2, Table 3). Although there were more 'sensitive' taxa recorded in abundance than 'tolerant' taxa, the extremely abundant 'tolerant' orthoclad midges resulted in the $SQMCI_s$ value of 2.7 units, a significant 2.7 units lower than the $SQMCI_s$ value found at this site by the previous spring (2014) survey.

Site 4 (KPK000660)

A moderate richness of twenty-seven macroinvertebrate taxa was recorded in the community at site 4, upstream of the Fonterra Kapuni weir and rail bridge, and downstream of the area of land irrigated by wastes from Fonterra Kapuni. This taxa richness was slightly more than the numbers of taxa recorded in recent monitoring years (Figure 4), and five more than that recorded at site 3b by this current survey (Table 3).

The community was characterised by one 'highly sensitive' taxon [mayfly (*Deleatidium*)]; six 'moderately sensitive' taxa [mayflies (*Austroclima* and *Coloburiscus*), elmid beetles, dobsonfly (*Archichauliodes*) and free-living caddisflies (*Costachorema* and *Hydrobiosis*); and four 'tolerant' taxa [*Potamopyrgus* snails, net-spinning caddisfly (*Hydropsyche-Aoteapsyche*), and midges (orthoclads and tanytarsids)]. Only one taxon showed a significant change in abundance between sites 3b and 4 (Table 3).

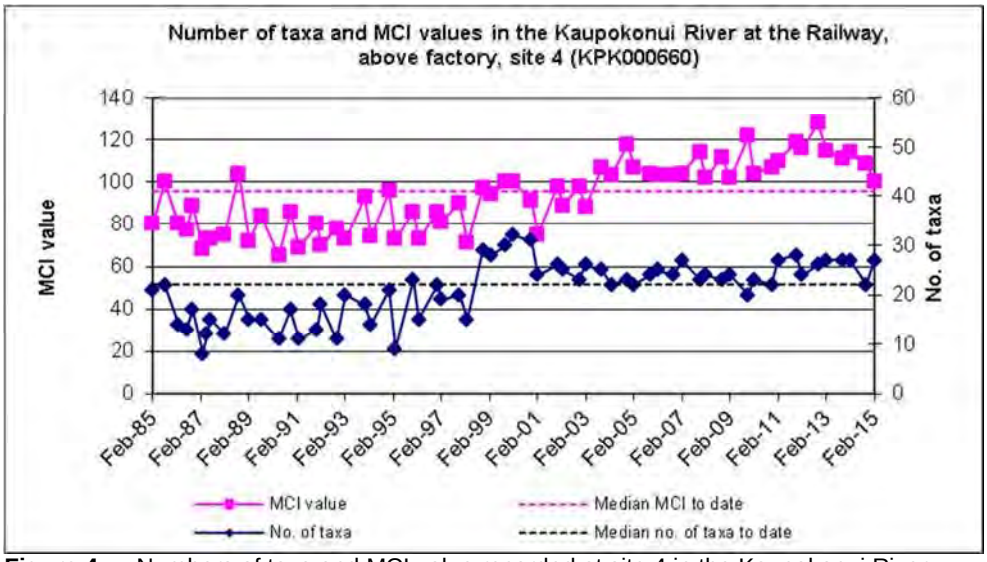

Figure 4 Numbers of taxa and MCI value recorded at site 4 in the Kaupokonui River since February 1985

The MCI score at site 4 was seven units less than the score recorded upstream at site 3b, reflecting a slightly less sensitive community composition (Table 3). The MCI score was four units below the median of values since 1998 but slightly higher than the historic median recorded to date (Table 3, Figure 4), continuing a trend of higher than average values over the last twenty-four surveys. This indicated 'good' generic health (TRC, 2015) and that this site had good physicochemical water quality preceding this survey.

The $SQMCI_s$ value for this (4.6 units) was 0.9 unit higher than that at site 3b (Table 3), primarily due to decreased abundance of 'tolerant' orthoclad midge larvae, coupled with an increased abundance of the less 'tolerant' net-spinning caddisfly *Hydropsyche-Aoteapsyche*. This score indicated that the community was dominated by similar proportions of 'sensitive' and 'tolerant' taxa and this was further confirmation that the community had not been recently adversely affected by land irrigation upstream of this site.

In prior surveys some of the deterioration in biological 'health' between sites 3b and 4 had been attributed to the impacts of dairy shed wastes assimilation in the receiving waters of the inflowing tributary a short distance upstream of site 4. No such deterioration was indicated by the results of this survey.

Site 5 (KPK000679)

A moderate richness of twenty-six macroinvertebrate taxa was found at site 5, downstream of the cooling water discharges from Fonterra Kapuni. This was three taxa more than the median number of taxa recorded at this site since 1998, and nine more than that recorded in the previous survey (Table 3, Figure 2)). This richness was only one taxon fewer than recorded at site 4 located upstream of the cooling water discharges.

The community was characterised by one 'highly sensitive' taxon [mayfly (*Deleatidium*)]; three 'moderately sensitive' taxa [mayfly (*Coloburiscus*), elmid beetles and free swimming caddisfly (*Hydrobiosis*)]; and four 'tolerant' taxa [snail (*Potamopyrgus*), net spinning caddisfly (*Hydropsyche-Aoteapsyche*) and midges (orthoclads and tanytarsids)] (Table 3). This represents an increase in the number of abundant taxa from that recorded in the previous (spring 2014) survey.

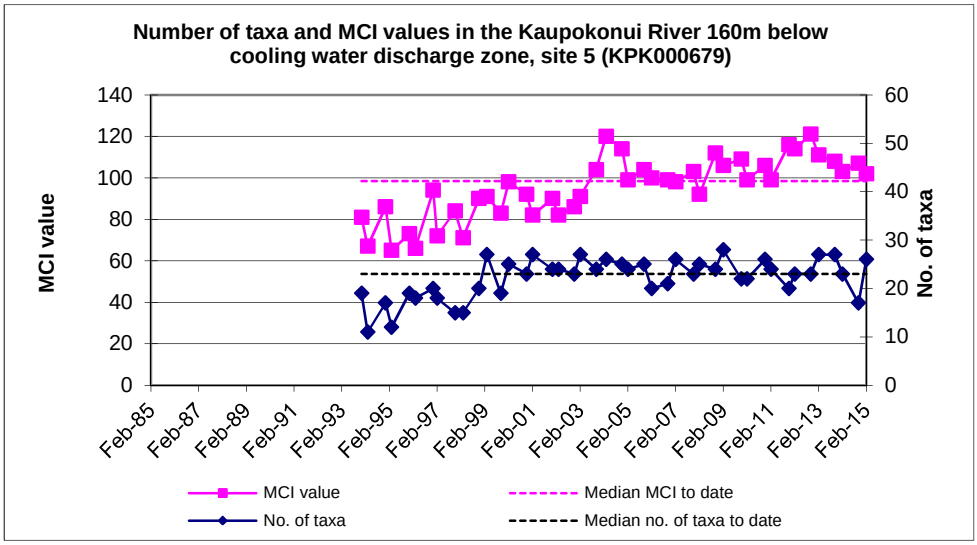

Figure 5 Numbers of taxa and MCI values recorded since December 1993 at site 5 in the Kaupokonui River

The MCI score (102 units) was higher than most of the earlier surveys' scores, especially those prior to 2003 (Figure 5) and four units above the median of scores from all surveys to date (Figure 2, Table 2). This MCI score was similar to that recorded at site 4 upstream of the cooling water spray discharge, despite the differences in community composition, with only twenty taxa common to both sites, of the thirty-three taxa recorded across both sites. There was no evidence of the sewage fungus recorded at this site in the previous survey.

The $SQMCI_S$ value (4.3 units) was similar to that recorded at site 4, and 0.6 unit higher that recorded at site 3b. The communities at sites 3b, 4 and 5 were dominated by similar taxa, including *Deleatidium* mayfly, *Hydropsyche-Aoteapsyche* caddisflies and orthoclad midge larvae. This explained the similarity in $SQMCI_S$ values between these sites, and overall was not indicative of significant impacts from the cooling water discharge.

It should be noted that the historical MCI median at this site was lowered by some poor results in the 1980s and early 1990s caused by wastes entering the river via the cooling water discharges. Most surveys in recent years had found no sign of the 'sewage fungus' growths that were recorded at site 5 in several of the 1980s and early 1990s surveys. However, an extensive 'sewage fungus' outbreak occurred in this reach of the river during the autumn-winter months of 2007. Mats of filamentous bacteria and protozoa ('heterotrophic growths') were found on the substrate by the late summer survey of 2008, coincident with the deterioration in the macroinvertebrate community at this site at that time, and in the spring 2010 survey bacterial growths were again recorded, although there was no significant deterioration in the macroinvertebrate community. At that time subtle impacts, such as the appearance of the blood worm midge (*Chironomus*), suggested that the degree of impact was potentially approaching a 'tipping point' after which deterioration in the macroinvertebrate community was more likely, provided the poor quality discharge continued. The spring

2014 survey again recorded the presence of sewage fungus, but in that case, there was no obvious impact on the macroinvertebrate communities, with blood worm midges being absent and no decline in MCI or $SQMCI_S$ scores. This indicated that a poor quality cooling water discharge had been occurring, but that it was not resulting in the same degree of deterioration in water quality as the discharges that occurred in the early 1990s. The current survey did not record any sewage fungus; neither did it indicate any change in macroinvertebrate communities caused by the cooling water discharge.

Site 6 (KPK000685)

A similar richness of twenty-seven taxa was recorded at site 6, at Skeet Road, a further 700 m below the cooling water discharges. This was four taxa more than the median number of taxa since 1998 for this site, seven more than the historical median, and similar to that recorded at sites 4 and 5 upstream (Table 2, Figure 2 and Figure 6).

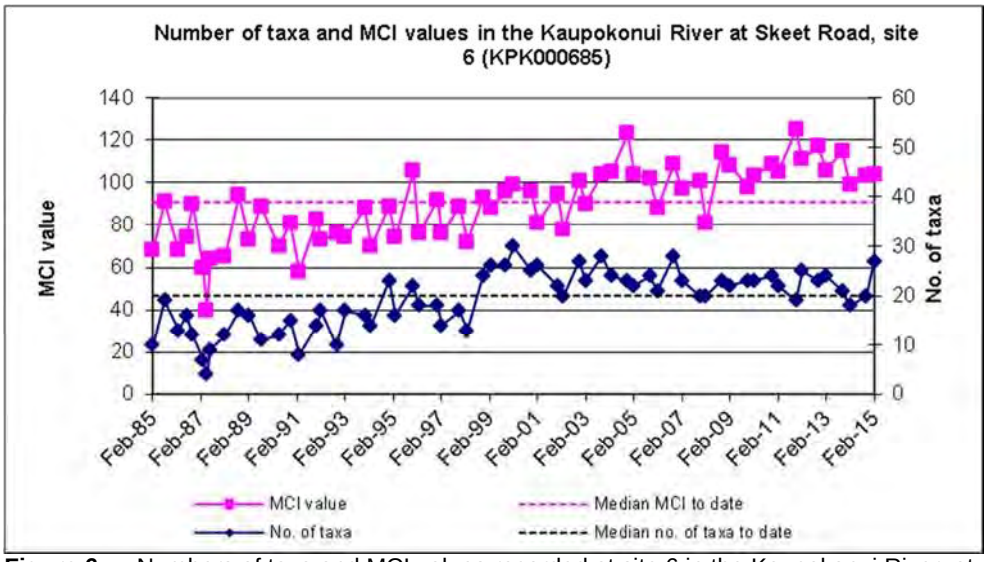

Figure 6 Numbers of taxa and MCI values recorded at site 6 in the Kaupokonui River, at Skeet Road, since February 1985

This community was characterised by more taxa then at site 5 with one 'highly sensitive' taxon (very abundant *Deleatidium* mayfly); five 'moderately sensitive' taxa [*Coloburiscus* mayfly, elmid beetles, dobsonfly (*Archichauliodes*), free swimming caddisfly (*Hydrobiosis*) and stony cased caddisfly (*Pycnocentrodes*)]; and five 'tolerant' taxa [snail (*Potamopyrgus*), (net-spinning caddisfly (*Hydropsyche-Aoteapsyche*), algal piercing caddisfly (*Oxyethira*) and midges (orthoclads and tanytarsids)] (Table 3). This represented an increase in the number of abundant taxa from that recorded at site 5, although this increase was spread between 'tolerant' and 'sensitive' taxa.

The MCI score of 104 units was thirteen units higher than the historical median for this site but only two units higher than the median of scores recorded since 1998. Although this result was lower than that recorded by most recent surveys, it was still higher than the majority of previous surveys undertaken to date (Figure 2, Table 2). The MCI score at this site can be variable (Figure 6) and, as the current result was much higher than the long-term median score and four units above the score recorded at site 4 (upstream of the cooling water discharges), there was no indication of marked deterioration in community health at this site at the time of the current survey.

The $SQMCI_s$ score (4.2 units) was only 0.1 unit less than that recorded at site 5, a very insignificant difference, suggesting little change in the health of the community structure.

Five taxa changed significantly in abundance at this site (from site 5), all related to increases or decreases in 'tolerant' taxa. This indicated that the subtle effects recorded by some past surveys were minimal at the time of the current survey and not considered to be significant in terms of impacts on the macroinvertebrate communities recorded at this site.

Site 7 (KPK000880)

A moderate richness of eighteen taxa was recorded at site 7, at Upper Glenn Road (Table 2), similar to both the long term median and the median richness of surveys since 1998. One 'highly sensitive' taxon was present in this community, being the common *Deleatidium* mayfly; fewer than that found at the four upstream sites, but typical of the number recorded by most previous surveys. Characteristic taxa included the no 'highly sensitive' taxa; three 'moderately sensitive' taxa [dobsonfly (*Archichauliodes*), free-living caddisfly (*Hydrobiosis*) and stony-cased caddisfly (*Pycnocentrodes*)]; and five 'tolerant' taxa [oligochaete worms, snail (*Potamopyrgus*), algal piercing caddisfly (*Oxyethira*) and midges (orthoclads and tanytarsids)]. Despite the distance between sites 6 and 7 and a degree of natural deterioration in macroinvertebrate communities normally found in a downstream direction, over such a distance, the community compositions were more dissimilar than usual between the two sites with only fifteen (of 30) taxa common to both communities. The main change in composition between the two sites was the loss of nine 'sensitive' taxa that were recorded at site 6, but not at site 7.

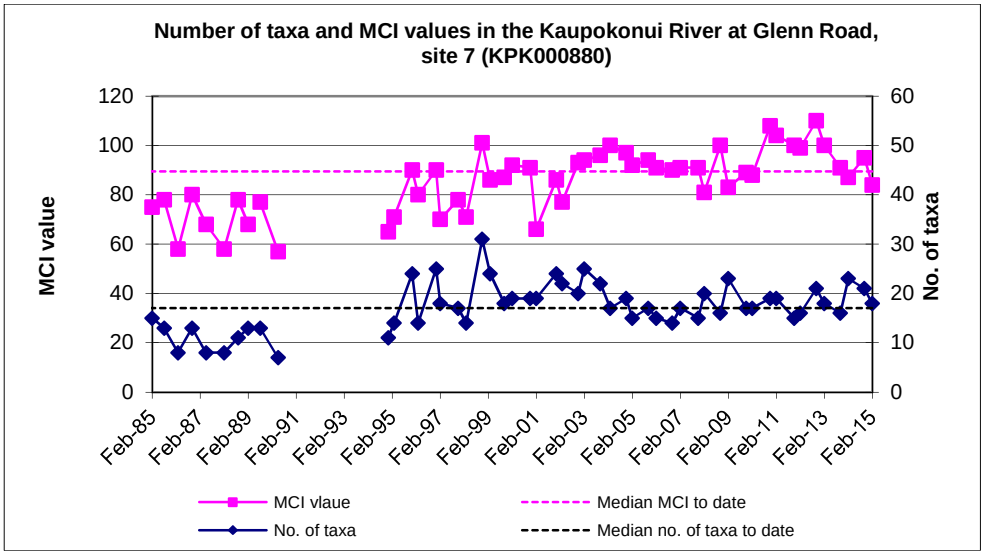

Figure 7 Numbers of taxa and MCI values recorded at site 7 in the Kaupokonui River, since February 1985

As a result of these changes in community composition, the proportion of 'tolerant' taxa (61% of taxa number) increased markedly from that recorded in the previous spring (2014) survey, resulting in a reduced MCI score of 84 units. This score was eight units lower than the median of scores since 1998, and five units lower than the historic median at this site (Table 2, Figure 7), neither of which was a statistically significant difference (Stark, 1998). However, this indicates some deterioration in community health, being the lowest score recorded over the last twelve surveys (Figure 7). This is likely to be a direct reflection of the long period of low flows that preceded this survey, accompanied with warm water temperatures. Just downstream of this site, water temperatures as warm as 26.9˚C were recorded in the month prior to this survey. The current MCI score was twenty units less than that recorded at site 6, some 9 km upstream, a statistically significant result (Stark, 1998). This was a larger reduction that the trend typically recorded though this reach, and a

deterioration on that recorded in the previous survey. It in part reflects the natural downstream deterioration typical of ringplain streams and rivers, with streams and rivers at this altitude and distance from the National Park boundary typically seeing a reduction in MCI score of approximately 0.6 MCI unit/km (Stark and Fowles, 2009), but this downstream deterioration appears to have been exacerbated by the low flows.

The $SQMCI_S$ score (3.7) showed a lesser decrease, being 0.5 unit lower than the score at the nearest upstream site (Table 3). This change was principally due to an increased abundance of 'very tolerant' oligochaete worms and decreased abundances of numerous 'sensitive' taxa including *Deleatidium* mayfly. Generally, there has been a decreasing trend in $SQMCI_S$ scores between sites 6 and 7, (especially in the summer surveys). This was usually due to the distance between the sites and the influence of the Dunns Creek tributary, which joins the river between the two sites. Occasionally, there has been little difference, due to site 6 showing impacts from the cooling water discharge. In the current survey, there was little evidence of some cooling water discharge influence at site 6, indicating that the deterioration in community health at site 7 may be largely attributed to some typical downstream deterioration and the additional influence of the Dunns Creek tributary.

Waiokura Stream

The Waiokura Stream was included in the biological monitoring programme for the first time in the 2002-2003 monitoring year, to monitor effects from irrigation of wastewater and stormwater from the Fonterra Kapuni site onto land in the Waiokura Stream catchment. The location of the irrigation areas in relation to the biological (and water quality) monitoring sites is shown in Figure 8. This was the fourteenth biological survey related to this monitoring programme conducted at the two sites in this stream and results from this survey are summarised in Table 4, with full results provided in Table 5. No 'heterotrophic growths' were seen on the bed of the stream nor were any found microscopically (during sample processing) by this survey at either of the two sites.

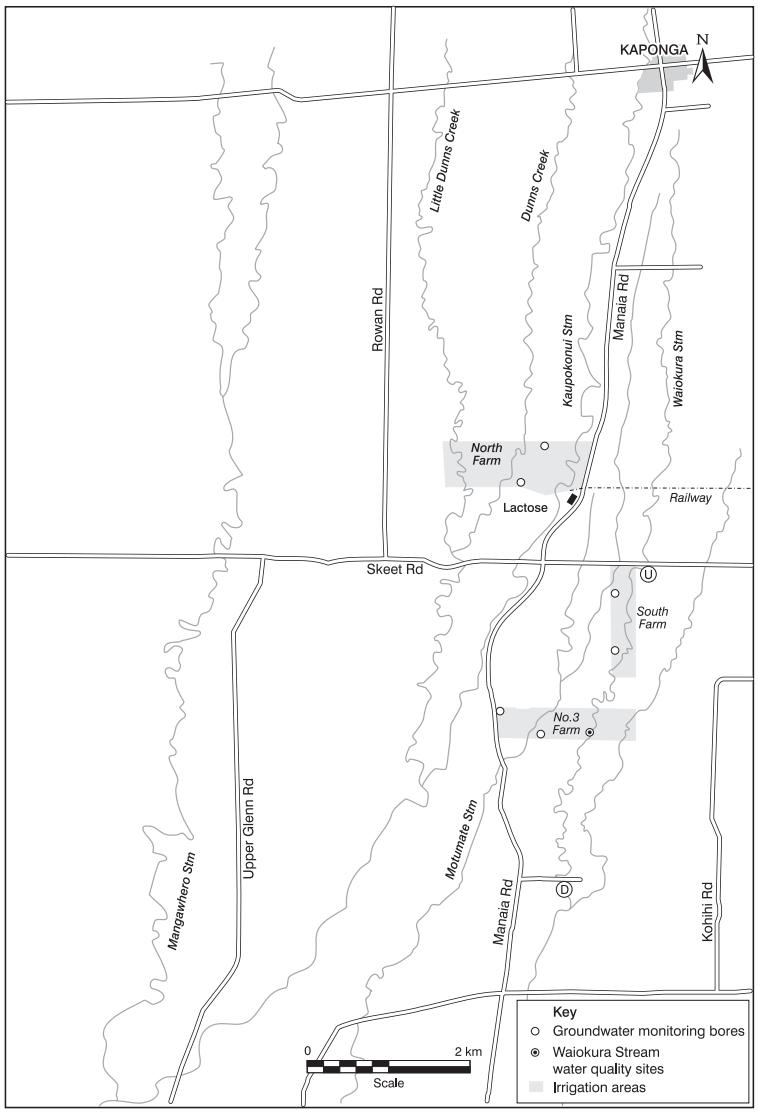

Figure 8 Waiokura Stream biomonitoring site (U and D) locations in relation to Fonterra Kapuni wastes irrigation

Figure 8 Waiokura Stream biomonitoring site (U and D) locations in relation to Fonterra Kapuni wastes irrigation

Table 4 Numbers of taxa and MCI values recorded previously in the Waiokura Stream, together with current results

Site	Number of previous surveys	Numbers of taxa			MCI values		
		Median	Range	Feb 2015	Median	Range	Feb 2015
U	19	23	18-29	19	99	88-114	106
D	13	24	15-27	21	92	81-103	91

Table 5 Macroinvertebrate fauna of the Waiokura Stream in relation to Fonterra, Kapuni land irrigation of wastes, sampled on 19 February 2015

Taxa List	Site Number	MCI score	U	D
	Site Code		WKR000500	WKR000650
	Sample Number		FWB15156	FWB15157
NEMATODA	Nematoda	3	R	-
ANNELIDA (WORMS)	Oligochaeta	1	C	R
	Lumbricidae	5	R	-
MOLLUSCA	*Potamopyrgus*	4	C	XA
CRUSTACEA	Ostracoda	1	-	A
	Paracalliope	5	-	A
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	VA	XA
	Coloburiscus	7	A	R
	Deleatidium	8	C	VA
	Zephlebia group	7	VA	R
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	-	C
COLEOPTERA (BEETLES)	Elmidae	6	A	VA
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	A	A
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	VA	A
	Hydrobiosis	5	C	C
	Neurochorema	6	R	-
	Psilochorema	6	-	C
	Beraeoptera	8	R	-
	Oxyethira	2	-	R
	Pycnocentria	7	C	-
	Pycnocentrodes	5	-	A
DIPTERA (TRUE FLIES)	*Harrisius*	6	R	-
	Maoridiamesa	3	-	R
	Orthocladiinae	2	-	R
	Tanytarsini	3	R	C
	Austrosimulium	3	C	R
	Tanyderidae	4	C	-
ACARINA (MITES)	Acarina	5	-	R
		No of taxa	19	21
		MCI	106	91
		SQMCIs	6.0	5.6
		EPT (taxa)	9	9
		%EPT (taxa)	47	43
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Site U (WKR000500)

A moderate richness of nineteen taxa was recorded at site U, upstream of the Fonterra wastes irrigation areas. This number of taxa was four taxa fewer than the median richness of the previous surveys undertaken at this site (Table 4). The community was characterised by no 'highly sensitive' taxa; five 'moderately sensitive' taxa (mayflies (very abundant *Austroclima*, *Coloburiscus*; and *Zephlebia* group), elmid beetles and dobsonfly (*Archichauliodes*)]; and one 'tolerant' taxon [net-spinning caddisfly (*Hydropsyche-Aoteapsyche*)] (Table 5). Most of these taxa have been characteristic of communities at this site to date (TRC, 2015).

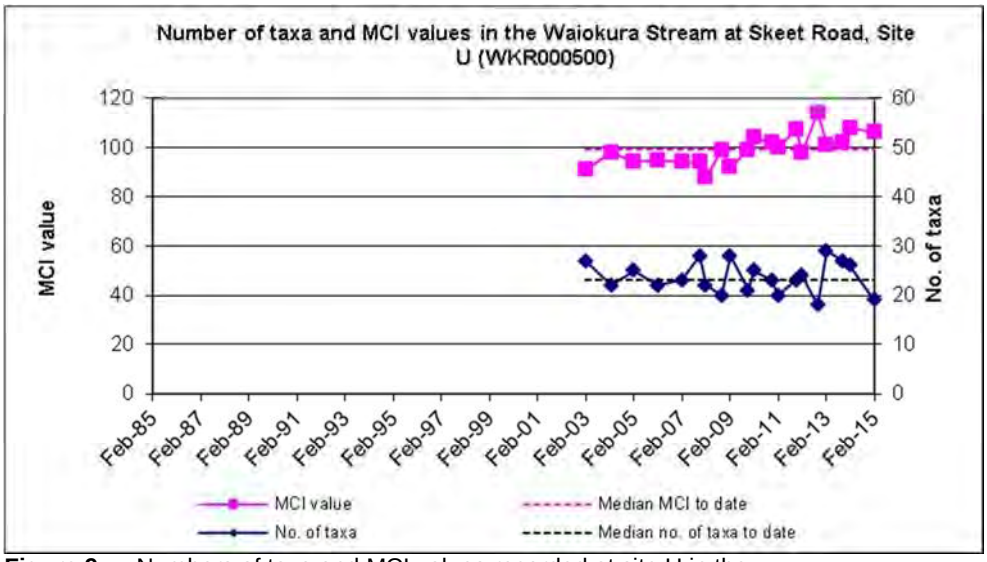

Figure 9 Numbers of taxa and MCI values recorded at site U in the Waiokura Stream since February 1985

The MCI value of 106 units was two units lower than that recorded by the previous summer (2014) survey, but seven units above the median of previous values recorded from the nineteen previous surveys at this site (Table 5, Figure 9). This score reflected the moderate proportion of 'tolerant' taxa (37% of taxa richness) in the community (Table 5). The Waiokura Stream rises below the National Park boundary and the site at Skeet Road (site U) is in the mid-reaches at an altitude of 150 m asl. A relationship for ringplain streams developed between MCI and site altitude (Stark and Fowles, 2009), predicts a MCI value of 100 units for this site. The historical site median (99 units) is one unit below this altitude prediction while the current summer score (106 units) was 6 units (above) the predictive value. The $SQMCI_s$ score of 6.0 units was near the maximum of the range of previously recorded values at this site, and reflected the dominance of several 'sensitive' taxa and two mayflies in particular (Table 5).

Site D (WKR000650)

A moderate richness of twenty-one taxa was recorded at this site downstream of the wastes irrigation areas in the Waiokura Stream catchment. This was relatively similar to that recorded at site U and the median taxa number previously recorded at this downstream site (Table 2). Four of the taxa that dominated the community at site U were also dominant at this site, with the addition of one 'highly sensitive' mayfly (*Deleatidium*), two 'moderately sensitive' taxa [*Paracalliope* amphipods and stony-cased caddisfly (*Pycnocentrodes*)] and two one 'tolerant' taxa (snail (*Potamopyrgus*) and ostracod seed shrimps) (Table 5). This was coincident with a significant change in habitat with macrophytes, which were absent at site U, being present throughout the stream and loss of bouldery substrate at this site.

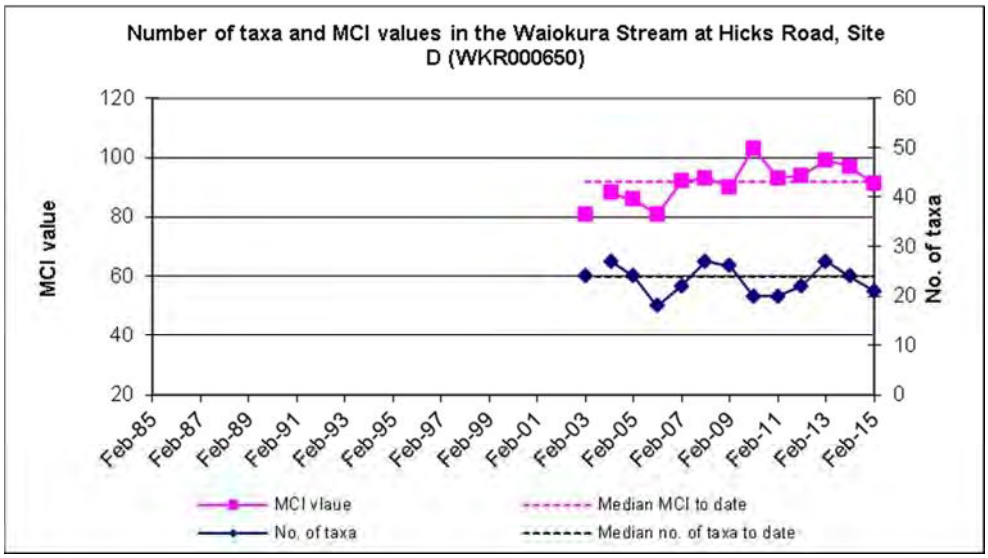

Figure 10 Numbers of taxa and MCI values recorded at site D in the Waiokura Stream since February 1985

A moderate proportion of 'tolerant' taxa (43% of taxa richness) was present at this site, which was reflected in the MCI value of 91 units. This score was six units lower than that recorded by the previous summer (2014) survey, but similar to the median of the twelve previous surveys performed at this site (Table 5, Figure 8). The MCI score was fifteen units less than that recorded upstream at site, which is a statistically significant difference (Stark, 1998). Although this indicates that the communities were different to each other, with the community at site D being more 'tolerant' to organic enrichment, in this case it is not considered to be due to the irrigation of wastes from the Fonterra factory. The primary drivers behind this drop in MCI score are considered to be the distance between sites U and D and the marked habitat differences between sites, especially the predominance of macrophytes at site D.

Despite eleven significant changes in individual taxon abundances between the sites, the $SQMCI_s$ score remained within 0.4 unit of the score at site U, upstream of the irrigation areas (Table 5). As the main change in MCI scores was attributable to differences in habitat between the two sites, the relative similarity in community structure indicated that wastes discharged from the Fonterra Kapuni site on to land in the Waiokura Stream catchment had not had a recent detrimental effect on the biological health of this stream.

Summary and Conclusions

The Council's standard 'kick-sampling' technique was used to collect streambed macroinvertebrates from five sites in the Kaupokonui River and two sites in the Waiokura Stream on 19 February 2015. Samples were sorted and identified to provide the number of taxa (richness), MCI and $SQMCI_s$ scores for each site. The samples were also microscopically scanned to determine the presence or absence of any mats, plumes or dense growths of bacteria, fungi or protozoa ("undesirable biological growths").

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.

In the Kaupokonui River, taxa richnesses were similar to or higher than historical median richnesses, while MCI scores indicated 'good' to 'fair' community health at all sites. MCI scores declined in a downstream direction, but largely to the degree expected, likely related to the progressive deterioration typical of Taranaki's ringplain streams and rivers. In the case of the current survey however, this progressive deterioration had been exacerbated by the extremely long period of stable flows that preceded this survey. The MCI scores at the upper four of the five sites were higher than their historical median scores, while site 7 had the lowest MCI score, six units less than its historical median. However, the other two sites downstream of the cooling water discharges (sites 5 & 6) showed little deterioration in community health from that recorded by the previous summer survey, which is a better than typical result for a summer survey. The survey continued to show that the Kaupokonui River generally has macroinvertebrate communities of 'good' health throughout most of the reach surveyed. The poorest community, found at site 7, was indicative of some influence from the Dunns Creek tributary within the reach between sites 6 and 7. A positive result was that there was no evidence of the sewage fungus recorded during the previous (spring 2014) survey.

It may be concluded that the factory's cooling water discharges had not resulted in significant adverse effects on the macroinvertebrate communities, although the communities appeared in slightly worse condition than that recorded in the previous spring survey, a relatively typical result. The current survey did not record the presence of sewage fungus or blood worm midges, indicating that the poor quality cooling water discharge that had been occurring prior to the spring 2014 survey had ceased.

MCI values continued to indicate in general that macroinvertebrate communities were mainly in 'good' health, being above median MCI scores from surveys conducted since 1998, despite the extended period of low flow that preceded this survey, and the related algal proliferation. Similarities in community composition, including the characteristic taxa, were generally consistent for all sites, although there were some additions at sites 6 and 7, further downstream. The deterioration in MCI score recorded between sites 6 and 7 (in the lower reaches), was a statistically significant result, and was greater than is commonly recorded in this river. As with the previous surveys, it is considered that this is due to progressive deterioration in communities in a downstream direction, typical of Taranaki ringplain rivers and streams, but in this case was exacerbated by the preceding low flows.

The trend of improvement in communities noted in recent years adjacent to the factory has generally continued to be recorded by this survey, following a break in the trend recorded by the February 2008 survey, which recorded the additional presence of 'undesirable heterotrophic growths' on the streambed. The spring 2010 survey also recorded such growths at two sites, although only subtle impacts on the macroinvertebrate communities were found. Such growths were again recorded in the spring 2014 survey, but not in the current survey.

The Waiokura Stream communities indicated that conditions during this survey were fairly typical when compared with the relatively limited number of previous surveys at these two sites to date. The MCI value recorded at the downstream site was significantly less than that recorded upstream, although this can be attributed largely to the distance between the sites

and the marked habitat differences between sites, especially the predominance of macrophytes at site D, rather than to any effects from the application of wastes to land from the Fonterra factory. This conclusion is supported by the $SQMCI_S$ scores, which were similar. There were some subtle changes in macroinvertebrate community compositions between the sites which were associated with differences in habitat, principally an increase in macrophytes and absence of boulders at the downstream site. These community differences were insignificant and not indicative of recent impacts of wastewater irrigation within the Waiokura Stream catchment.

References

Dunning KJ, 2002a: Biomonitoring of the Kaupokonui River, in relation to the Lactose Co NZ Ltd farm and factory, December 2001. TRC report KD90.

Dunning KJ, 2002b: Biomonitoring of the Kaupokonui River, and the Motumate Stream in relation to the Lactose Co NZ Ltd farm and factory, March 2002. TRC report KD128.

Dunning KJ, 2002c: Biomonitoring of the Kaupokonui River in relation to the FONTERRA Kapuni farm and factory, November 2002. TRC report KD138.

Fowles CR, 2003: Biomonitoring of sites in the Waiokura Stream in relation to the irrigation of lactose production wastes from the NZMP Kapuni factory, February 2003.

Fowles CR, & Colgan B, 2004a: Biomonitoring of the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, March 2004. TRC report CF335.

Fowles CR, & Colgan B, 2004b: Biomonitoring of sites in the Waiokura Stream in relation to the land irrigation of lactose production wastes from the Fonterra Kapuni factory, March 2004. TRC report CF328.

Fowles CR, & Jansma B, 2008a: Biomonitoring of sites in the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, November 2007. TRC report CF461.

Fowles CR, & Jansma B, 2008b: Biomonitoring of sites in the Kaupokonui River and the Waiokura Stream in relation to the Fonterra Kapuni farm and factory, February 2009. TRC report CF463.

Fowles CR, & Jansma B, 2014a: Biomonitoring of sites in the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, November 2013. TRC report CF627.

Fowles CR, & Jansma B, 2014b: Biomonitoring of the Kaupokonui River and Waiokura Stream in relation to the Fonterra Kapuni farm and factory, February 2014. TRC report CF628.

Hope KJ, 2005: Biomonitoring of the Kaupokonui River and Waiokura Stream in relation to the Fonterra Kapuni farm and factory, February 2005. TRC report KH037.

Hope KJ, 2006a: Biomonitoring of the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, October 2005. TRC report KH055.

Hope KJ, 2006b: Biomonitoring of the Kaupokonui River and Waiokura Stream in relation to the Fonterra Kapuni farm and factory, February 2006. TRC report KH079.

Jansma B, 2007: Biomonitoring of the Kaupokonui River and Waiokura Stream in relation to the Fonterra Kapuni farm and factory, February 2007. TRC report BJ032.

Jansma B, 2009a: Biomonitoring of sites in the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, October 2008. TRC report BJ057.

Jansma B, 2009b: Biomonitoring of sites in the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, February 2009. TRC report BJ058.

Jansma B, 2010a: Biomonitoring of sites in the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, November 2009. TRC report BJ122.

Jansma B, 2010b: Biomonitoring of the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, February 2010. TRC report BJ123.

Jansma B, 2011a: Biomonitoring of the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, November 2010. TRC report BJ165.

Jansma B, 2011b: Biomonitoring of the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, February 2011. TRC report BJ166.

Jansma B, 2013a: Biomonitoring of the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, November 2011. TRC report BJ181.

Jansma B, 2013b: Biomonitoring of the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, February 2012. TRC report BJ182.

Jansma B, 2014a: Biomonitoring of the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, October 2012. TRC report BJ227.

Jansma B, 2014b: Biomonitoring of the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, February 2013. TRC report BJ228.

Jansma B, 2015: Biomonitoring of the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, October 2014. TRC report BJ255.

Jansma B and Hope KJ, 2007: Biomonitoring of the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, October 2006. TRC report KH090.

Moore SC, 2003: Biomonitoring of the Kaupokonui River, in relation to the NZMP Kapuni farm and factory, February 2003. TRC report SM584.

Moore SC, 2004: Biomonitoring of the Kaupokonui River, in relation to the NZMP Kapuni farm and factory, October 2003. TRC report SM590.

Stark JD, 1985: A macroinvertebrate community index of water quality for stony streams. *Water and Soil* Miscellaneous Publication No. 87.

Stark JD, 1998: SQMCI: a biotic index for freshwater macroinvertebrate coded abundance data. *New Zealand Journal of Marine and Freshwater Research 32(1*): 55-66.

Stark JD, 1999: An evaluation of TRC's SQMCI biomonitoring index. Cawthron Institute, Nelson. Cawthron Report No. 472.

Stark JD, Boothroyd IKG, Harding JS, Maxted JR, Scarsbrook MR, 2001: Protocols for sampling macroinvertebrates in wadeable streams. New Zealand Macroinvertebrate Working Group Report No. 1. Prepared for the Ministry for the Environment. Sustainable Management Fund Project No. 5103. 57p.

Stark, JD and Fowles, CR, 2009: Relationships between MCI, site altitude, and distance from source for Taranaki ring plain streams. Stark Environmental Report No 2009-01 47pp.

TRC, 1999: Some statistics from the Taranaki Regional Council database (FWB) of freshwater macroinvertebrate surveys performed during the period from January 1980 to 31 December 1988, (SEM reference report). TRC Technical Report 99-17.

TRC, 2015: Freshwater Macroinvertebrate Fauna Biological Monitoring Programme Annual State of the Environment Monitoring Report 2013-2014. TRC Technical Report 2014-20.

To Job Manager, James Kitto
From Scientific Officers, B Jansma and B Thomas
Report No BT061
Doc No 1698587
Date 13 June 2016

Biomonitoring of the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, October 2015

Introduction

This biological survey was the first of two scheduled in relation to the Fonterra Kapuni (formerly Lactose) factory in the 2015-2016 monitoring year. The results from surveys performed since the 2001-2002 monitoring year are discussed in reports listed in the references section of this report.

This survey relates to the following consents held by Fonterra Kapuni Ltd:

0919 to discharge cooling water to the Kaupokonui River;
0922 to spray irrigate wastewater and stormwater to land in the Kaupokonui catchment;
0923 to spray irrigate wastewater and stormwater to land in the Waiokura and Motumate catchments;
0924 to discharge stormwater and cooling water to the Kaupokonui River;
4235 to discharge stormwater to the Kaupokonui River during factory shutdown periods;
4604 to discharge stormwater to the Kaupokonui River from the factory extension;
6423 to discharge stormwater from an inhalation grade lactose plant site into the Kaupokonui River

Methods

The standard '400 ml kick-sampling' technique was used to collect streambed macroinvertebrates from five sites in the Kaupokonui River in relation to discharges to the river and on to land in the catchment (Table 1, Figure 1) on 16 October 2015. The 'kick-sampling' technique is very similar to Protocol C1 (hard-bottomed, semi-quantitative) of the New Zealand Macroinvertebrate Working Group (NZMWG) protocols for macroinvertebrate samples in wadeable streams (Stark et al, 2001).

Table 1 Biomonitoring sites in the Kaupokonui River

Stream	Site No.	Site Code	Location
Kaupokonui River	3b	KPK000655	1 km u/s of railway bridge
	4	KPK000660	Railway, above factory
	5	KPK000679	160m below cooling water discharge zone
	6	KPK000685	Skeet Road
	7	KPK000880	Glenn Road

Samples were preserved with Kahle's Fluid for later sorting and identification under a stereomicroscope according to Taranaki Regional Council methodology using protocol P1 of NZMWG protocols for sampling macroinvertebrates in wadeable streams (Stark et al. 2001).

Macroinvertebrate taxa found in each sample were recorded as:

R (rare)	= less than 5 individuals;
C (common)	= 5-19 individuals;
A (abundant)	= estimated 20-99 individuals;
VA (very abundant)	= estimated 100-499 individuals;
XA (extremely abundant)	= estimated 500 individuals or more.

Stark (1985) developed a scoring system for macroinvertebrate taxa according to their sensitivity to organic pollution in stony New Zealand streams. Highly 'sensitive' taxa were assigned the highest scores of 9 or 10, while the most 'tolerant' forms scored 1. Sensitivity scores for certain taxa have been modified in accordance with Taranaki experience. Averaging the scores assigned to the taxa found at a site, and multiplying the average by a scaling factor of 20, produces a Macroinvertebrate Community Index (MCI) value.

The MCI was designed as a measure of the overall sensitivity of macroinvertebrate communities to the effects of organic pollution. MCI results can also reflect the effects of warm temperatures, slow current speeds and low dissolved oxygen levels, because the taxa capable of tolerating these conditions generally have low sensitivity scores. Usually more 'sensitive' communities (with higher MCI values) inhabit less polluted waterways.

A semi-quantitative MCI value ($SQMCI_s$) has also been calculated for the taxa present at each site by multiplying each taxon score by a loading factor (related to its abundance), totalling these products, and dividing by the sum of the loading factors (Stark, 1998 and 1999). The loading factors were 1 for rare (R), 5 for common (C), 20 for abundant (A), 100 for very abundant (VA) and 500 for extremely abundant (XA). Unlike the MCI, the $SQMCI_s$ is not multiplied by a scaling factor of 20, so that its corresponding range of values is 20x lower.

When necessary, sub-samples of periphyton (algae and other microflora) taken from the macroinvertebrate samples were scanned under 40-400x magnification to determine the presence or absence of any mats, plumes or dense growths of bacteria, fungi or protozoa ("undesirable biological growths") at a microscopic level. The presence of masses of these organisms can be an indicator of organic enrichment within a stream.

Figure 1 Biomonitoring sites in the Kaupokonui River sampled in relation to Fonterra Kapuni factory discharges

Results and discussion

This survey was undertaken following a period of receding flows in the Kaupokonui River, and followed 22 and 24 days after flow events in excess of three and seven times median flow respectively. The Kaupokonui River had a moderate, clear, uncoloured, and swift flow at all sampling sites. River flow at the Glenn Road recorder site was 1.7 m^3/sec which was above the mean annual low flow (0.751 m^3/sec), but below median flow (2.04 m^3/sec) for the Kaupokonui River.

At the time of this midday survey, water temperatures in the Kaupokonui River ranged from 11.8°C to 12.9°C. Periphyton mats were patchy all sites, while sites 5, 6 and 7 also supported patchy filamentous periphyton. Cobbles, gravel and boulders were the predominant substrate at all sites in the river. Sites 4 and 5 were partially shaded, while the remaining sites were unshaded.

Macroinvertebrate communities

Kaupokonui River

Historically the mid to lower reaches of the Kaupokonui River have shown the effects of nutrient enrichment from the surrounding farmland, and in past years (mainly prior to 2000) there have been a number of surveys showing detectable impacts of discharges from the lactose factory on the riverbed fauna. On many past sampling occasions, the sites immediately upstream and downstream of the Fonterra Kapuni factory supported moderate numbers of taxa, with relatively low proportions of 'sensitive' taxa (such as mayflies and stoneflies), resulting in median MCI values in the low 80s (Table 2). Since 1998 however, macroinvertebrate communities have improved throughout the reach and have shown higher numbers of taxa and MCI scores on most occasions. Median values for both the total data set and the results since 1998 are included in Table 2. Faunal results from the current survey are presented in full in Table 3.

Table 2 Numbers of taxa and MCI values recorded previously in the Kaupokonui River (since 1985), together with current results

Site	Number of previous surveys	Numbers of taxa				MCI values			
		Median (all data)	Range (all data)	*Median (Nov 1998 to date)*	Current survey	Median (all data)	Range (all data)	*Median (Nov 1998 to date)*	Current survey
3b	49	24	13-28	*24*	23	106	68-125	*110*	108
4	63	22	8-32	*25*	25	96	65-128	*104*	108
5	45	23	11-28	*24*	19	98	65-121	*100*	100
6	63	20	4-30	*23*	28	91	40-125	*103*	104
7	54	17	7-31	*19*	20	90	57-110	*92*	99

Generally the summer (February to March) surveys have found lower proportions of 'sensitive' taxa resulting in lower MCI values than the spring (October to November) surveys (see Figure 3, Figure 4, Figure 5, Figure 6 and Figure 7).

In this October 2015 survey, all sampling sites supported between 19 and 28 taxa. These results were all within 5 taxa of the site medians from data since 1998. MCI scores at all sites were similar to their respective median values for surveys since November 1998. The MCI scores at all sites were also above their respective median values for the entire record (Table 2, Figure 2). MCI scores generally decreased steadily in a downstream direction, with the highest scores recorded at the 'control site'. MCI scores ranged from 99 to 108 units,

reflecting relatively fair to good physicochemical water quality, indicating that land irrigation of wastewater had not adversely affected the Kaupokonui River macroinvertebrate communities in the months prior to this survey. There was also no obvious impact of the cooling water discharges in the mid-reaches of the river as indicated by the lack of sewage fungus at the downstream sites. Similar to results frequently recorded by most previous surveys, there was a 5 unit decrease in scores between sites 6 and 7, indicating further impacts on the macroinvertebrate communities at site 7. In most previous surveys, the inflow from Dunns Creek in this reach was likely to have contributed to this recorded deterioration, although the natural decrease in MCI with distance downstream in the lower mid-reaches of the Taranaki ringplain, over a stream distance of about 9 km (of 5 units (Stark and Fowles, 2009)) should also be taken into account.

The 'fair' to 'good' MCI scores were also reflected by the results of the microscopic scan for undesirable biological growths, which recorded no such growths at any site. This is a continuation of the improvement recorded from the previous spring survey (October 2014), which recorded sewage fungus at sites 5 and 6. This indicates that the cooling water discharge had either improved in quality, or was being better assimilated.

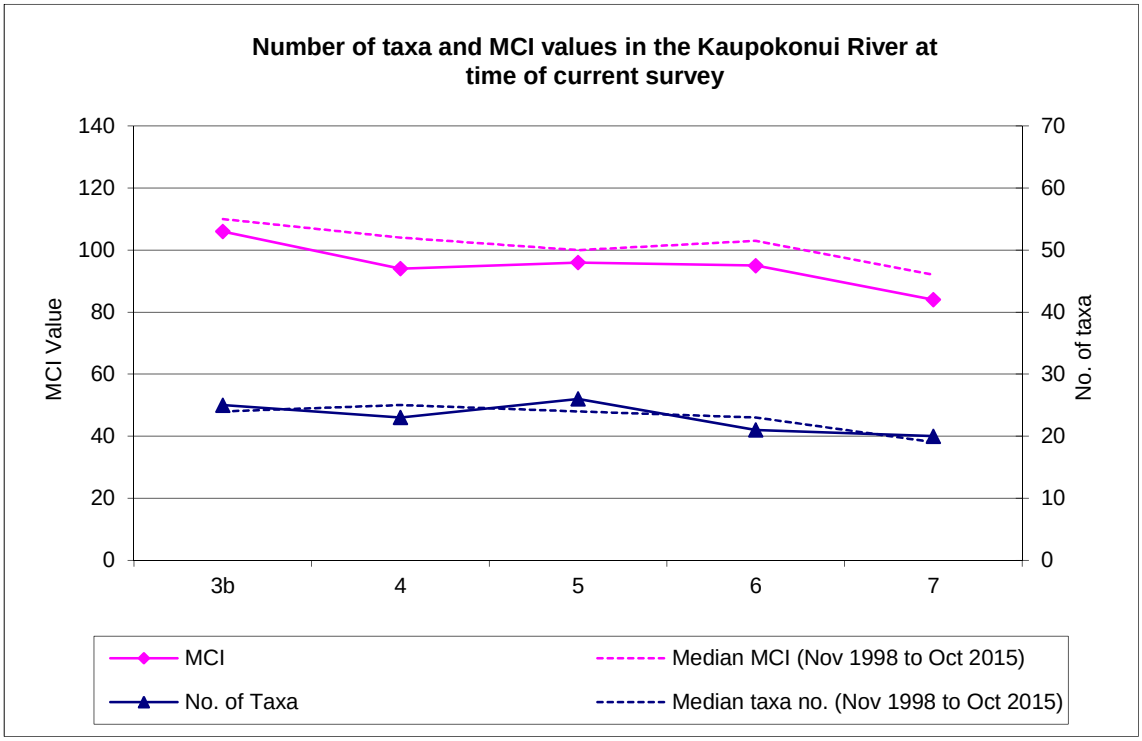

Figure 2 Numbers of taxa and MCI values recorded in the Kaupokonui River in this survey, together with median values from previous surveys (November 1998 to date)

Table 3 Macroinvertebrate fauna of the Kaupokonui River in relation to Fonterra Kapuni samples on 16 October 2015

Taxa List	Site Number	MCI score	3b	4	5	6	7
	Site Code		KPK000655	KPK000660	KPK000679	KPK000685	KPK000880
	Sample Number		FWB15307	FWB15308	FWB15309	FWB15310	FWB15311
PLATYHELMINTHES (FLATWORMS)	*Cura*	3	-	-	-	-	R
NEMATODA	Nematoda	3	-	-	-	R	-
ANNELIDA (WORMS)	Oligochaeta	1	C	C	C	A	A
MOLLUSCA	*Potamopyrgus*	4	R	C	R	C	C
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	-	R	R	R	R
	Coloburiscus	7	VA	VA	VA	VA	R
	Deleatidium	8	XA	XA	VA	XA	VA
	Nesameletus	9	R	R	-	R	-
PLECOPTERA (STONEFLIES)	*Acroperla*	5	R	C	R	R	R
	Megaleptoperla	9	-	-	-	-	R
	Zelandobius	5	R	R	C	C	R
COLEOPTERA (BEETLES)	Elmidae	6	A	A	C	A	R
	Hydraenidae	8	R	C	-	R	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C	A	C	A	C
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	C	A	C	A	R
	Costachorema	7	A	A	A	A	R
	Hydrobiosis	5	R	C	R	A	C
	Neurochorema	6	-	R	-	R	-
	Beraeoptera	8	A	A	R	C	-
	Olinga	9	R	R	-	R	-
	Pycnocentria	7	R	-	-	-	-
	Pycnocentrodes	5	VA	VA	R	VA	XA
DIPTERA (TRUE FLIES)	*Aphrophila*	5	C	C	C	A	R
	Eriopterini	5	-	-	-	R	-
	Maoridiamesa	3	VA	VA	VA	VA	A
	Orthocladiinae	2	A	C	C	A	C
	Tanypodinae	5	-	R	-	R	-
	Tanytarsini	3	R	C	C	A	C
	Empididae	3	R	R	R	R	R
	Muscidae	3	-	-	-	R	-
	Austrosimulium	3	R	R	-	R	-
		No of taxa	23	25	19	28	20
		MCI	108	108	100	104	99
		SQMCIs	6.7	6.7	5.8	6.4	5.2
		EPT (taxa)	12	13	10	13	10
		%EPT (taxa)	52	52	53	46	50

'Tolerant' taxa | 'Moderately sensitive' taxa | 'Highly sensitive' taxa

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Site 3b (KPK000655)

A moderate richness of twenty-three taxa was recorded at site 3b, upstream of the Fonterra Kapuni farm. This was slightly less than the long term median number of taxa recorded at this site to date (Table 2 and Table 3) and the median richness of more recent records (since 1998). The community was characterised by eight taxa including two 'highly sensitive' taxa [mayfly (*Deleatidium*) and caddisfly (*Beraeoptera*)]; four 'moderately sensitive' taxa [*Coloburiscus* mayfly, elmid beetles, free-living caddisflies (*Costachorema*) and stony-cased

caddisfly (*Pycnocentrodes*) and two 'tolerant' taxa [midges (orthoclads and *Maoridiamesa*)]. This dominance was similar to the relative proportions of 'highly sensitive' to 'tolerant' taxa dominating the community, in comparison with the characteristic taxa found by the previous summer (2015) survey.

The moderate proportion of 'sensitive' taxa in the community (65% of taxa richness) was reflected in the MCI score (108) which was similar to the previous summer (2015) survey score and eight units lower than the previous spring score at this site (Figure 3). The presence of five 'highly sensitive' taxa indicated good preceding physicochemical water quality at this control site, above all Fonterra activities in the Kaupokonui River catchment.

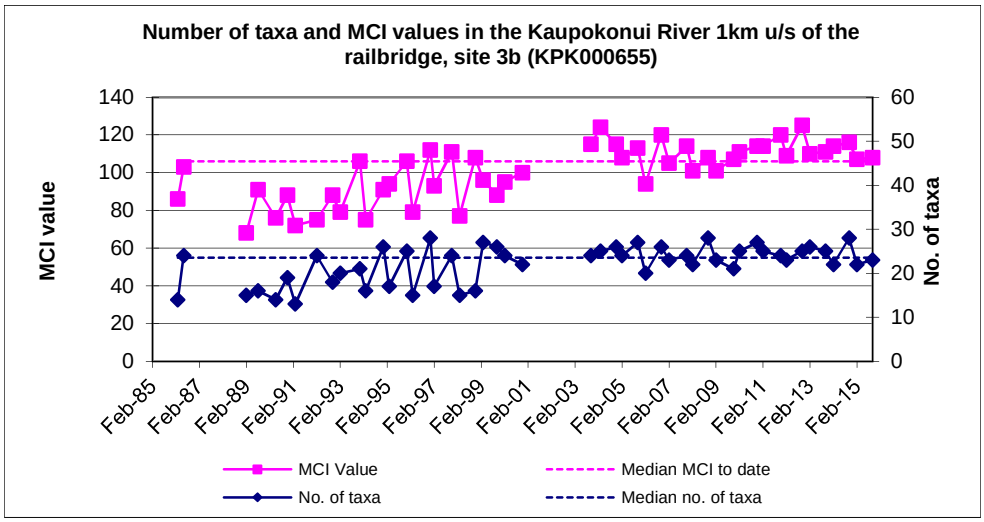

Figure 3 Numbers of taxa and MCI values recorded at site 3b in the Kaupokonui River since 1985

The MCI score of 108 units was well within the range recorded in recent surveys (Figure 3). It was two units less than than the median score for surveys since 1998 and two units higher than the median from all surveys conducted to date (Figure 2, Table 2). The numerical dominance by 'sensitive' taxa, in particular the extremely abundant 'highly sensitive' mayfly *Deleatidium* resulted in the $SQMCI_s$ value of 6.7 units, a significant 3.0 units higher than the $SQMCI_s$ value found at this site by the previous summer (2015) survey.

Site 4 (KPK000660)

A moderate richness of twenty-five macroinvertebrate taxa was recorded in the community at site 4, upstream of the Fonterra Kapuni weir and rail bridge, and downstream of the area of land irrigated by wastes from Fonterra Kapuni. This taxa richness was similar to the numbers of taxa recorded in recent monitoring years (Figure 4), and three more than that recorded at site 3b by this current survey (Table 3).

The community was characterised by two 'highly sensitive' taxa [mayfly (*Deleatidium*) and caddisfly (*Beraeoptera*)]; five 'moderately sensitive' taxa [mayfly (*Coloburiscus*), elmid beetles, dobsonfly (*Archichauliodes*), free-living caddisflies (*Costachorema*), and stony-cased caddisfly (*Pycnocentrodes*)]; and two 'tolerant' taxa [net-spinning caddisfly (*Aoteapsyche*), and midge (*Maoridiamesa*)]. There were no significant changes in taxa abundances between sites 3b and 4 (Table 3).

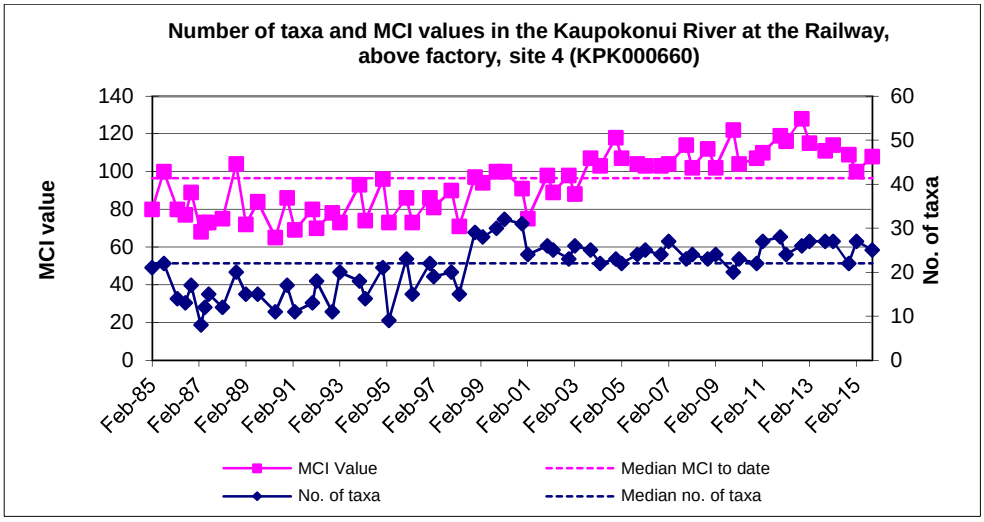

Figure 4 Numbers of taxa and MCI value recorded at site 4 in the Kaupokonui River since February 1985

The MCI score of 108 units was the same as that recorded upstream at site 3b (Table 3). The MCI score was significantly higher (Stark, 1998) than the historic median recorded to date and four units above the median of values since 1998 (Table 3, Figure 4), continuing a trend of higher than average values over the last twenty-five surveys. This indicated 'good' generic health (TRC, 2013) and that this site had good physicochemical water quality preceding this survey.

The $SQMCI_s$ value for site 4 (6.7 units) was the same as that recorded at site 3b (Table 3), further confirmation that the community had not been recently adversely affected by land irrigation upstream of this site.

In prior surveys some deterioration in biological 'health' between sites 3b and 4 had been attributed to the impacts of dairy shed wastes assimilation in the receiving waters of the inflowing tributary a short distance upstream of site 4. No such deterioration was indicated by the results of this survey.

Site 5 (KPK000679)

A reduced richness of nineteen macroinvertebrate taxa was found at site 5, downstream of the cooling water discharges from Fonterra Kapuni. This was five taxa less than the median number of taxa recorded at this site since 1998 (Table 3, Figure 2). This richness was also six taxa fewer than recorded at site 4 located upstream of the cooling water discharges.

The community was characterised by one 'highly sensitive' taxon [mayfly (*Deleatidium*)]; two 'moderately sensitive' taxa [mayfly (*Coloburiscus*) and free-living caddisflies (*Costachorema*)]; and one 'tolerant' taxon [midge (*Maoridiamesa*)] (Table 3). This represents a reduction in the number of abundant taxa from that recorded in the previous (summer 2015) survey.

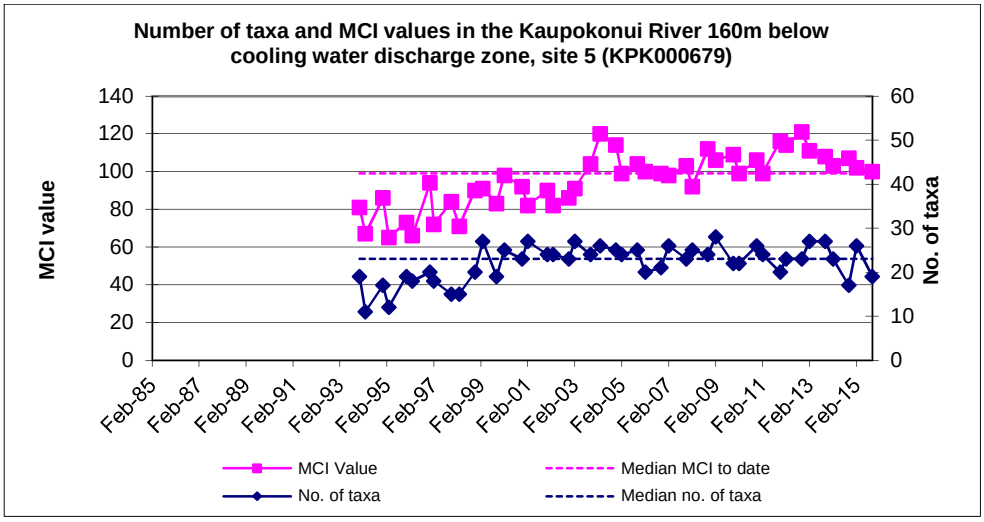

Figure 5 Numbers of taxa and MCI values recorded since December 1993 at site 5 in the Kaupokonui River

The MCI score (100 units) was higher than most of the earlier surveys' scores, especially those prior to 2003 (Figure 5) and two units above the median of scores from all surveys to date (Table 2). This MCI score was eight units less than that recorded at site 4 upstream of the cooling water spray discharge. Nineteen out of twenty-five taxa were common across both sites 4 and 5. There was no evidence of the sewage fungus recorded at this site in the previous survey.

The $SQMCI_S$ value (5.8 units) was 0.9 unit lower than that recorded at site 3b and site 4. As with sites 3b and 4, the community at this site was dominated by *Deleatidium* mayfly, which was very abundant. There were three significant changes in taxa abundance between site 4 and 5, including the decrease of two 'highly sensitive' taxa and one 'moderately sensitive' taxon which may be indicative of some impacts from the cooling water discharge but may also be attributed to subtle habitat differences, in particular to an increase in nuisance periphyton and greater proportion of harder substrate at this site.

It should be noted that the historical MCI median at this site was lowered by some poor results in the 1980s and early 1990s caused by wastes entering the river via the cooling water discharges. Most surveys in recent years had found no sign of the 'sewage fungus' growths that were recorded at site 5 in several of the 1980s and early 1990s surveys. However, an extensive 'sewage fungus' outbreak occurred in this reach of the river during the autumn-winter months of 2007. Mats of filamentous bacteria and protozoa ('heterotrophic growths') were found on the substrate by the late summer survey of 2008, coincident with the deterioration in the macroinvertebrate community at this site at that time, and in the spring 2010 survey bacterial growths were again recorded, although there was no significant deterioration in the macroinvertebrate community. At that time subtle impacts, such as the appearance of the blood worm midge (*Chironomus*), suggested that the degree of impact was potentially approaching a 'tipping point' after which deterioration in the macroinvertebrate community was more likely, provided the poor quality discharge continued. The spring 2014 survey again recorded the presence of sewage fungus, but in that case, there was no obvious impact on the macroinvertebrate communities, with blood worm midges being absent and no decline in MCI or $SQMCI_S$ scores. This indicated that a poor quality cooling water discharge had been occurring, but that it was not resulting in the same degree of deterioration in water quality as the discharges that occurred in the early 1990s. The current survey did not record any sewage fungus.

Site 6 (KPK000685)

An increased richness of twenty-eight taxa was recorded at site 6, at Skeet Road, a further 700 m below the cooling water discharges. This was five taxa more than the median number of taxa since 1998 for this site and eight taxa more than the historical median. It was also nine taxa more than found at the nearest upstream site 5 (Table 2, Figure 2 and Figure 6).

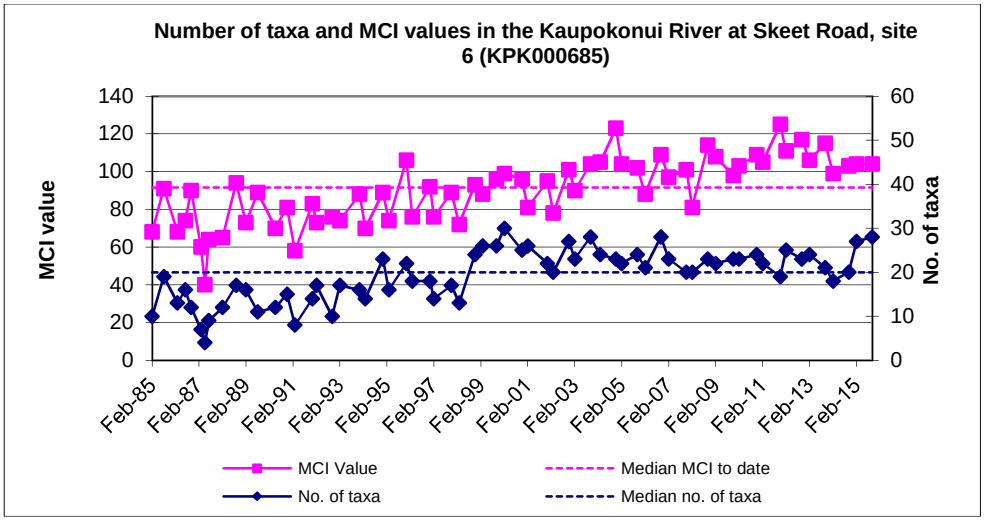

Figure 6 Numbers of taxa and MCI values recorded at site 6 in the Kaupokonui River, at Skeet Road, since February 1985

This community was characterised by more taxa than at site 5, with one 'highly sensitive' taxon (extremely abundant *Deleatidium* mayfly); seven 'moderately sensitive' taxa [*Coloburiscus* mayfly, elmid beetles, dobsonfly (*Archichauliodes*), free-living caddisflies (*Costachorema*) and (*Hydrobiosis*), caddisfly (*Pycnocentrodes*) and cranefly (*Aphrophila*)]; and four 'tolerant' taxa [oligochaete worms, (net-spinning caddisfly (*Aoteapsyche*) and midges (*Maoridiamesa*) and (Tanytarsini)] (Table 3). This represented an increase in the number of abundant 'sensitive' taxa from that recorded at site 5.

The MCI score of 104 units was thirteen units higher than the historical median for this site but only one unit higher than the median of scores recorded since 1998. This result was similar to that recorded by most recent surveys, but still higher than the majority of previous surveys undertaken to date (Figure 2, Table 2). The MCI score at this site can be variable (Figure 6), and as the current result was much higher than the long-term median score and only four units below the score recorded at site 4 (upstream of the cooling water discharges), there was no indication of marked deterioration in community health at this site at the time of the current survey.

The $SQMCI_s$ (6.4 units) was 0.6 unit higher than that recorded at site 5, suggesting an improvement in the health of the community structure. Only two taxa changed significantly in abundance at this site (from site 5), but the increased abundance of 'highly sensitive' *Deleatidium* mayfly, which was recorded in extreme abundance, together with an increased abundance of five other 'sensitive' taxa were the primary drivers behind the improved $SQMCI_S$ score. This indicated that the subtle effects recorded by some past surveys were minimal at the time of the current survey and not considered to be significant in terms of impacts on the macroinvertebrate communities recorded at this site.

Site 7 (KPK000880)

A moderate richness of twenty taxa was recorded at site 7, at Upper Glenn Road (Table 2), above both the long term median and the median richness of surveys since 1998. One 'highly sensitive' taxon was present in this community, being the very abundant *Deleatidium* mayfly; fewer than that found at three of the upstream sites, but typical of the number recorded by most previous surveys. Characteristic taxa included the one aforementioned 'highly sensitive' mayfly; one 'moderately sensitive' taxon [stony-cased caddisfly (*Pycnocentrodes*)]; and two 'tolerant' taxa [oligochaete worms, and midges (*Maoridiamesa*)]. Despite the distance between sites 6 and 7 and a degree of natural deterioration in macroinvertebrate communities normally found in a downstream direction over such a distance, the community compositions were more dissimilar than usual between the two sites with only seventeen (of 28) taxa common to both communities. In addition there were six significant changes in taxa abundances between the two sites.

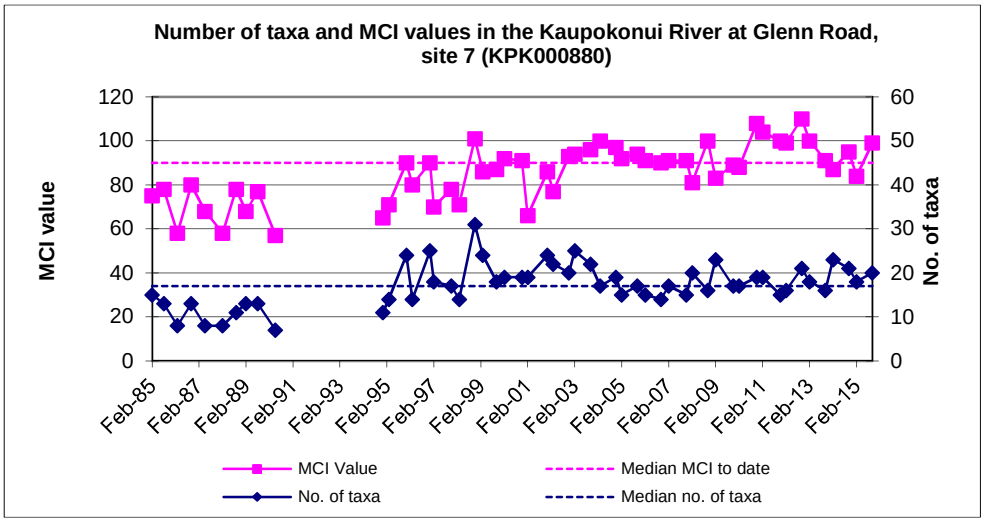

Figure 7 Numbers of taxa and MCI values recorded at site 7 in the Kaupokonui River, since February 1985

The proportion of 'tolerant' taxa (40% of taxa number) reduced from that recorded in the previous summer (2015) survey and resulted in an increased MCI score of 99 units. This score was seven units higher than the median of scores since 1998, and nine units higher than the historic median at this site (Table 2, Figure 7), neither of which was a statistically significant difference (Stark, 1998). This indicated some recovery from that recorded in the previous survey, and is a return to the above-median health normally recorded since 2010 (Figure 7). The current MCI score was five units less than that recorded at site 6, some 9 km upstream. This was a relatively typical trend through this reach, and an improvement on that recorded by the previous survey, where very low flows had exacerbated the deterioration in MCI score. It also reflects the natural downstream deterioration typical of ringplain streams and rivers, with streams and rivers at this altitude and distance from the National Park boundary typically seeing a reduction in MCI score of approximately 0.6 MCI unit/km (Stark and Fowles, 2009).

The $SQMCI_S$ score (5.2) was the lowest recorded score of all sites and was 1.2 units lower than the score at the nearest upstream site (Table 3). This change was principally due to the significant decrease in abundance of several 'sensitive' taxa including; [mayfly (*Coloburiscus*), elmid beetles, caddisflies (*Costachorema* and *Beraeoptera*) and cranefly (*Aphrophila*)]. Generally, there has been a decreasing trend in $SQMCI_S$ scores between sites 6 and 7, (especially in the summer surveys). This was usually due to the distance between the sites and the influence of the Dunns Creek tributary, which joins the river between the two

sites. Occasionally, there has been little difference, due to site 6 showing impacts from the cooling water discharge. In the current survey, there was no evidence of cooling water discharge influence at site 6, indicating that the deterioration in community health at site 7 may be largely attributed to some typical downstream deterioration and the additional influence of the Dunns Creek tributary.

Summary and Conclusions

The Council's standard 'kick-sampling' technique was used to collect streambed macroinvertebrates from five sites in the Kaupokonui River on 16 October 2015. Samples were sorted and identified to provide the number of taxa (richness), MCI and $SQMCI_s$ scores for each site. The samples were also microscopically scanned to determine the presence or absence of any mats, plumes or dense growths of bacteria, fungi or protozoa ("undesirable biological growths").

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.

In the Kaupokonui River, taxa richnesses were similar to or higher than historical median richnesses (with the exception of site 5), while MCI scores indicated 'good' to 'fair' community health at all sites. MCI scores declined in a downstream direction, but only to the degree expected, likely related to the progressive deterioration typical of Taranaki's ringplain streams and rivers. The MCI scores at all five sites were higher than their historical median scores, and the three sites downstream of the cooling water discharges showed some improvement in community health from that recorded by the previous summer survey, which is a fairly typical result for a spring survey. The survey continued to show that the Kaupokonui River generally has macroinvertebrate communities of 'good' health throughout most of the reach surveyed. The poorest community, found at site 7, was indicative of some influence from the Dunns Creek tributary within the reach between sites 6 and 7.

It may be concluded that the factory's cooling water discharges had not resulted in significant adverse effects on the macroinvertebrate communities, with the communities appearing generally healthier than that recorded in the previous summer survey, a relatively typical result. The current survey did not record the presence of sewage fungus or blood worm midges, indicating that the poor quality cooling water discharge that had been occurring prior to the spring 2014 survey had ceased. In addition, there was no deterioration in the macroinvertebrate communities between sites upstream and downstream of spray irrigation of wastes onto land (but upstream of the cooling water discharge) from the Fonterra Kapuni factory recorded by the current survey.

MCI values continued to indicate in general that macroinvertebrate communities were mainly in 'good' health, being similar or above median MCI scores from surveys conducted since 1998. Similarities in community composition, including the characteristic taxa, were generally consistent for all sites, although there were some exceptions at site 5, and some

additions at sites 6 and 7, further downstream. The deterioration in MCI score recorded between sites 6 and 7 (in the lower reaches), was not a statistically significant result, but was a result commonly recorded in this river, often due to progressive deterioration in communities in a downstream direction, typical of Taranaki ringplain rivers and streams.

The trend of improvement in communities noted in recent years adjacent to the factory has generally continued to be recorded by this survey, following a break in the trend recorded by the February 2008 survey, which recorded the additional presence of 'undesirable heterotrophic growths' on the streambed. The spring 2010 survey also recorded such growths at two sites, although only subtle impacts on the macroinvertebrate communities were found. Such growths were again recorded in the spring 2014 survey, but not in the summer 2015 survey or the current survey.

References

Dunning KJ, 2002a: Biomonitoring of the Kaupokonui River, in relation to the Lactose Co NZ Ltd farm and factory, December 2001. TRC report KD90.

Dunning KJ, 2002b: Biomonitoring of the Kaupokonui River, and the Motumate Stream in relation to the Lactose Co NZ Ltd farm and factory, March 2002. TRC report KD128.

Dunning KJ, 2002c: Biomonitoring of the Kaupokonui River in relation to the FONTERRA Kapuni farm and factory, November 2002. TRC report KD138.

Fowles CR, 2003: Biomonitoring of sites in the Waiokura Stream in relation to the irrigation of lactose production wastes from the NZMP Kapuni factory, February 2003.

Fowles CR, & Colgan B, 2004a: Biomonitoring of the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, March 2004. TRC report CF335.

Fowles CR, & Colgan B, 2004b: Biomonitoring of sites in the Waiokura Stream in relation to the land irrigation of lactose production wastes from the Fonterra Kapuni factory, March 2004. TRC report CF328.

Fowles CR, & Jansma B, 2008a: Biomonitoring of sites in the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, November 2007. TRC report CF461.

Fowles CR, & Jansma B, 2008b: Biomonitoring of sites in the Kaupokonui River and the Waiokura Stream in relation to the Fonterra Kapuni farm and factory, February 2009. TRC report CF463.

Fowles CR, & Jansma B, 2014a: Biomonitoring of sites in the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, November 2013. TRC report CF627.

Fowles CR, & Jansma B, 2014b: Biomonitoring of the Kaupokonui River and Waiokura Stream in relation to the Fonterra Kapuni farm and factory, February 2014. TRC report CF628.

Hope KJ, 2005: Biomonitoring of the Kaupokonui River and Waiokura Stream in relation to the Fonterra Kapuni farm and factory, February 2005. TRC report KH037.

Hope KJ, 2006a: Biomonitoring of the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, October 2005. TRC report KH055.

Hope KJ, 2006b: Biomonitoring of the Kaupokonui River and Waiokura Stream in relation to the Fonterra Kapuni farm and factory, February 2006. TRC report KH079.

Jansma B, 2007: Biomonitoring of the Kaupokonui River and Waiokura Stream in relation to the Fonterra Kapuni farm and factory, February 2007. TRC report BJ032.

Jansma B, 2009a: Biomonitoring of sites in the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, October 2008. TRC report BJ057.

Jansma B, 2009b: Biomonitoring of sites in the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, February 2009. TRC report BJ058.

Jansma B, 2010a: Biomonitoring of sites in the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, November 2009. TRC report BJ122.

Jansma B, 2010b: Biomonitoring of the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, February 2010. TRC report BJ123.

Jansma B, 2011a: Biomonitoring of the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, November 2010. TRC report BJ165.

Jansma B, 2011b: Biomonitoring of the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, February 2011. TRC report BJ166.

Jansma B, 2013a: Biomonitoring of the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, November 2011. TRC report BJ181.

Jansma B, 2013b: Biomonitoring of the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, February 2012. TRC report BJ182.

Jansma B, 2014a: Biomonitoring of the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, October 2012. TRC report BJ227.

Jansma B, 2014b: Biomonitoring of the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, February 2013. TRC report BJ228.

Jansma B and Hope KJ, 2007: Biomonitoring of the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, October 2006. TRC report KH090.

Moore SC, 2003: Biomonitoring of the Kaupokonui River, in relation to the NZMP Kapuni farm and factory, February 2003. TRC report SM584.

Moore SC, 2004: Biomonitoring of the Kaupokonui River, in relation to the NZMP Kapuni farm and factory, October 2003. TRC report SM590.

Stark JD, 1985: A macroinvertebrate community index of water quality for stony streams. *Water and Soil* Miscellaneous Publication No. 87.

Stark JD, 1998: SQMCI: a biotic index for freshwater macroinvertebrate coded abundance data. *New Zealand Journal of Marine and Freshwater Research 32(1*): 55-66.

Stark JD, 1999: An evaluation of TRC's SQMCI biomonitoring index. Cawthron Institute, Nelson. Cawthron Report No. 472.

Stark JD, Boothroyd IKG, Harding JS, Maxted JR, Scarsbrook MR, 2001: Protocols for sampling macroinvertebrates in wadeable streams. New Zealand Macroinvertebrate Working Group Report No. 1. Prepared for the Ministry for the Environment. Sustainable Management Fund Project No. 5103. 57p.

Stark, JD and Fowles, CR, 2009: Relationships between MCI, site altitude, and distance from source for Taranaki ring plain streams. Stark Environmental Report No 2009-01 47pp.

TRC, 1999: Some statistics from the Taranaki Regional Council database (FWB) of freshwater macroinvertebrate surveys performed during the period from January 1980 to 31 December 1988, (SEM reference report). TRC Technical Report 99-17.

TRC, 2013: Freshwater Macroinvertebrate Fauna Biological Monitoring Programme Annual State of the Environment Monitoring Report 2012-2013. TRC Technical Report 2013-48.

To Job Manager, James Kitto
From Scientific Officers, B Jansma and B Thomas
Report No BT062
Doc No 1698782
Date 27 June 2016

Biomonitoring of the Kaupokonui River and Waiokura Stream in relation to the Fonterra Kapuni farm and factory, February 2016

Introduction

This biological survey was the second of two scheduled in relation to the Fonterra Kapuni (formerly Lactose) factory in the 2015-2016 monitoring year. The results from surveys performed since the 2001-2002 monitoring year are discussed in reports listed in the references section of this report.

This survey relates to the following consents held by Fonterra Kapuni Ltd:

0919 to discharge cooling water to the Kaupokonui River;
0922 to spray irrigate wastewater and stormwater to land in the Kaupokonui catchment;
0923 to spray irrigate wastewater and stormwater to land in the Waiokura and Motumate catchments;
0924 to discharge stormwater and cooling water to the Kaupokonui River;
4235 to discharge stormwater to the Kaupokonui River during factory shutdown periods;
4604 to discharge stormwater to the Kaupokonui River from the factory extension;
6423 to discharge stormwater from an inhalation grade lactose plant site into the Kaupokonui River

Methods

The standard '400 ml kick-sampling' technique was used on 02 February 2016 to collect streambed macroinvertebrates from seven sites in the Kaupokonui River and Waiokura Stream in relation to discharges to the river and on to land in the catchment (Table 1, Figure 1). The 'kick-sampling' technique is very similar to Protocol C1 (hard-bottomed, semi-quantitative) of the New Zealand Macroinvertebrate Working Group (NZMWG) protocols for macroinvertebrate samples in wadeable streams (Stark et al, 2001).

Table 1 Biomonitoring sites in the Kaupokonui River and Waiokura Stream

Stream	Site No.	Site Code	Location
Kaupokonui River	3b	KPK000655	1 km u/s of railway bridge
	4	KPK000660	Railway, above factory
	5	KPK000679	160m below cooling water discharge zone
	6	KPK000685	Skeet Road
	7	KPK000880	Glenn Road
Waiokura Stream	U	WKR000500	Skeet Road
	D	WKR000650	At Hicks (Thomas) Road

Samples were preserved with Kahle's Fluid for later sorting and identification under a stereomicroscope according to Taranaki Regional Council methodology using protocol P1 of NZMWG protocols for sampling macroinvertebrates in wadeable streams (Stark et al. 2001).

Macroinvertebrate taxa found in each sample were recorded as:

R (rare)	= less than 5 individuals;
C (common)	= 5-19 individuals;
A (abundant)	= estimated 20-99 individuals;
VA (very abundant)	= estimated 100-499 individuals;
XA (extremely abundant)	= estimated 500 individuals or more.

Stark (1985) developed a scoring system for macroinvertebrate taxa according to their sensitivity to organic pollution in stony New Zealand streams. Highly 'sensitive' taxa were assigned the highest scores of 9 or 10, while the most 'tolerant' forms scored 1. Sensitivity scores for certain taxa have been modified in accordance with Taranaki experience. Averaging the scores assigned to the taxa found at a site, and multiplying the average by a scaling factor of 20, produces a Macroinvertebrate Community Index (MCI) value.

The MCI was designed as a measure of the overall sensitivity of macroinvertebrate communities to the effects of organic pollution. MCI results can also reflect the effects of warm temperatures, slow current speeds and low dissolved oxygen levels, because the taxa capable of tolerating these conditions generally have low sensitivity scores. Usually more 'sensitive' communities (with higher MCI values) inhabit less polluted waterways.

A semi-quantitative MCI value ($SQMCI_s$) has also been calculated for the taxa present at each site by multiplying each taxon score by a loading factor (related to its abundance), totalling these products, and dividing by the sum of the loading factors (Stark, 1998 and 1999). The loading factors were 1 for rare (R), 5 for common (C), 20 for abundant (A), 100 for very abundant (VA) and 500 for extremely abundant (XA). Unlike the MCI, the $SQMCI_s$ is not multiplied by a scaling factor of 20, so that its corresponding range of values is 20x lower.

When necessary, sub-samples of periphyton (algae and other microflora) taken from the macroinvertebrate samples were scanned under 40-400x magnification to determine the presence or absence of any mats, plumes or dense growths of bacteria, fungi or protozoa ("undesirable biological growths") at a microscopic level. The presence of masses of these organisms can be an indicator of organic enrichment within a stream.

Figure 1 Biomonitoring sites in the Kaupokonui River sampled in relation to Fonterra Kapuni factory discharges

Results and discussion

This survey was undertaken following a long period of receding flows in the Kaupokonui River, and followed 21 and 130 days after flow events in excess of three and seven times median flow respectively. The Kaupokonui River had a very low, clear, uncoloured, and swift flow at all sampling sites. River flow at the Glenn Road recorder site was 0.676 m^3/sec, just below the mean annual low flow (0.751 m^3/sec), and well below median flow (2.04 m^3/sec) for the Kaupokonui River.

At the time of this midday survey, water temperatures in the Kaupokonui River ranged from 20.6°C to 22.0°C. Periphyton mats and algal filaments were patchy to widespread at all sites, a direct reflection of the lack of preceding scouring flows. Cobbles, gravel and boulders were the predominant substrate at all sites in the river. The Waiokura Stream sites had a finer substrate with the bed primarily composed of gravels and cobbles. Aquatic vegetation grew throughout the stream at site D, while no macrophytes were recorded growing at site U. Algae were noted only as slippery films on the substrate at site U, while site D supported patches of algal filaments and slippery algal mats. Water temperatures ranged from 16.5˚C to 18.4˚C at the time of this mid-morning component of the survey. The Waiokura Stream had also recorded an extended period of stable flows, with this survey performed 129 and 187 days after flow events in excess of three and seven times median flow respectively.

Macroinvertebrate communities

Kaupokonui River

Historically the mid to lower reaches of the Kaupokonui River have shown the effects of nutrient enrichment from the surrounding farmland, and in past years (mainly prior to 2000) there have been a number of surveys showing detectable impacts of discharges from the lactose factory on the riverbed fauna. On many past sampling occasions, the sites immediately upstream and downstream of the Fonterra Kapuni factory supported moderate numbers of taxa, with relatively low proportions of 'sensitive' taxa (such as mayflies and stoneflies), resulting in median MCI values in the low 80s (Table 2). Since 1998 however, macroinvertebrate communities have improved throughout the reach and have shown higher numbers of taxa and MCI scores on most occasions. Median values for both the total data set and the results since 1998 are included in Table 2. Faunal results from the current survey are presented in full in Table 3.

Generally the summer (February to March) surveys have found lower proportions of 'sensitive' taxa resulting in lower MCI values than the spring (October to November) surveys (see Figure 3, Figure 4, Figure 5, Figure 6 and Figure 7).

Table 2 Numbers of taxa and MCI values recorded previously in the Kaupokonui River (since 1985), together with current results

Site	Number of previous surveys	Numbers of taxa				MCI values			
		Median (all data)	Range (all data)	*Median (Nov 1998 to date)*	Current survey	Median (all data)	Range (all data)	*Median (Nov 1998 to date)*	Current survey
3b	50	24	13-28	*24*	25	106	68-125	*110*	106
4	64	22	8-32	*25*	23	97	65-128	*104*	94
5	45	23	11-28	*24*	26	99	65-121	*100*	96
6	64	20	4-30	*23*	21	92	40-125	*103*	95
7	55	17	7-31	*19*	20	90	57-110	*92*	84

In this February 2016 survey, all sampling sites supported between 20 and 26 taxa. These results were all within 1-2 taxa of the site medians from data since 1998. MCI scores at all sites were lower (although not significantly (Stark, 1998) than their respective median values for surveys since November 1998. The MCI score at site 6 was slightly higher than its median value for the entire record while the remaining sites had scores either the same (site 3b) or slightly lower than historical medians (Table 2, Figure 2). Taxa richness was relatively similar between sites with the highest number (26) recorded at site 5 and the lowest number (20) recorded at site 7. MCI scores were relatively stable in a downstream direction, although the highest score was recorded at the 'control site' (site 3b), and the lowest (by 22 units) was recorded at site 7. MCI scores ranged from 84 to 106 units, reflecting relatively 'fair' to 'good' physicochemical water quality. There was no obvious impact of the cooling water discharges in the mid-reaches of the river as indicated by the lack of sewage fungus at the downstream sites. In the current survey there was an 11 unit decrease in scores between sites 6 and 7, an improvement on the previous summer (2015) survey which recorded a 20 unit decrease. In most previous surveys, the inflow from Dunns Creek in this reach was likely to have contributed to this recorded deterioration, although the natural decrease in MCI with distance downstream in the lower mid-reaches of the Taranaki ringplain, over a stream distance of about 9 km (of 5 units (Stark and Fowles, 2009)) should also be taken into account.

The 'fair' to 'good' MCI scores were also reflected by the results of the microscopic scan for undesirable biological growths, which recorded no such growths at any site. This is a continuation of the improvement recorded from the spring October 2014 survey, which recorded sewage fungus at sites 5 and 6. This indicates that the cooling water discharge had either improved in quality, or was being better assimilated.

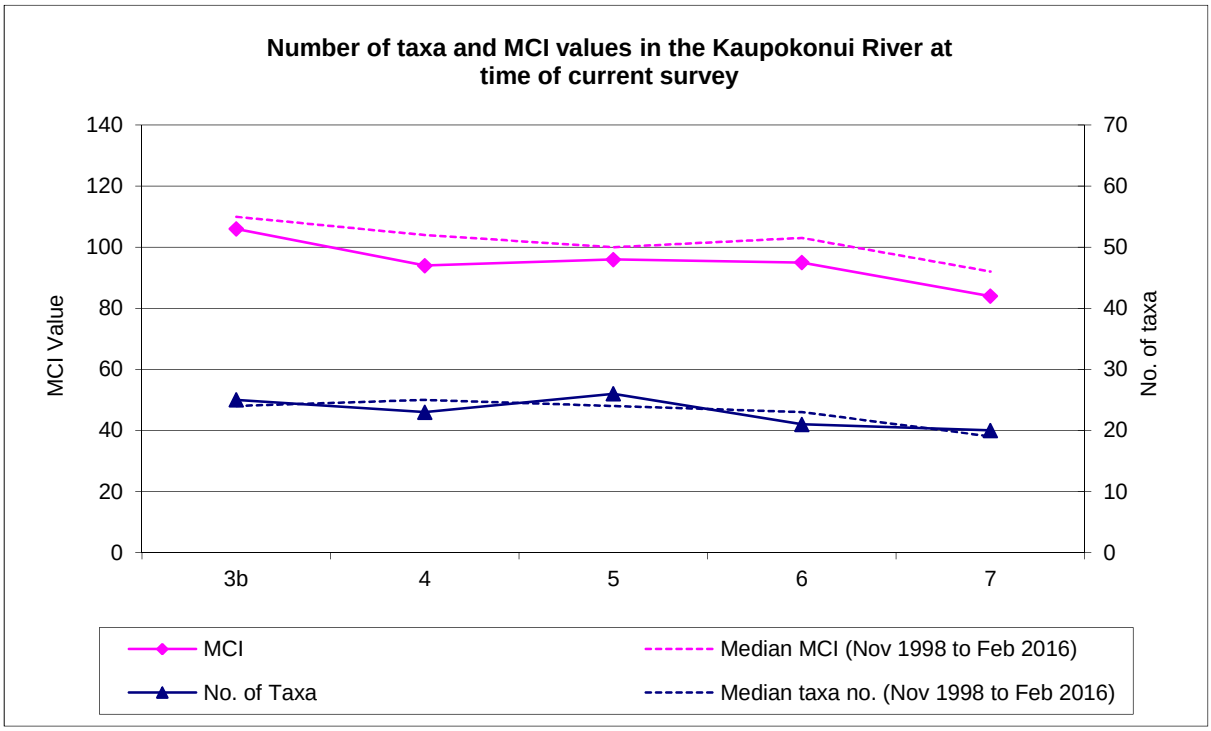

Figure 2 Numbers of taxa and MCI values recorded in the Kaupokonui River in this survey, together with median values from previous surveys (November 1998 to date)

Table 3 Macroinvertebrate fauna of the Kaupokonui River in relation to Fonterra Kapuni samples on 02 February 2016

Taxa List	Site Number	MCI score	3b	4	5	6	7
	Site Code		KPK000655	KPK000660	KPK000679	KPK000685	KPK000880
	Sample Number		FWB16044	FWB16045	FWB16046	FWB16047	FWB16048
PLATYHELMINTHES (FLATWORMS)	*Cura*	3	-	R	-	-	-
NEMERTEA	Nemertea	3	R	C	R	-	R
ANNELIDA (WORMS)	Oligochaeta	1	-	A	-	C	C
	Lumbricidae	5	-	-	R	-	-
MOLLUSCA	*Physa*	3	-	-	R	R	-
	Potamopyrgus	4	A	VA	A	A	VA
CRUSTACEA	Ostracoda	1	-	-	-	-	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	A	C	R	A	C
	Coloburiscus	7	A	A	C	R	R
	Deleatidium	8	VA	A	A	C	A
	Zephlebia group	7	R	-	R	-	-
HEMIPTERA (BUGS)	*Saldula*	5	-	-	R	-	R
COLEOPTERA (BEETLES)	Elmidae	6	A	A	C	A	C
	Hydraenidae	8	R	R	R	-	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	A	A	A	A	A
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	XA	VA	VA	A	R
	Costachorema	7	C	-	C	R	-
	Hydrobiosis	5	A	C	C	A	C
	Neurochorema	6	C	-	-	R	-
	Psilochorema	6	R	-	-	-	-
	Beraeoptera	8	R	-	-	-	-
	Hudsonema	6	-	R	-	-	-
	Olinga	9	C	R	-	R	-
	Oxyethira	2	C	A	C	VA	C
	Pycnocentrodes	5	C	C	C	A	VA
DIPTERA (TRUE FLIES)	*Aphrophila*	5	C	A	A	C	C
	Limonia	6	-	-	R	-	-
	Maoridiamesa	3	C	-	R	R	-
	Orthocladiinae	2	A	VA	A	VA	VA
	Tanypodinae	5	R	-	-	-	-
	Tanytarsini	3	C	A	A	A	C
	Empididae	3	R	C	C	A	R
	Ephydridae	4	-	-	R	-	-
	Muscidae	3	R	R	R	R	A
	Austrosimulium	3	-	R	R	-	R
	Tanyderidae	4	-	R	-	-	-
	No of taxa		25	23	26	21	20
	MCI		106	94	96	95	84
	SQMCIs		4.8	3.9	4.5	3.5	4.1
	EPT (taxa)		12	8	8	9	6
	%EPT (taxa)		48	35	31	43	30

'Tolerant' taxa | 'Moderately sensitive' taxa | 'Highly sensitive' taxa

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Site 3b (KPK000655)

A moderate richness of twenty-five taxa was recorded at site 3b, upstream of the Fonterra Kapuni farm. This was one more than the long term median number of taxa recorded at this site to date (Table 2) and one more than the median richness of more recent records (since 1998). The community was characterised by nine taxa including one 'highly sensitive' taxon [mayfly (*Deleatidium*)]; five 'moderately sensitive' taxa [mayflies (*Austroclima*) and (*Coloburiscus*), elmid beetles, dobsonfly (*Archichauliodes*) and the free-living caddisfly (*Hydrobiosis*)]; and three 'tolerant' taxa [snail (*Potamopyrgus*), net-spinning caddisfly (*Hydropsyche-Aoteapsyche*) and orthoclad midges]. This dominance represented a slight decrease in the relative proportions of 'highly sensitive' to 'tolerant' taxa dominating the community, in comparison with the characteristic taxa found by the previous spring (2015) survey.

The moderate proportion of 'tolerant' taxa in the community (36% of taxa richness) was reflected in the MCI score (106) which was similar to the most recent surveys, and reflective of the long period of stable flows and relatively prolific periphyton growths observed. This score was two units less than that recorded in the previous spring survey (Figure 3). The presence of four 'highly sensitive' taxa indicated good preceding physicochemical water quality at this control site, above all Fonterra activities in the Kaupokonui River catchment.

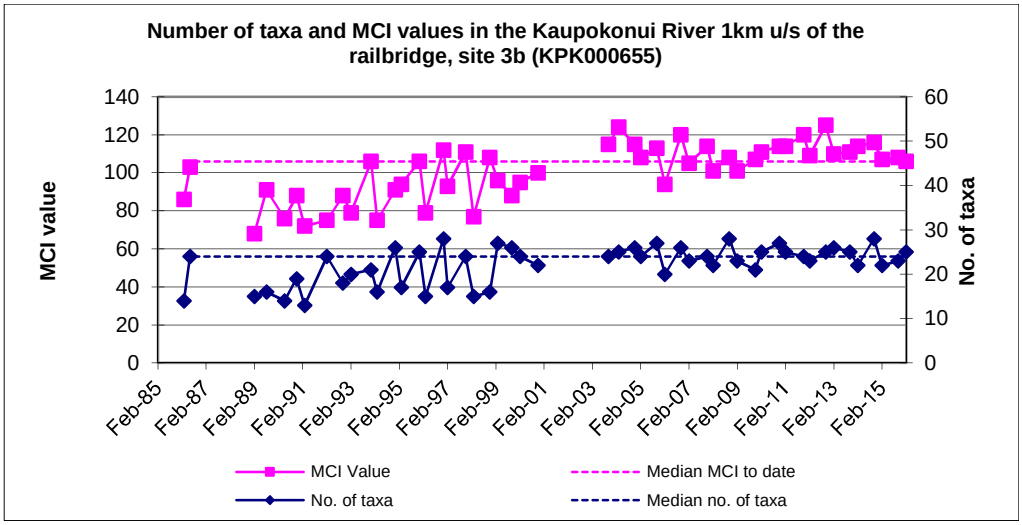

Figure 3 Numbers of taxa and MCI values recorded at site 3b in the Kaupokonui River since 1985

The MCI score of 106 units was well within the range recorded in recent surveys (Figure 3). It was four units lower than the median score for surveys since 1998 and the same as the median from all surveys conducted to date (Figure 2, Table 2). Although there were more 'sensitive' taxa recorded in abundance than 'tolerant' taxa, the extremely abundant 'tolerant' caddisfly (*Hydropsyche-Aoteapsyche*) resulted in the $SQMCI_s$ value of 4.8 units, a substantial 1.9 units lower than the $SQMCI_s$ value found at this site by the previous spring (2015) survey.

Site 4 (KPK000660)

A moderate richness of twenty-three macroinvertebrate taxa was recorded in the community at site 4, upstream of the Fonterra Kapuni weir and rail bridge, and downstream of the area of land irrigated by wastes from Fonterra Kapuni. This taxa richness was slightly less than

the numbers of taxa recorded in recent monitoring years (Figure 4), and two less than that recorded at site 3b by this current survey (Table 3).

The community was characterised by one 'highly sensitive' taxon [mayfly (*Deleatidium*)]; four 'moderately sensitive' taxa [mayfly (*Coloburiscus*), elmid beetles, dobsonfly (*Archichauliodes*) and cranefly (*Aphrophila*)}; and six 'tolerant' taxa [oligochaete worms, snails (*Potamopyrgus*), caddisflies (*Hydropsyche-Aoteapsyche*) and (*Oxyethira*), and midges (orthoclads and tanytarsids)]. There were four significant changes in taxa abundances between sites 3b and 4, including the decrease of two 'sensitive' taxa and one 'tolerant' taxon and the increased abundance of one 'tolerant' taxon (Table 3).

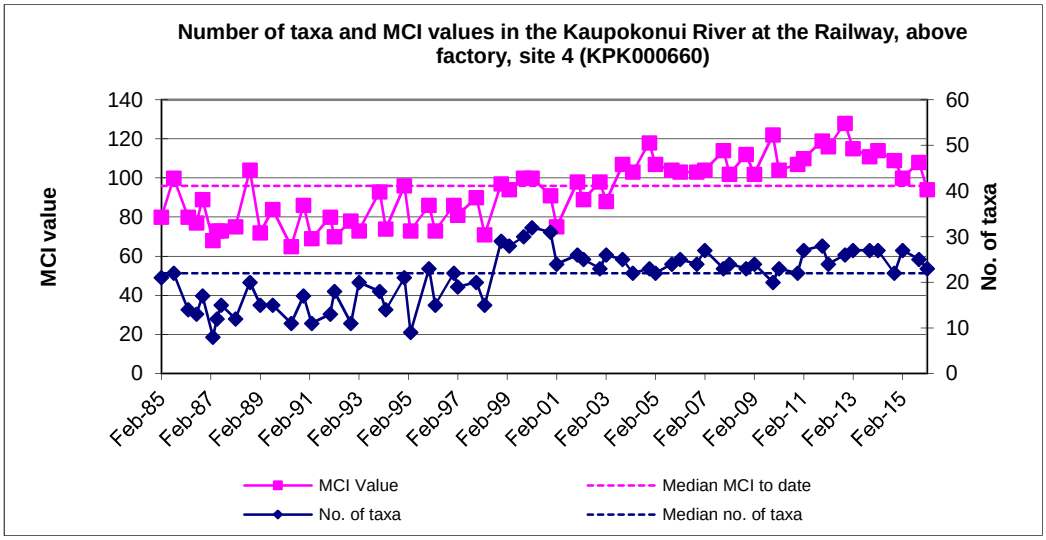

Figure 4 Numbers of taxa and MCI value recorded at site 4 in the Kaupokonui River since February 1985

The MCI score at site 4 was a significant (Stark, 1998) 12 units less than the score recorded upstream at site 3b, reflecting a less sensitive community composition (Table 3). The MCI score was a substantial 10 units below the median of values since 1998 and slightly lower (by three units) than the historic median recorded to date (Table 3, Figure 4), discontinuing a trend of higher than average values over the last twenty-five surveys. This indicated 'fair' generic health (TRC, 2015) and that this site had moderate physicochemical water quality preceding this survey.

The $SQMCI_s$ value of 3.9 units was 0.9 unit lower than that recorded at site 3b (Table 3), primarily due to an increased abundance of several 'tolerant' taxa (oligochaete worms, snails (*Potamopyrgus*), orthoclad midge larvae and caddis larvae (*Oxyethira*). This score indicated that the community was dominated by a higher proportion of 'tolerant' taxa, a possible indication that the community had been recently adversely affected by land irrigation upstream of this site. Similar to prior surveys some of the deterioration in biological 'health' between sites 3b and 4 may also be attributed to the impacts of dairy shed wastes assimilation in the receiving waters of the inflowing tributary a short distance upstream of site 4.

Site 5 (KPK000679)

A moderate richness of twenty-six macroinvertebrate taxa was found at site 5, downstream of the cooling water discharges from Fonterra Kapuni. This was two taxa more than the median number of taxa recorded at this site since 1998, and seven more than that recorded

by the previous survey (Table 2, Figure 2)). This richness was three taxa more than that recorded at site 4 located upstream of the cooling water discharges.

The community was characterised by one 'highly sensitive' taxon [mayfly (*Deleatidium*)]; two 'moderately sensitive' taxa [dobsonfly (*Archichauliodes*) and cranefly (*Aphrophila*)]; and four 'tolerant' taxa [snail (*Potamopyrgus*), net spinning caddisfly (*Hydropsyche-Aoteapsyche*) and midges (orthoclads and tanytarsids)] (Table 3). This represents an increase in the number of abundant taxa from that recorded in the previous (spring 2015) survey.

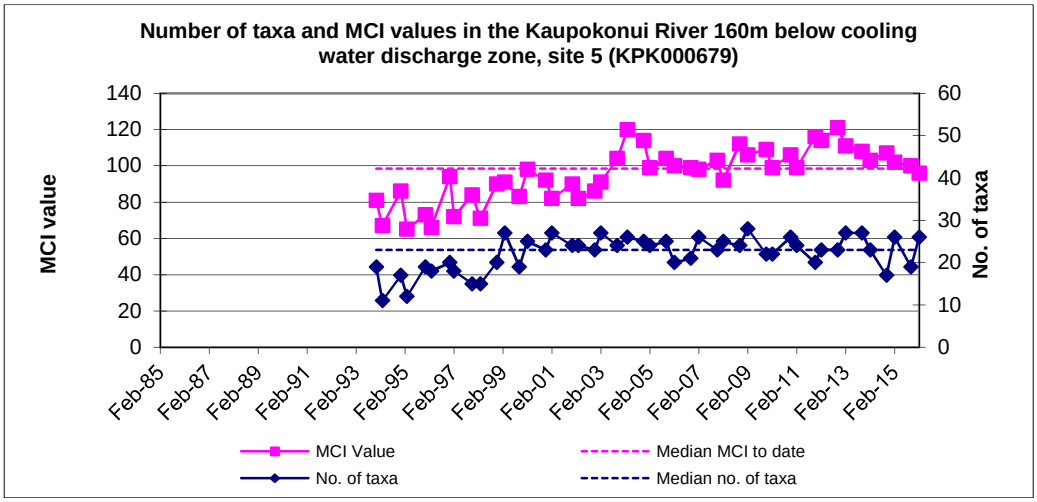

Figure 5 Numbers of taxa and MCI values recorded since December 1993 at site 5 in the Kaupokonui River

The MCI score (96 units) was higher than most of the earlier surveys' scores, especially those prior to 2003 (Figure 5) and three units below the median of scores from all surveys to date (Figure 2, Table 2). This MCI score was similar to that recorded at site 4 upstream of the cooling water spray discharge (despite the differences in community composition), with only eighteen taxa common to both sites, of the thirty-one taxa recorded across both sites. There was no evidence of the sewage fungus recorded at this site in the previous survey.

The $SQMCI_S$ value (4.5 units) was above that recorded at site 4, but 0.3 unit lower than that recorded at site 3b. The communities at sites 3b, 4 and 5 were dominated by similar taxa, including *Deleatidium* mayfly, *Hydropsyche-Aoteapsyche* caddisflies, dobsonfly *Archichauliodes*, *Potamopyrgus* snails and orthoclad midge larvae.

It should be noted that the historical MCI median at this site was lowered by some poor results in the 1980s and early 1990s caused by wastes entering the river via the cooling water discharges. Most surveys in recent years had found no sign of the 'sewage fungus' growths that were recorded at site 5 in several of the 1980s and early 1990s surveys. However, an extensive 'sewage fungus' outbreak occurred in this reach of the river during the autumn-winter months of 2007. Mats of filamentous bacteria and protozoa ('heterotrophic growths') were found on the substrate by the late summer survey of 2008, coincident with the deterioration in the macroinvertebrate community at this site at that time, and in the spring 2010 survey bacterial growths were again recorded, although there was no significant deterioration in the macroinvertebrate community. At that time subtle impacts, such as the appearance of the blood worm midge (*Chironomus*), suggested that the degree of impact was potentially approaching a 'tipping point' after which deterioration in the macroinvertebrate community was more likely, provided the poor quality discharge continued. The spring

2014 survey again recorded the presence of sewage fungus, but in that case, there was no obvious impact on the macroinvertebrate communities, with blood worm midges being absent and no decline in MCI or $SQMCI_S$ scores. This indicated that a poor quality cooling water discharge had been occurring, but that it was not resulting in the same degree of deterioration in water quality as the discharges that occurred in the early 1990s. The current survey did not record any sewage fungus; neither did it indicate any change in macroinvertebrate communities caused by the cooling water discharge.

Site 6 (KPK000685)

A richness of twenty-one taxa was recorded at site 6, at Skeet Road, a further 700 m below the cooling water discharges. This was two taxa less than the median number of taxa since 1998 for this site, one more than the historical median, and slightly less than that recorded at sites 4 and 5 upstream (Table 2, Figure 2 and Figure 6).

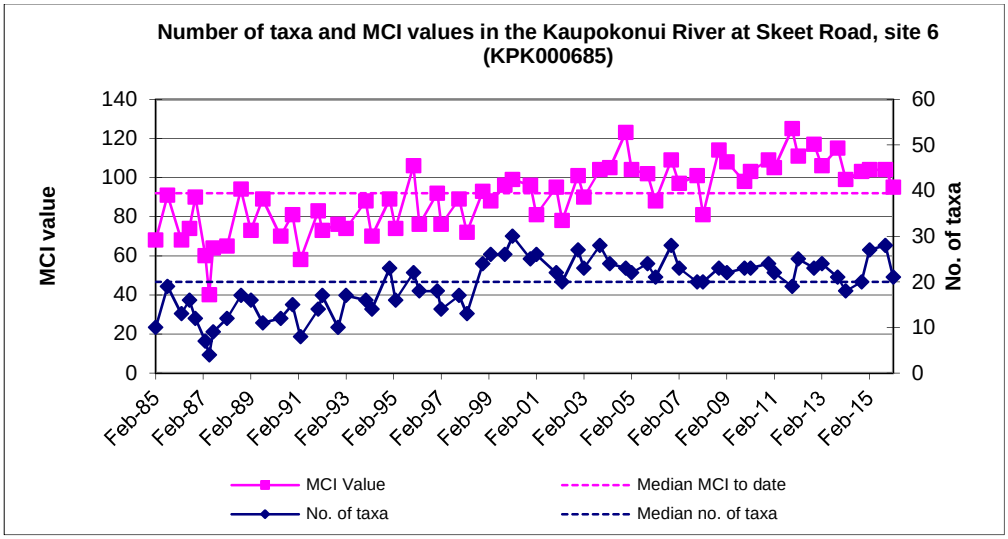

Figure 6 Numbers of taxa and MCI values recorded at site 6 in the Kaupokonui River, at Skeet Road, since February 1985

This community was characterised by more taxa than at site 5 with five 'moderately sensitive' taxa [*Austroclima* mayfly, elmid beetles, dobsonfly (*Archichauliodes*), free swimming caddisfly (*Hydrobiosis*) and stony cased caddisfly (*Pycnocentrodes*)]; and six 'tolerant' taxa [snail (*Potamopyrgus*), (net-spinning caddisfly (*Hydropsyche-Aoteapsyche*), algal piercing caddisfly (*Oxyethira*), fly larvae (Empididae) and midges (orthoclads and tanytarsids)] (Table 3). Unlike the upstream sites, there were no 'highly sensitive' taxa recorded in abundance at this site. This represented an increase in the number of abundant taxa from that recorded at site 5, although this increase was spread between 'tolerant' and 'sensitive' taxa.

The MCI score of 95 units was three units higher than the historical median for this site but was eight units lower than the median of scores recorded since 1998. Although this result was lower than that recorded by most recent surveys, it was still higher than the majority of previous surveys undertaken to date (Figure 6, Table 2). The MCI score at this site can be variable (Figure 6) and, as the current result was only slightly higher than the long-term median score and one unit above the score recorded at site 4 (upstream of the cooling water discharges), there was no indication of marked deterioration in community health at this site at the time of the current survey.

The $SQMCI_s$ score (3.5 units) was 1.0 unit less than that recorded at site 5, suggesting a decrease in the health of the community structure. Three taxa changed significantly in abundance at this site (from site 5), two related to increases in 'tolerant' taxa and one to an increase in a 'sensitive' taxon. This indicated that the subtle effects recorded by some past surveys were minimal at the time of the current survey and not considered to be significant in terms of impacts on the macroinvertebrate communities recorded at this site.

Site 7 (KPK000880)

A moderate richness of twenty taxa was recorded at site 7, at Upper Glenn Road (Table 2), similar to both the long term median and the median richness of surveys since 1998. Characteristic taxa included one 'highly sensitive' taxon [mayfly (*Deleatidium*)]; two 'moderately sensitive' taxa [dobsonfly (*Archichauliodes*) and stony-cased caddisfly (*Pycnocentrodes*)]; and three 'tolerant' taxa [snail (*Potamopyrgus*), orthoclad midges and house fly larvae (Muscidae)]. Sixteen, out of 25 taxa were common to both site 6 and 7 reflective of a degree of natural deterioration in macroinvertebrate communities normally found in a downstream direction, over such a distance.

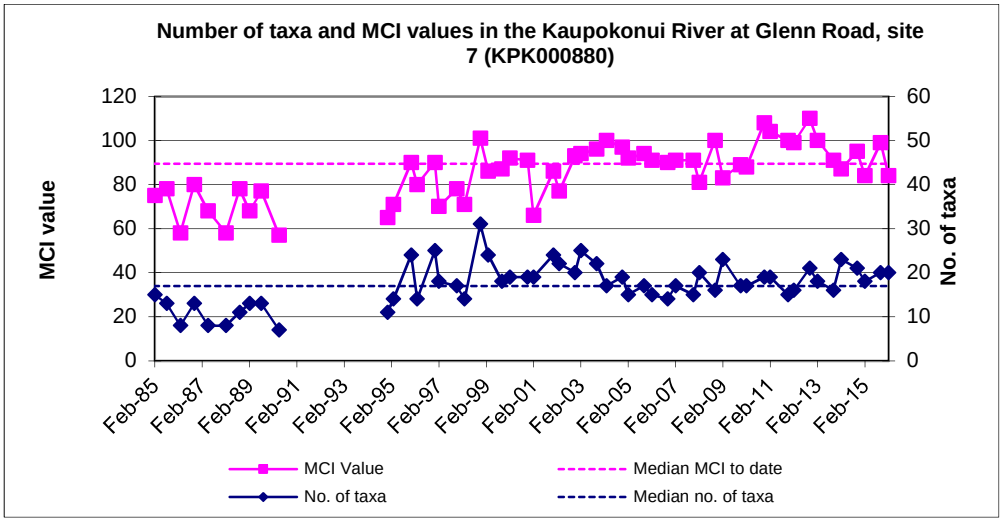

Figure 7 Numbers of taxa and MCI values recorded at site 7 in the Kaupokonui River, since February 1985

The proportion of 'tolerant' taxa (55% of taxa number) increased from that recorded in the previous spring (2015) survey and resulted in a decreased MCI score of 84 units. This score was eight units lower than the median of scores since 1998, and six units lower than the historic median at this site (Table 2, Figure 7), neither of which was a statistically significant difference (Stark, 1998). However, this indicates some deterioration in community health, being equal to the lowest score recorded over the last thirteen surveys (Figure 7). This is likely to be a direct reflection of the long period of low flows that preceded this survey, accompanied with warm water temperatures. Just downstream of this site, water temperatures as warm as 27.9˚C were recorded in the month prior to this survey. The current MCI score was eleven units less than that recorded at site 6, some 9 km upstream, a statistically significant result (Stark, 1998). This reduction indicated deterioration on that recorded in the previous survey. It in part reflects the natural downstream deterioration typical of ringplain streams and rivers, with streams and rivers at this altitude and distance from the National Park boundary typically seeing a reduction in MCI score of approximately 0.6 MCI unit/km (Stark and Fowles, 2009), but this downstream deterioration appears to have been exacerbated by the low flows.

The $SQMCI_S$ score (4.1) showed a slight increase, being 0.6 unit higher than the score at the nearest upstream site (Table 3). This change was principally due to an increased abundance of 'highly sensitive' *Deleatidium* mayfly and decreased abundances of numerous 'tolerant' taxa. Unlike the current survey there has generally been a decreasing trend in $SQMCI_S$ scores between sites 6 and 7, (especially in the summer surveys). This was usually due to the distance between the sites and the influence of the Dunns Creek tributary, which joins the river between the two sites. Occasionally, there had been little difference, due to site 6 showing impacts from the cooling water discharge. However in the current survey, there was no significant evidence of cooling water discharge influence at site 6.

Waiokura Stream

The Waiokura Stream was included in the biological monitoring programme for the first time in the 2002-2003 monitoring year, to monitor effects from irrigation of wastewater and stormwater from the Fonterra Kapuni site onto land in the Waiokura Stream catchment. The location of the irrigation areas in relation to the biological (and water quality) monitoring sites is shown in Figure 8. This was the twenty-second biological survey related to this monitoring programme conducted at the two sites in this stream and results from this survey are summarised in Table 4, with full results provided in Table 5 . No 'heterotrophic growths' were seen on the bed of the stream nor were any found microscopically (during sample processing) by this survey at either of the two sites.

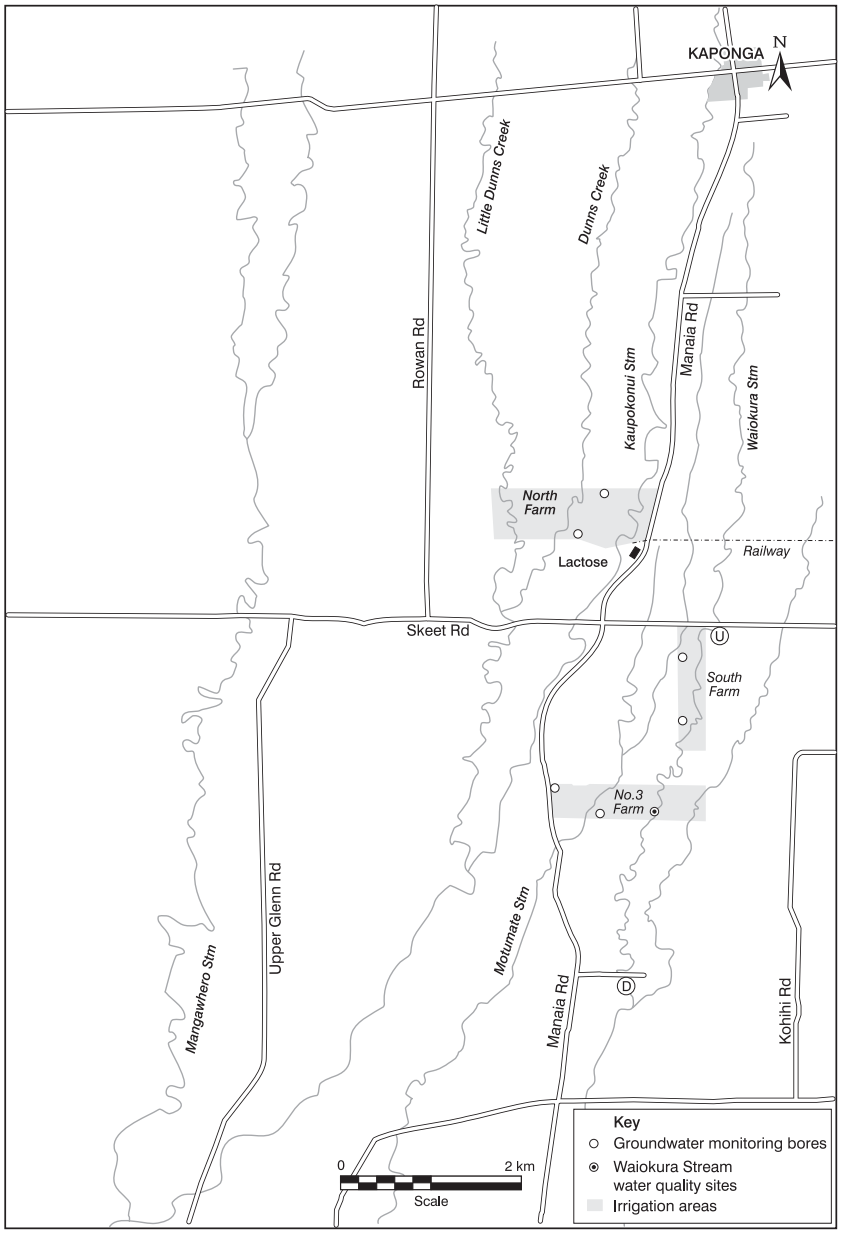

Figure 8 Waiokura Stream biomonitoring site (U and D) locations in relation to Fonterra Kapuni wastes irrigation

Table 4 Numbers of taxa and MCI values recorded previously in the Waiokura Stream, together with current results

Site	Number of previous surveys	Numbers of taxa			MCI values		
		Median	Range	Feb 2016	Median	Range	Feb 2016
U	21	23	18-29	29	99	88-114	99
D	14	23	15-27	27	92	81-103	91

Table 5 Macroinvertebrate fauna of the Waiokura Stream in relation to Fonterra, Kapuni land irrigation of wastes, sampled on 09 February 2016

Taxa List	Site Number	MCI score	U	D
	Site Code		WKR000500	WKR000650
	Sample Number		FWB16049	FWB16050
NEMATODA	Nematoda	3	R	-
ANNELIDA (WORMS)	Oligochaeta	1	R	R
MOLLUSCA	*Potamopyrgus*	4	C	XA
	Sphaeriidae	3	-	R
CRUSTACEA	Ostracoda	1	R	C
	Paracalliope	5	R	A
	Paraleptamphopidae	5	A	C
	Paranephrops	5	R	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	XA	XA
	Coloburiscus	7	C	R
	Deleatidium	8	R	-
	Zephlebia group	7	VA	VA
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	R	R
COLEOPTERA (BEETLES)	Elmidae	6	A	VA
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	A	A
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	VA	VA
	Hydrobiosis	5	C	C
	Hydropsyche (Orthopsyche)	9	R	-
	Psilochorema	6	R	C
	Hudsonema	6	-	C
	Oeconesidae	5	-	R
	Oxyethira	2	R	R
	Pycnocentria	7	C	VA
	Pycnocentrodes	5	-	C
	Triplectides	5	R	-
DIPTERA (TRUE FLIES)	*Aphrophila*	5	R	-
	Eriopterini	5	R	-
	Harrisius	6	R	-
	Orthocladiinae	2	-	R
	Polypedilum	3	C	-
	Tanytarsini	3	R	R
	Muscidae	3	-	R
	Austrosimulium	3	A	C
	Tanyderidae	4	R	R
ACARINA (MITES)	Acarina	5	R	R
		No of taxa	29	27
		MCI	99	91
		SQMCIs	6.4	5.6
		EPT (taxa)	11	11
		%EPT (taxa)	38	41

'Tolerant' taxa | 'Moderately sensitive' taxa | 'Highly sensitive' taxa

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Site U (WKR000500)

A moderately high richness of twenty-nine taxa was recorded at site U, upstream of the Fonterra wastes irrigation areas. This number of taxa was six taxa higher than the median richness of the previous surveys undertaken at this site (Table 4). The community was characterised by no 'highly sensitive' taxa; five 'moderately sensitive' taxa [mayflies (*Austroclima* and *Zephlebia* group), elmid beetles , dobsonfly (*Archichauliodes*) and amphipod (Paraleptamphopidae)]; and two 'tolerant' taxa [net-spinning caddisfly (*Hydropsyche-Aoteapsyche*) and black fly larvae (*Austrosimulium*)] (Table 5).

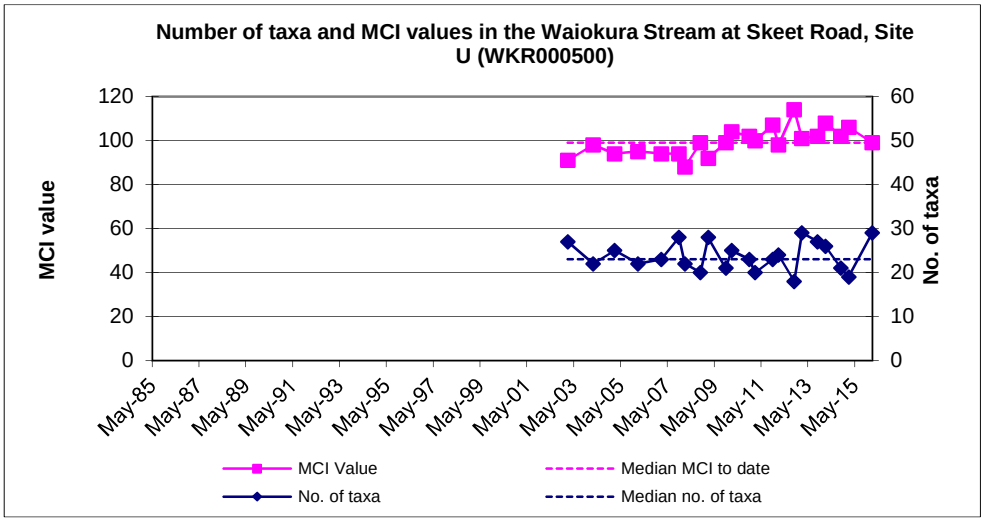

Figure 9 Numbers of taxa and MCI values recorded at site U in the Waiokura Stream since February 1985

The MCI value of 99 units was seven units lower than that recorded by the previous spring (2015) survey, but the same as the median of previous values recorded from the twenty-one previous surveys at this site (Table 5, Figure 9). This score reflected the moderate proportion of 'tolerant' taxa (34% of taxa richness) in the community (Table 5). The Waiokura Stream rises below the National Park boundary and the site at Skeet Road (site U) is in the mid-reaches at an altitude of 150 m asl. A relationship for ringplain streams developed between MCI and site altitude (Stark and Fowles, 2009), predicts a MCI value of 100 units for this site. The historical site median and current MCI score of 99 units is one unit below this altitude prediction. The $SQMCI_s$ score of 6.4 units was the highest score recorded at this site to date and reflected the dominance of several 'sensitive' taxa and two mayflies in particular (Table 5).

Site D (WKR000650)

A moderate richness of twenty-seven taxa was recorded at this site downstream of the wastes irrigation areas in the Waiokura Stream catchment. This was relatively similar to that recorded at site U and was four taxa higher than the median taxa number previously recorded at this downstream site (Table 2). The community was characterised by no 'highly sensitive' taxa; six 'moderately sensitive' taxa [*Paracalliope* amphipods, mayflies (*Austroclima* and *Zephlebia* group), elmid beetles, dobsonfly (*Archichauliodes*) and sandy cased caddis (*Pycnocentria*)]; and two 'tolerant' taxa [snail (*Potamopyrgus*) and net-spinning caddisfly (*Hydropsyche-Aoteapsyche*)] (Table 5). There were six significant changes in taxa abundances between site U and D, coincident with a significant change in habitat including an increase in periphyton and macrophytes at site D.

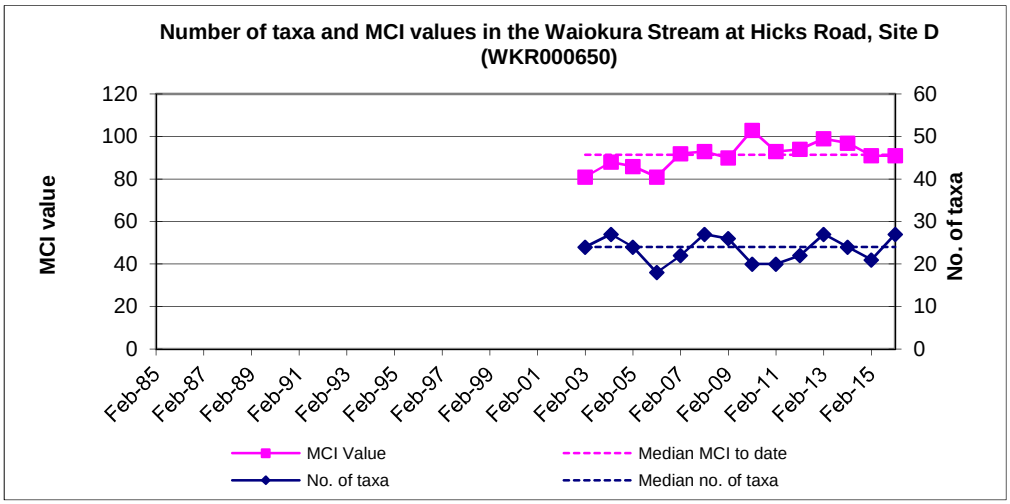

Figure 10 Numbers of taxa and MCI values recorded at site D in the Waiokura Stream since February 1985

A moderate proportion of 'tolerant' taxa (41% of taxa richness) was present at this site, which was reflected in the MCI value of 91 units. This score was the same as that recorded by the previous summer (2015) survey, and was similar to the median of the fourteen previous surveys performed at this site (Table 5 and Figure 8). The MCI score was eight units less than that recorded upstream at site, which is an insignificant difference (Stark, 1998). This decrease in MCI score is not considered to be due to the irrigation of wastes from the Fonterra factory. The primary drivers behind this drop in MCI score are considered to be the distance between sites U and D and the marked habitat differences between sites, especially the predominance of macrophytes at site D.

Despite six significant changes in individual taxon abundances between the sites, the $SQMCI_s$ score remained within 0.8 unit of the score at site U, upstream of the irrigation areas (Table 5). As the main change in MCI scores was attributable to differences in habitat between the two sites, the relative similarity in community structure indicated that wastes discharged from the Fonterra Kapuni site on to land in the Waiokura Stream catchment had not had a recent detrimental effect on the biological health of this stream.

Summary and Conclusions

The Council's standard 'kick-sampling' technique was used to collect streambed macroinvertebrates from five sites in the Kaupokonui River and two sites in the Waiokura Stream on 09 February 2016. Samples were sorted and identified to provide the number of taxa (richness), MCI and $SQMCI_s$ scores for each site. The samples were also microscopically scanned to determine the presence or absence of any mats, plumes or dense growths of bacteria, fungi or protozoa ("undesirable biological growths").

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.

In the Kaupokonui River, taxa richnesses were all slightly higher than historical median richnesses, while MCI scores indicated 'good' to 'fair' community health at all sites. MCI scores generally declined in a downstream direction, but largely to the degree expected, likely related to the progressive deterioration typical of Taranaki's ringplain streams and rivers. In the case of the current survey however, this progressive deterioration had been exacerbated by the long period of stable flows that preceded this survey. The MCI score at the upper site 3b was the same as the historical median score, while the MCI scores at site 4 and 5 were lower than their historical medians. Site 6 was the only site to record an MCI score higher than its historical median. The significant decreases in MCI and $SQMCI_S$ scores recorded between sites 3b and 4 were a possible indication that the community had been recently adversely affected by land irrigation upstream of this site, however may also be attributed to the impacts of dairy shed wastes assimilation in the receiving waters of the inflowing tributary a short distance upstream of site 4. The current survey showed that the Kaupokonui River generally has macroinvertebrate communities of 'fair' health throughout most of the reach surveyed. The poorest community, found at site 7, was indicative of possible influence from the Dunns Creek tributary within the reach between sites 6 and 7 however was also a reflection of a natural progressive downstream deterioration that was exacerbated by low flows.

It may be concluded that the factory's cooling water discharges had not resulted in significant adverse effects on the macroinvertebrate communities, although the communities appeared in slightly worse condition than that recorded in the previous spring survey, a relatively typical result. The current survey did not record the presence of sewage fungus or blood worm midges, indicating that the poor quality cooling water discharge that had been occurring prior to the spring 2014 survey had ceased.

MCI values indicated in general that macroinvertebrate communities were mainly in 'fair' health, being below median MCI scores from surveys conducted since 1998, perhaps a reflection of the extended period of low flow that preceded this survey, and the related algal proliferation. Similarities in community composition, including the characteristic taxa, were generally consistent for all sites, although there were some additions at sites 6 and 7, further downstream. The deterioration in MCI score recorded between sites 6 and 7 (in the lower reaches), was a statistically significant result. As with the previous surveys, it is considered that this is due to progressive deterioration in communities in a downstream direction, typical of Taranaki ringplain rivers and streams, but in this case was exacerbated by the preceding low flows.

The trend of improvement in communities noted in recent years adjacent to the factory has generally continued to be recorded by this survey, following a break in the trend recorded by the February 2008 survey, which recorded the additional presence of 'undesirable heterotrophic growths' on the streambed. The spring 2010 survey also recorded such growths at two sites, although only subtle impacts on the macroinvertebrate communities were found. Such growths were again recorded in the spring 2014 survey, but not in the current survey.

The Waiokura Stream communities indicated that conditions during this survey were fairly typical when compared with previous surveys at these two sites to date. The MCI value recorded at the downstream site was slightly less than that recorded upstream, although this can be attributed largely to the distance between the sites and the marked habitat differences between sites, especially the predominance of macrophytes at site D, rather than to any

effects from the application of wastes to land from the Fonterra factory. This conclusion is supported by the $SQMCI_S$ scores, which were not significantly different to one another. There were some subtle changes in macroinvertebrate community compositions between the sites which were associated with differences in habitat, principally an increase in macrophytes and periphyton at the downstream site. These community differences were insignificant and not indicative of recent impacts of wastewater irrigation within the Waiokura Stream catchment.

References

Dunning KJ, 2002a: Biomonitoring of the Kaupokonui River, in relation to the Lactose Co NZ Ltd farm and factory, December 2001. TRC report KD90.

Dunning KJ, 2002b: Biomonitoring of the Kaupokonui River, and the Motumate Stream in relation to the Lactose Co NZ Ltd farm and factory, March 2002. TRC report KD128.

Dunning KJ, 2002c: Biomonitoring of the Kaupokonui River in relation to the FONTERRA Kapuni farm and factory, November 2002. TRC report KD138.

Fowles CR, 2003: Biomonitoring of sites in the Waiokura Stream in relation to the irrigation of lactose production wastes from the NZMP Kapuni factory, February 2003.

Fowles CR, & Colgan B, 2004a: Biomonitoring of the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, March 2004. TRC report CF335.

Fowles CR, & Colgan B, 2004b: Biomonitoring of sites in the Waiokura Stream in relation to the land irrigation of lactose production wastes from the Fonterra Kapuni factory, March 2004. TRC report CF328.

Fowles CR, & Jansma B, 2008a: Biomonitoring of sites in the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, November 2007. TRC report CF461.

Fowles CR, & Jansma B, 2008b: Biomonitoring of sites in the Kaupokonui River and the Waiokura Stream in relation to the Fonterra Kapuni farm and factory, February 2009. TRC report CF463.

Fowles CR, & Jansma B, 2014a: Biomonitoring of sites in the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, November 2013. TRC report CF627.

Fowles CR, & Jansma B, 2014b: Biomonitoring of the Kaupokonui River and Waiokura Stream in relation to the Fonterra Kapuni farm and factory, February 2014. TRC report CF628.

Hope KJ, 2005: Biomonitoring of the Kaupokonui River and Waiokura Stream in relation to the Fonterra Kapuni farm and factory, February 2005. TRC report KH037.

Hope KJ, 2006a: Biomonitoring of the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, October 2005. TRC report KH055.

Hope KJ, 2006b: Biomonitoring of the Kaupokonui River and Waiokura Stream in relation to the Fonterra Kapuni farm and factory, February 2006. TRC report KH079.

Jansma B, 2007: Biomonitoring of the Kaupokonui River and Waiokura Stream in relation to the Fonterra Kapuni farm and factory, February 2007. TRC report BJ032.

Jansma B, 2009a: Biomonitoring of sites in the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, October 2008. TRC report BJ057.

Jansma B, 2009b: Biomonitoring of sites in the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, February 2009. TRC report BJ058.

Jansma B, 2010a: Biomonitoring of sites in the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, November 2009. TRC report BJ122.

Jansma B, 2010b: Biomonitoring of the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, February 2010. TRC report BJ123.

Jansma B, 2011a: Biomonitoring of the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, November 2010. TRC report BJ165.

Jansma B, 2011b: Biomonitoring of the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, February 2011. TRC report BJ166.

Jansma B, 2013a: Biomonitoring of the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, November 2011. TRC report BJ181.

Jansma B, 2013b: Biomonitoring of the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, February 2012. TRC report BJ182.

Jansma B, 2014a: Biomonitoring of the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, October 2012. TRC report BJ227.

Jansma B, 2014b: Biomonitoring of the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, February 2013. TRC report BJ228.

Jansma B, 2015: Biomonitoring of the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, October 2014. TRC report BJ255.

Jansma B and Hope KJ, 2007: Biomonitoring of the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, October 2006. TRC report KH090.

Moore SC, 2003: Biomonitoring of the Kaupokonui River, in relation to the NZMP Kapuni farm and factory, February 2003. TRC report SM584.

Moore SC, 2004: Biomonitoring of the Kaupokonui River, in relation to the NZMP Kapuni farm and factory, October 2003. TRC report SM590.

Stark JD, 1985: A macroinvertebrate community index of water quality for stony streams. *Water and Soil* Miscellaneous Publication No. 87.

Stark JD, 1998: SQMCI: a biotic index for freshwater macroinvertebrate coded abundance data. *New Zealand Journal of Marine and Freshwater Research 32(1*): 55-66.

Stark JD, 1999: An evaluation of TRC's SQMCI biomonitoring index. Cawthron Institute, Nelson. Cawthron Report No. 472.

Stark JD, Boothroyd IKG, Harding JS, Maxted JR, Scarsbrook MR, 2001: Protocols for sampling macroinvertebrates in wadeable streams. New Zealand Macroinvertebrate Working Group Report No. 1. Prepared for the Ministry for the Environment. Sustainable Management Fund Project No. 5103. 57p.

Stark, JD and Fowles, CR, 2009: Relationships between MCI, site altitude, and distance from source for Taranaki ring plain streams. Stark Environmental Report No 2009-01 47pp.

Thomas BR, 2016: Biomonitoring of the Kaupokonui River in relation to the Fonterra Kapuni farm and factory, October 2015. TRC report BT061.

TRC, 1999: Some statistics from the Taranaki Regional Council database (FWB) of freshwater macroinvertebrate surveys performed during the period from January 1980 to 31 December 1988, (SEM reference report). TRC Technical Report 99-17.

TRC, 2015: Freshwater Macroinvertebrate Fauna Biological Monitoring Programme Annual State of the Environment Monitoring Report 2013-2014. TRC Technical Report 2014-20.